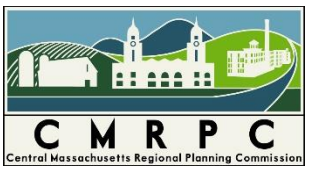

TOWN OF WARREN

2022 Hazard Mitigation Plan (HMP) & Municipal Vulnerability Preparedness (MVP) Plan

Prepared by the Local Hazard Mitigation Team
Town of Warren, Massachusetts

&

The Central Massachusetts Regional Planning Commission
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Worcester, MA 01604
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ACKNOWLEDGEMENTS

This Hazard Mitigation Plan (HMP) update, Municipal Vulnerability Preparedness (MVP) planning process, and Community Resiliency Building Workshop was funded by the Massachusetts Executive Office of Energy and Environmental Affairs (EEA). This report and the CRB Workshop were prepared for the community of Warren by the Central Massachusetts Regional Planning Commission (CMRPC).

The Warren Board of Selectmen extends its thanks to participants in the HMP and MVP Core Project Team for their time and hard work in participating in this project. Core Team members include, but are not limited to:

Adam Lavoie, Warren Fire Chief

Carol Sanders-Sausville, Warren Water District Commissioner Administrator, Member of Community Advisory Committee

Jeremy Olson, Highway Surveyor, Member of Community Advisory Committee (MVP Core Team Leader)

Jim McKeon, Warren Emergency Management Director

Jim Ferrera, Warren Town Administrator

Joyce Eichacker, Member of Conservation Commission

Rich Eichacker, Member of Board of Selectmen, Member of Community Advisory Committee

Sharon Meli, Senior Center Director

Sue Ramsey, Parks and Recreation Commissioner

In addition, thanks are extended to the staff of the Central Massachusetts Regional Planning Commission for process facilitation and preparation of this document:

Mary Hannah Smith, Associate Planner

Chris Dunphy, Principal Planner

Sarah Plutnicki, Intern

Matthew Franz, GIS Analyst

Thanks are also due to the Executive Office of Energy and Environmental Affairs (EEA) and the Massachusetts Emergency Management Agency (MEMA) for guidance and feedback regarding this plan. Specific thanks to the following individuals for their help throughout this planning process:

Andrew Smith, MVP Greater Connecticut River Valley Coordinator, EEA

Jeff Zukowski, Hazard Mitigation Planner, MEMA

EXECUTIVE SUMMARY

The following plan documents Warren's assessment of its natural hazards, risks to the town posed by climate change, and actions that the Town can take to reduce its vulnerability to natural hazards and adapt to climate change. Through the Municipal Vulnerability Preparedness (MVP) program and the Hazard Mitigation Planning (HMP) process, Warren has completed an assessment of town vulnerabilities and an action plan to address these challenges, which was informed by community outreach and community stakeholders. As a result of completing this plan, Warren is eligible to apply for hazard mitigation funding through the Federal Emergency Management Agency (FEMA) and climate adaptation funding through the MVP Action Grant program.

Planning Process

Warren began working on this plan in October 2021. The planning process consisted of:

1. Assembling a Core Project Team of municipal staff who led the process, developed the public survey, advertised opportunities for community input, provided detailed information on municipal activities, and organized the Community Resilience Building workshop.
2. Developing and publicizing a public survey to solicit community opinions on climate change in Warren.
3. Hosting the Community Resilience Building workshop to engage community stakeholders in the planning process. At this workshop, 24 stakeholders assessed community vulnerabilities and strengths and developed an action plan to build community resilience to natural hazards and climate change.
4. Updating the list of hazards, critical facilities, and vulnerable populations from the 2019 HMP.
5. Finalizing the prioritized action plan and implementation strategy.
6. Inviting public comments on the final plan document.

Vulnerability and Risk

The Warren Core Team identified extreme temperatures, flooding, severe storms (thunderstorms, wind, and tornados), and severe winter storms (snowstorms, ice storms, nor'easters), as the four hazards that are likely to pose the most risk to the town. This plan also assesses the town's vulnerability to wildfires, earthquakes, dam failure, drought, and landslides.

Warren's Hazard Mitigation Strategy

The hazard mitigation strategy captured in the action plan contains over 20 actions that the Town would like to complete during the next five years to build community resilience. These actions address, and are described by, the following plan objectives:

- Address current stormwater drainage issues and proactively incorporate resilience to extreme precipitation

- Address roadway erosion and maintenance issues and proactively incorporate resilience to extreme precipitation
- Protect the natural environment and ecosystem services
- Maintain and improve flood mitigation infrastructure
- Ensure hazard mitigation and emergency preparedness is an ongoing community process
- Ensure availability of water for fire suppression
- Maintain readiness and response capacities of Warren's emergency services
- Protect the natural environment and ecosystem services
- Protect water quality and public health
- Reduce power outages
- Support community quality of life
- Undertake other actions that build community resilience to climate change and natural hazards

The plan includes one or more specific actions for each of the town's objectives. The following actions were designated the highest priority for the town to mitigate natural hazards or foster community climate resilience:

- Replace the culvert at Old West Brookfield Road and pursue grant funding to pay for this improvement
- Upsize culvert on O'Neil Road, rebuild roadbed, and ensure culvert can handle beaver activity and potential blockages
- Develop comprehensive town-wide plan to prioritize stormwater improvements
- Modernize drainage infrastructure that channels Comins Pond spillway water through downtown Warren and through CSX overpass bridge
- Develop solution to address heavy runoff coming off of Coy Hill
- Present cost/benefit analysis of changing road salting practices to town decision makers
- Study regulatory solutions to prevent new development from making stormwater runoff worse
- Find funding to repair the Pulaski Bridge at South Street, an identified evacuation route.
- Continue to pursue funding to mitigate stormwater runoff on Lower Reed Street through drainage installation; Mitigation will stop the roadway from being shut down during heavy storms
- Continue hand pulling effort at Lucy Stone Park to manage invasive vegetation, and use town communication channels to promote this volunteer project
- Bring Wrights Mill Levee into compliance with Army Corps of Engineers
- Provide letters of support as needed to help West Brookfield's efforts to upgrade dam infrastructure at the Lake Wickaboag
- Develop solution to prevent reeds and debris from blocking Comins Pond spillway
- Improve signage for evacuation routes

- Make municipal vulnerability preparedness a regular line item of the Warren Community Development Committee, which will enable the ongoing review and updating of the plan
- Create and maintain a Capital Improvement Planning Committee, which will incorporate hazard mitigation and climate change into the town's capital plans
- Pursue Green Communities grant funding to improve HVAC systems in public buildings to prevent interior mold growth
- Create a systematic and prioritized plan for hazard tree removal in consultation with National Grid
- Create a prioritized list of potential hazardous waste sites that could become a future problem for the town given flooding or water level changes; Conduct a survey of historical records and DEP records to develop list; Use that list to determine whether to install monitoring wells
- Discuss the current status of stormwater drainage with new Waste Water Treatment Facility director, including the potential for future precipitation increases given climate change

Next Steps

The Town of Warren is committed to implementing the actions outlined in this plan. Town leadership will seek funding and incorporate the projects identified in this document into ongoing work plans. The town will also strive to integrate hazard mitigation principles into future municipal plans and policy decisions. Finally, Warren will monitor, evaluate, and update the Hazard Mitigation and Municipal Vulnerability Preparedness Plan, as needed, to reflect work completed, to note changes in local priorities, and to incorporate new best practices.

1.0 INTRODUCTION

1.1 PLAN PURPOSE

This plan identifies the natural hazards facing the Town of Warren, assesses the vulnerabilities of the area's critical facilities, infrastructure, residents, and businesses, and presents recommendations to mitigate the adverse effects of typical natural hazards. This plan also incorporates how the Town of Warren must adapt to prepare for the increasing impacts of climate change.

New England weather is renowned for its mercurial and dramatic nature. Late summer hurricanes, major winter blizzards, and summer droughts are all part of the climatic atmosphere in Central Massachusetts. These occur frequently enough to be familiar scenes to residents of Warren. The intersection of these natural hazards with the built environment can transition these routine events into classified natural disasters. In addition, as climate change continues to progress, the severity and frequency of hazard risk will increase.

This planning effort has drawn on the knowledge of local municipal officials and residents. The recommendations presented in the following report are intended to be realistic and practical steps for mitigating natural hazards and preparing the community as best as possible for the effects of climate change. Implementation of these actions will translate into savings – fewer lives lost, less property destroyed, and less disruption to essential services and ecological systems.

1.2 WHAT IS A HAZARD MITIGATION PLAN?

Congress enacted the Disaster Mitigation Act of 2000 (DMA 2000) on October 10, 2000. Also known as the Stafford Act Amendments, the bill was signed into law by President Clinton on October 30, 2000, creating Public Law 106-390. The law established a national program for pre-disaster mitigation and streamlined the federal administration of disaster relief. Specific rules on the implementation of DMA 2000 were published in the Federal Register in February 2002 and required that all communities must have a Hazard Mitigation Plan (HMP) in place in order to qualify for future federal disaster mitigation grants following a Presidential disaster declaration. The Hazard Mitigation Plan emphasizes local policies or actions that can be implemented over the long-term to reduce or prevent future disaster damages caused by natural hazards.

1.3 WHAT IS A MUNICIPAL VULNERABILITY PREPAREDNESS PLAN?

In September 2016, Massachusetts Governor Baker signed Executive Order 569, directing multiple state agencies to develop and implement a statewide comprehensive climate adaptation plan with the best climate-change data available. Recognizing that many adaptation solutions are local in nature, a key commitment of Executive Order 569 is to assist local governments in completing their own assessments and resiliency plans. The Municipal Vulnerability Preparedness (MVP) Grant and Designation Program represents the first step in fulfilling this commitment.

The MVP program provides planning grants to municipalities to complete vulnerability assessments and develop action-oriented resiliency plans. Funding is used by cities and towns to hire an MVP-

certified consultant who is trained to provide technical assistance and complete a community's vulnerability assessment and resiliency plan using the Community Resilience Building Framework. Towns and cities are free to choose the consultant of their choice from a list of certified MVP providers. The Town of Warren invited the Central Massachusetts Regional Planning Commission (CMRPC) to lead them in this planning effort.

Communities that complete the MVP planning process become certified "MVP Communities" and are eligible for MVP Action Grant funding and other opportunities through the Commonwealth.

1.4 HAZARD MITIGATION AND MUNICIPAL VULNERABILITY PREPAREDNESS PLANNING IN WARREN

This plan is funded through a Fiscal Year 2022 MVP Planning Grant awarded by the Massachusetts Executive Office of Energy and Environmental Affairs. Warren has received this funding to create a Hazard Mitigation and Municipal Vulnerability Preparedness Plan. CMRPC worked with the Town of Warren to create one combined report for both Hazard Mitigation and Municipal Vulnerability Preparedness. Warren's combined HMP and MVP action plan accounts for natural hazards based on historic natural hazard data and future climate change projections. This combined plan also accounts for additional risk imposed by climate change, following the Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP) example.

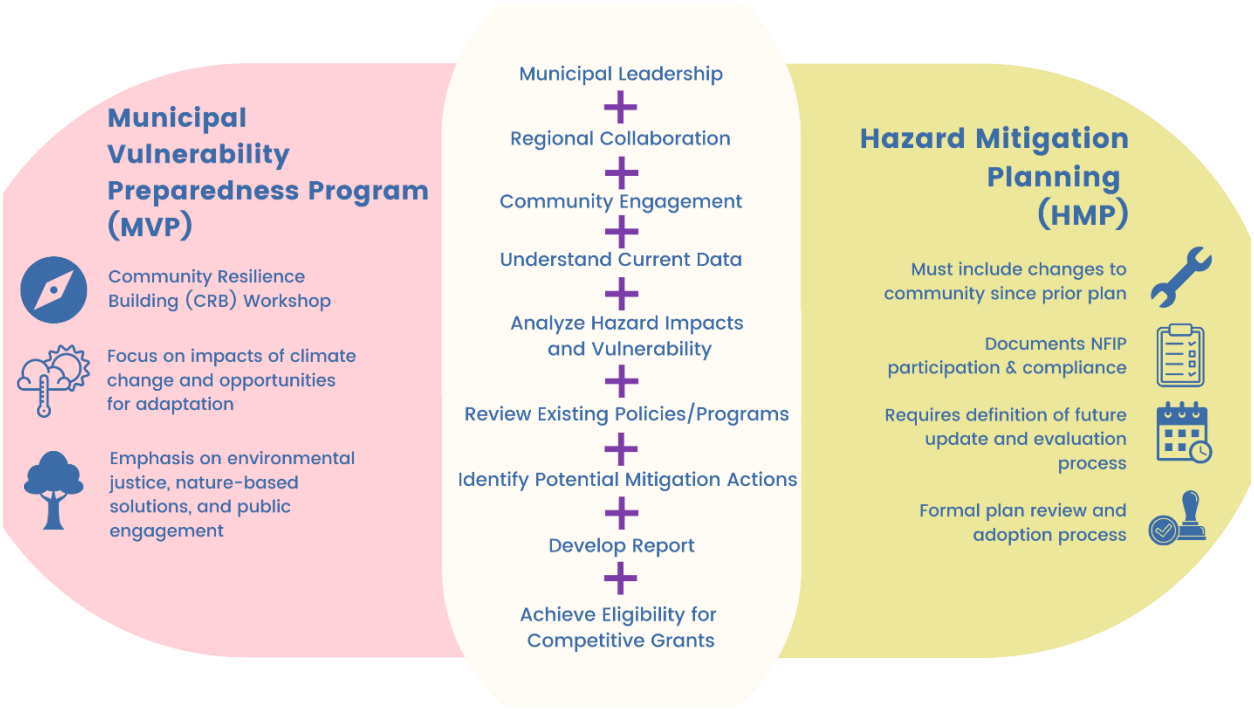


Figure 1: Similarities and differences between MVP and HMP programs.

1.5 PLANNING PROCESS SUMMARY

The planning process for Warren was composed of three distinct but connected phases – data collection and technical review, awareness, and public input and planning.

The first phase of the process was focused on outreach, public participation and input, and planning. This phase was critical to ensuring awareness of the planning process among a wide range of local officials, coordinating plan elements with other sectors of the community, and providing opportunities for public comment and input from a representative base of residents and other stakeholders in each community. CMRPC and the Warren Core Team solicited initial public opinions on natural hazards and climate change through a public survey, discussed below in Section 1.6. Next, this phase of the process included the Community Resilience Building (CRB) workshop, which brought together local stakeholders to discuss vulnerabilities in town to natural hazards and climate change.

Identification of natural hazards impacting Warren was accomplished through review of available information from various sources. These included federal and state reports and datasets, as well as existing plans. An assessment of risks and vulnerabilities was performed primarily using geographic information systems (GIS) to identify the infrastructure (critical facilities, public buildings, roads, homes, businesses, etc.) at the highest risk for being damaged by hazards, particularly flooding. Local knowledge, as imparted by town officials, staff, emergency management volunteers and other stakeholders, was also a critical element of this phase.

After completing a first draft of the plan, the Warren Core Team and CMRPC hosted a listening session to finalize the draft and solicit additional public comment. The CRB workshop helped CMRPC gauge community priorities for hazard mitigation and climate change adaptation and understand local resources and existing policies and procedures. With this information in hand, the planning team developed an informed and community-specific list of hazard mitigation and climate change adaptation strategies for Warren.

Warren sought additional MVP funding for the purpose of building on the process of creating awareness through the development of mobile tour and a video, highlighting some of the critical features identified through the previous workshops. The two-hour tour occurred on July 13, 2022, and was led members of the MVP Core Team and MVP Provider. Following an introduction at the Warren Senior Center, over a dozen residents viewed some current or projected climate impacts in the town. Areas of focus primarily included places where road and drainage infrastructure has shown to be inadequate during storm events, as well as areas overwhelmed by the release of water of failed natural dams. MVP Chairman Jeremy Olson, also the town's Highway Surveyor, detailed some of his challenges in maintaining these areas as well as reconstructing road and drainage structures that have failed. Heavy precipitation, like Warren experienced during the 2021 summer rainstorms, is becoming more common. Warren is currently planning and prioritizing stormwater drainage improvements to reduce damage to roadways from future storms. The mobile tour was also filmed and used as the primary basis for an informational video developed and to be featured on the town's web site.

The Warren core team was comprised of:

- Adam Lavoie, Warren Fire Chief
- Carol Sanders-Sausville, Warren Water District Commissioner Administrator, Member of Community Advisory Committee
- Jeremy Olson, Highway Surveyor, Member of Community Advisory Committee (MVP Core Team Leader)
- Jim McKeon, Warren Emergency Management Director
- Jim Ferrera, Warren Town Administrator
- Joyce Eichacker, Member of Conservation Commission
- Rich Eichacker, Member of Board of Selectmen, Member of Community Advisory Committee
- Sharon Meli, Senior Center Director
- Sue Ramsey, Parks and Recreation Commissioner

Other members of the core project team included:

- Mary Hannah Smith, Associate Planner, CMRPC
- Chris Dunphy, Principal Planner, CMRPC

1.6 SURVEY

In December 2021, the team created an introductory survey for the Warren HMP/MVP. This survey was intended to gauge the understanding of Warren residents' thoughts on climate change impacts and natural hazards. The survey was created and distributed using SurveyMonkey.

The survey consisted of 9 questions. The survey began by asking residents how natural hazards may have impacted their lives. The questions then asked about the larger community and for individuals to identify aspects of life in Warren that have been affected by natural hazards. The list of survey questions and the full results are in Appendix B of this report. By the time the survey closed on July 18, 2022, 139 individuals had taken in the survey. This represents 2.6% of Warren's approximately 5,200 residents, or 7.7% of approximately 1,800 households. The survey did not request demographic information, so respondents may not consist of a representative sample of the population. However, the residents that participated offered opinions on hazards and vulnerabilities, concerns about climate change, and priorities and suggestions for future climate adaptation actions. Responses focused on flooding, winter storms, and power outages.

Of the 139 responses received:

- Winter storms and thunderstorms/microbursts/extreme wind are the types of hazards that have personally impacted the most Warren residents. However, many people have not been impacted by natural hazards while living in Warren.
- Most people think that climate change will impact their life for the worst or are not sure how it will impact their life.

- There was a wide variety of specific concerns about the potential impacts of climate change. Flooding and the impacts on the water supply were common concerns.
- 62% of respondents were very concerned or somewhat concerned about climate change.
- Resident health and safety, followed by local natural resources and environment, and local infrastructure, are the Warren community assets that respondents are most concerned about in the context of potential climate impacts.
- Residents are most interested in learning more about climate change's impact on local water quality and water supply, and town budget and finances.
- A few respondents expressed skepticism about climate change in general, or the need to focus government attention on this issue.

Figure 2 below shows the approximate locations of the hazard impacts that survey respondents reported for Warren. The survey results in Appendix B of this report include several more general hazard impacts.

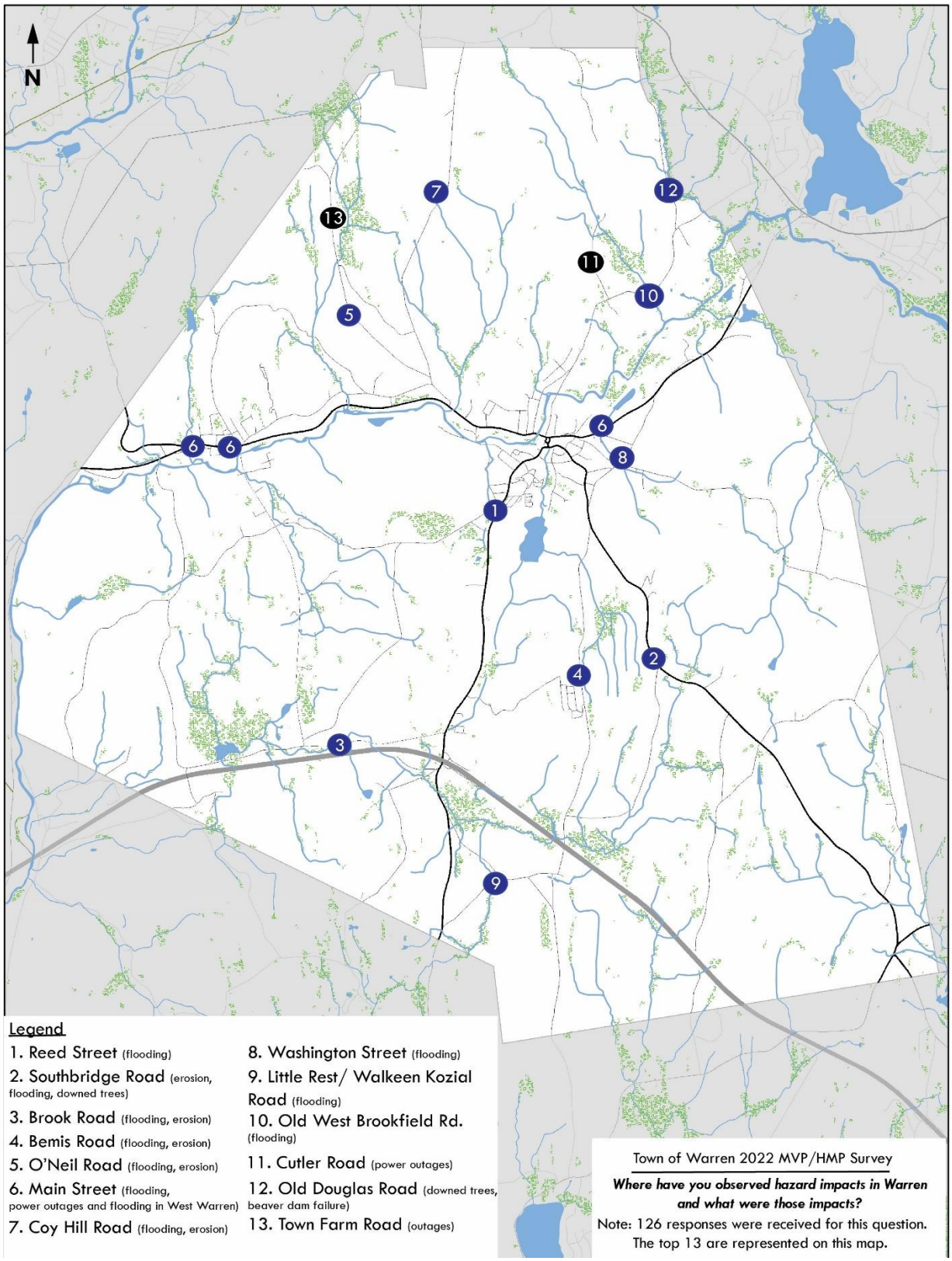


Figure 2: Top 13 responses to survey question about hazard impacts in Warren.

Survey respondents had many ideas about how the town could cultivate local resilience to natural hazards, including[1]:

More education and outreach about how climate change could impact my life and what I can do personally.

Encourage native plants and wildlife in baren areas. Preventive flooding management plans and methods for execution.

Improve culverts and small bridges.

Create community shelters for use during heat waves more education and outreach about how climate change could impact my life; costs of prevention to natural hazards.

Fix todays water runoff from hill around town, and small back roads, education, shelters, localize existing junkyards and study the impact of contamination.

Improve storm water management; shelter and food for the most vulnerable among us during extreme heat or cold; protecting the trees and forests.

Specific actions that get townspeople involved such as planting trees Things that are both constructive and educational.

Control the beaver population and remove the dams.

In no particular order: Forest Management Fire Prevention; help the farming community; more volunteer opportunities to assist the town; storm management: water quality; disaster preparedness.

Create emergency management team capable of traffic management flood mitigation backup power sources for critical infrastructure and proactive partnerships with local utilities.

Offering outreach opportunities to educate locals about climate change and the effects it may have; forecasting, and ways to combat the negative impacts.

Improve water treatment, update our sewer department and cultivate a positive investment by including the residents.

Improve road drainage; solve Spring St/Main St/Ware Rd flooding issue.

Improve drinking water supply Improve flooding of roads.

Improving storm water management is needed before any impacts of climate change as it is already a problem in Warren unrelated to climate change so I think that would be a great place to start.

Stop us from power lost and gross water.

[1] Some responses have been omitted from this list because they duplicate what has already been listed.

Trim trees on town property, clean out storm drains.

1) grant funding plan for the town part of a sustainability plan 2) bylaw protection on deforestation different from land management 3) storm water management and infrastructure rebuild (find grant money for infrastructure- need to fix or build in water retention areas or culverts to handle water loads) 4) a community Rec center would be great for education and potential shelter or municipality buildings need to be rebuilt 5) towns relationships so that we are connected and have outside response to the town if needed.

Improve water lines improve water drainage system improve tree removal around power lines.

Repair and maintain the roads.

Community shelters fir heat waves and power outages. Take down dangerous trees before they cause damage.

Make concerns of the town and its community easily accessible to everyone in many formats local newspaper for those who don't navigate the internet well and easy links on a local town site that is regularly updated along with something like a community concern portal where anyone can submit their concerns.

Better drainage including patching roadways. Cutting back of trees to limit risk of downed power lines.

community shelters during heat waves. Encourage planting of climate-resilient tree species. Composting education.

Financial incentives for sustainable energy. No more solar farms. Improve local roads and drainage.

Care packages for families who risk being trapped due to flooding and washouts: can't access resources with limited routes to/from home with known history of these hazards. Road barriers or trimming tree lines back away from roads. Seriously and fully improve infrastructure; not just patch work after the fact. Gov't assistance or programming to get AC units or oil/heating assistance for low income or health challenged families. Phone tree system for wellness checks before/during/after severe weather.

Start doing something about the beaver problem instead of ignoring it and letting it go.

Cut down dead trees, reverse 911, Walkeen Koziol rd. and others around the marshes need better planning and fixing to stop the flooding and ice hazards.

Hydroelectric plant at the dam.

Be proactive in storm prep, communication.

I have always thought we need more trees planted downtown. There are ways to grow trees on the sidewalks and not only would that help the environment, but it would really make downtown look

beautiful. How about planting a Christmas tree that can grow huge along the common. Some nice Maples in front of the gas station. Think visually about where to plant trees. Get feedback on the planting locations. Is anyone interested in an active Garden Club? We could probably get donations for trees, probably even from Walmart and Lowe's.

Save your money for a real disaster.

Definitely improve storm water management.

Extensive tree maintenance along roads and power lines. Educating community on how it impacts them. Storm water management, especially along roads.

Seek out financial resources/grants to support changes to infrastructure and sustainability.

Understand that how things impact seniors is far different than how things impact younger people. I am also still extremely concerned about some trees that surround phone trunks, electrical wires, poles, not being able to communicate with some who may need to check on elderly relatives.

Effective tree cutting program. Use of native flora for ground stabilization. Community preparedness program.

Bring in or ask informed people and/or engineers when building/repairing roads, (just because it looks good on paper, doesn't mean it's going to work,) hiring smart people, using town resources responsibly and maintaining them.

Limit town approval of the removal of large swaths of existing forest for solar projects which causes us to lose carbon storage, increases runoff etc. solar projects should be directed to area that already have no trees like old parking lots, old abandoned farmland, etc. Transition some infrastructure in town offices, schools to include solar to reduce the town's carbon footprint.

Teach the town residents to be more self-sufficient. Gardening, rain water collection, emergency preparedness, helping neighbors . . .

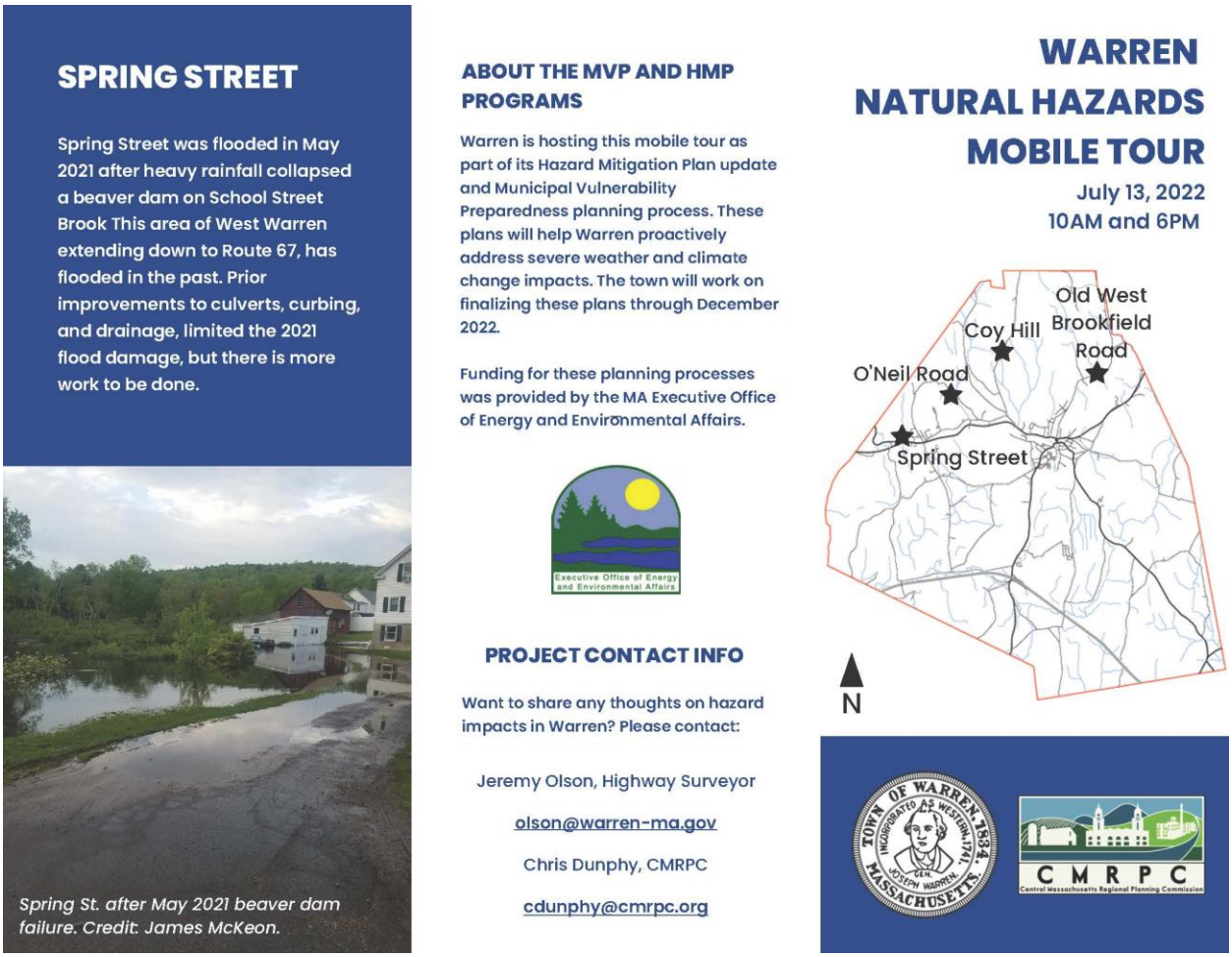
Improve the water departments. Move them from private to municipal water department.

Get more plow trucks. They do a poor job currently.

Those examples are terrific! Shelter in very important (plus transportation to get there)...? Town wide Initiatives to help to both educate and motivate the reduction of "habits" that contribute to carbon release/water overuse. Change will only happen if we can see not only what the changed habit looks like but what the results will be... (both if we don't change and if we do.)

Warren also hosted a mobile tour and created a 15-minute video to further engage residents with the planning process. The two-hour mobile tour occurred on July 13, 2022, and was led members of the MVP Core Team and MVP Provider. Following an introduction at the Warren Senior Center, over a dozen residents viewed some current or projected climate impacts in the Town. Areas of focus primarily included places where road and drainage infrastructure has shown to be inadequate during storm events, as well as areas overwhelmed by the release of water of failed natural dams.

MVP Chairman Jeremy Olson, also the town's Highway Surveyor, detailed some of his challenges in maintaining these areas as well as reconstructing road and drainage structures that have failed. Heavy precipitation, like Warren experienced during the 2021 summer rainstorms, is becoming more common. Warren is currently planning and prioritizing stormwater drainage improvements to reduce damage to roadways from future storms. The mobile tour was also filmed and used as the primary basis for an informational video developed and to be featured on the town's website.



Warren Mobile Tour Brochure, page 1.

Old West Brookfield Road flooding and erosion after July 2021 storm. Credit: Jeremy Olson.

OLD WEST BROOKFIELD ROAD

In July 2021, Old West Brookfield Road was flooded where it crosses Sullivan Brook. During this storm, the culverts underneath the road were unable to handle the volume of stormwater. Water flowed over the road and eroded the road surface.

In 2022, the Warren Highway Department was awarded funding to upgrade the culverts and reconstruct the road surface at this site.

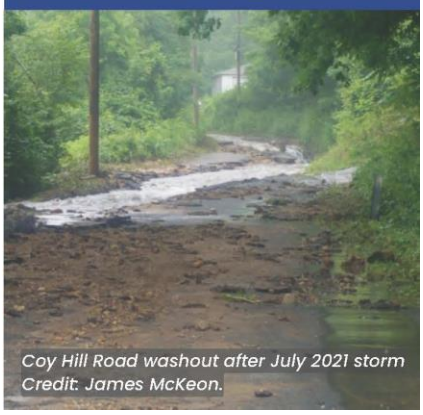
O'NEIL ROAD

A stretch of O'Neil Road below O'Neil Brook was washed out and covered in debris after a July 2021 storm. This location is downstream from a beaver dam and below a steep hillside, which could make it especially vulnerable to damage from stormwater. Increasing the culvert at O'Neil Brook and improving roadside drainage could address the flood risk at this site.

COY HILL ROAD

Coy Hill Road was also washed out during a July 2021 storm. A stretch of asphalt was eroded and other sections were covered in the debris, making the road impassible.

Heavy precipitation, like Warren experienced during the 2021 summer rainstorms, is becoming more common. Warren is currently planning and prioritizing stormwater drainage improvements to reduce damage to roadways from future storms.



Coy Hill Road washout after July 2021 storm Credit: James McKeon.

Warren Mobile Tour Brochure, page 2.

Reporters from Turley Publication's Ware River News joined for the mobile tour and subsequently published a news article featuring the climate related challenges.

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A TURLEY PUBLICATION | www.turley.com
www.wareriverews.turley.com

Town vulnerable to natural disasters

Driving tour highlights town's weaknesses

By Paula Ouimette
Editor
pouimette@turley.com

WARREN – The town of Warren is similar to many traditional New England towns, with a mix of rolling farmland and densely populated areas.

Surrounded by three mountain peaks, most of the people in town reside in the valley that is formed downtown and in West Warren.

Please see TOUR, page 5

Highway Surveyor and Community Development Advisory Committee Chair Jeremy Olson explains how Coy Hill and surrounding peaks can act as a funnel for rainfall.

Photo Courtesy of Jeremy Olson

Large sections of roadway were washed away during last summer's flooding.

SelectBoard and Building Commissioner discuss fire-damaged properties

By Paula Ouimette
Editor
pouimette@turley.com

WARE – Building Commissioner and Inspector Anna Marques, along with Town Counsel Nicole C

ostanzo, detailed what steps the town takes after a fire has damaged residential housing or a commercial building during a meeting of the Select Board Tuesday night.

In the event of a fire, Marques said she makes immediate contact with the property owners to assess the level of damage. Help is then offered to property owners to find contractors capable of making any necessary repairs if the building is salvageable.

Marques said the process also involves communicating with insurance companies. During that, she remains in constant contact with the property owner after the event until any and all issues are resolved, which involves either demolition of the structures on the property or repairing them to their previous condition.

When a building sustains considerable damage from a fire and the property owner does not demolish it, the town can seek an order to demolish in two ways: through the Building Commissioner if the building is found structurally unsafe or through the SelectBoard if they deem it a nuisance property.

"Each fire is unique," Marques said, and the level of damage varies with each one.

Town Counsel would be involved with either of these two options to seek demolition, Marques said.

Costanzo said the Select Board can take action to demolish under Chapter 139 by holding a hearing. They can also place liens on the property and order the owner to have the work done.

Select Board member Keith Kruckas expressed concerned about fire-damaged properties being sold and further neglected, eventually burdening the taxpayers with the cost of demolition.

"Some have not been fixed and continue to sit," he said.

Kruckas questioned why concerns about dealing with fire-damaged properties raised

Please see WARE, page 3

Article about the Mobile Tour featured on the front page of the Ware River News on July 21, 2022. The entire article can be found here:
https://www.turley.com/wareriverews/wrn_archives/WAR072122.pdf

Photo Courtesy of James McKeon

Water coming down Coy Hill cut through O'Neil Road, removing the road surface.

Photo Courtesy of James McKeon

A beaver dam breach caused flooding to this property.

Photo Courtesy of James McKeon

Brook Road also experienced severe damage from last July's flooding.

TOUR from page 9

alongside the Quaboag River.

Last July, Warren and surrounding towns received a record 15 inches of rain over three weeks, with six of those inches falling in just a three-hour span. The results were devestating to several parts of Warren's 63.2 miles of roadway, which were highlighted during a natural hazard mobile tour held last Wednesday.

The town hosted this tour as part of its Hazard Mitigation Plan update and Municipal Vulnerability Preparedness planning process.

Central Massachusetts Regional Planning Commission's Principal Planner Christopher Dunphy said the MVP grant program was created in 2017 as part of Governor Baker's Executive Order 569 and provides support for cities and towns in the commonwealth to identify climate hazards, assess vulnerabilities, and develop action plans to improve resilience to climate change.

"CMRPC has been assisting area communities with the MVP program as part of our Climate Resilience Planning efforts since the program's inception. MVP planning is required in order to seek an Action Grant," Dunphy said.

Warren intends to pursue MVP Action Grants for several projects in town, starting with insufficient culverts, he said.

The tour, led by Highway Surveyor and Community Development Advisory Committee Chair Jeremy Olson and Dunphy, was the culmination of months of meetings by the Committee to identify municipal vulnerability at five key sites when facing the impact of climate change.

A group of about 20 residents joined the tour, with transportation provided by the Council on Aging and Dunphy.

Climate change and infrastructure

"Extreme weather is something that is very obvious," Olson said, pointing out the pattern of hot, dry periods, and torrential downpours.

This creates a situation that can quickly clog or overwhelm many of the town's culverts, which were not designed to handle the volume of water that can pass through during a severe storm.

Relief for July 2021 storms

Estimated cost of repairs and rebuilding the 11 roadways damaged by the July 2021 storms was figured at $4 million plus, and figures have increased considerably over the last few months Olson said.

Photo Courtesy of Jeremy Olson

Water from the beaver pond crosses Old West Brookfield Road during severe storms in July 2021.

The town received $1.1 million through American Rescue Plan Act funds nine months after the incident, to repair the affected roads. Olson said he estimates this funding will cover the repairs of three of the 11 roads.

Old West Brookfield Road

One culvert located on a sharp bend on Old West Brookfield Road, where over a dozen beavers have made their home at Sullivan Brook needs to be replaced.

During the July 2021 storms, water from the beaver pond covered the roadway, causing major washout, almost to the centerline of the road. This resulted in the road being reduced to one lane for almost two months before repairs were made.

The 36-inch culvert is located eight feet below the road surface, with the town's natural gas line running above it. The flooding damaged the end of the culvert opposite the pond, compressing it to only 24-inches.

Repairing the culvert would not be possible, Olson said. "The pipe is too deep, too damaged, and too expensive to repair," he said.

"My biggest concern for Old West Brookfield Road is there is only a 36-inch damaged culvert responsible for draining millions of gallons of water under a very vulnerable spot in the road," Olson said. The road is a major traffic route into Warren from West Brookfield, serving as the main route for many students and faculty to get to Quaboag Reginal Middle High School, located closer to downtown Warren.

Olson also shared concerns about the natural gas line due to the condition of the culvert.

"If there was damage to the gas line that could affect hundreds of houses all over our community along with the safety of the residents that live nearby the location," he said.

In the event of a road closure, police, fire and ambulance would be greatly impacted, with lengthy detours adding critical minutes to emergency response times.

"Sometimes just a few minutes makes the difference," Olson said.

"This is a vital route in town that has to remain open," Olson said.

The damaged culvert on Old West Brookfield Road would be the first issue addressed if the town receives an Action Grant, replacing the pipe with a large box culvert, at a cost expected to reach $2.5 million.

Gilbert Road/New Reed Street

Located near the Mass Pike, Gilbert Road and New Reed Street also experiences flooding from Tufts Brook and Brook Pond, making it impassable during severe storms. A detour would add an extra 15-20 minutes of driving, making it a major concern for emergency response.

"It's more of an impact for residents," Olson said when the road is shutdown, cutting off access to hospitals and schools.

Prior to the construction of the Mass Pike, there used to be a factory at the site with a dam, which was removed to create the turnpike, Olson said.

O'Neil Road

Located at the bottom of the west side of Coy Hill, the culvert on O'Neil Road is larger than many, but it received considerable damage during the July 2021 storms.

"The water was several feet over the embankment," Olson said with it continuing to rush even after the storms had subsided.

Coy Hill Road

The highest point in town, Coy Hill reaches an elevation of 1,158 feet above sea level, comparable to nearby Southbridge and Mark's mountains.

These peaks are one the factors contributing to Warren's flooding issues, creating a funnel to the town below.

"So much water falls on these hills and all runs downhill," Olson said. "This program could address some of those issues," he said of the MVP program.

About one-third of the town's power supply is fed through Coy Hill, which is also home to a high number of snow and ice events, due to its elevation and climate.

The road is also home to an active dairy farm, and it is crucial to keep the road safe for travel, Olson said.

Spring Street

Olson brought residents to a culvert on Spring Street, which had been replaced by a large box culvert several years before. The large box culvert is also beneficial to aquatic wildlife, allowing animals to pass through freely due to its open design.

Spring Street had flooded in May 2021 after heavy rainfall caused a beaver dam to fail nearby.

Roadways and funding

Operating on a budget of $70,000 to maintain the town's roadways, Olson said there are at least 11 roads and several streets that need extensive work, and several more that are showing signs of aging.

"Culvert replacements, drainage replacements due to corroding metal pipes and crumbling concrete catch basins are a constant battle," Olson said. "So many of these roads need additional new drainage added to deal with the extreme rain events as well."

Deteriorated road surfaces are also of concern, with some road surfaces over 25 years old and past their life expectancy. "Unfortunately, with rapidly rising construction cost it is very difficult to estimate the overall costs at this time," Olson said.

The town also receives about $287,000 annually in Chapter 90 money, on average. With this money, the Highway Department tries to repair and pave one road a year, or resurface a couple of roads. "With rising cost in construction that money does not go as far as it did a few years ago. That is why additional funding through grants and other programs have become vital to keeping up with rising costs," Olson said.

MVP and grants

"Completing the MVP planning process allows a community to become eligible for MVP Action Grants and garners additional consideration for other available state grants," Dunphy said.

One vital state program is the Massachusetts One Stop for Growth program, which is described on the Mass.gov website as "a single application portal and collaborative review process of state grant programs that make targeted investments.

This process streamlines the experience for the applicant and better coordinates economic development programs and staff on engagement and grant making. By participating in this process and submitting an Expression of Interest and/or a Full Application, a project will be automatically referred to all relevant grant programs."

Dunphy said the data and information obtained through the MVP planning process is extremely useful to communities as they state their case for these grant funds.

Want to get involved?

To share any thoughts on hazard impacts in Warren, contact Olson at olson@warren-ma.gov or Dunphy at cdunphy@cmrpc.org.

The town will work on finalizing their MVP and HMP through December 2022. Funding for these planning processes was provided by the MA Executive Office of Energy and Environmental Affairs.

The remainder of the article in the Ware River News from July 21, 2022. The entire article can be found here: https://www.turley.com/wareriverneWs/wrn_archives/WAR072122.pdf

1.7 PLANNING TIMELINE

2.0 COMMUNITY PROFILE, LAND USE, AND DEVELOPMENT TRENDS

2.1 WARREN COMMUNITY PROFILE

The Central Massachusetts Regional Planning Commission (CMRPC) region occupies roughly 1,000 square miles in the southern two-thirds of Worcester County, Massachusetts. The area surrounds the City of Worcester, which is the second-largest city in Massachusetts and New England, with a population of 206,518 people as of the 2020 Decennial US Census. Nearly 588,141 people live in the CMRPC Region.

The CMRPC area is framed on the west by the Central Massachusetts uplands, on the south by Rhode Island and Connecticut, on the east by the Boston metropolitan area, and on the north by the Montachusett region in northern Worcester County. The forty-community region has been divided for planning purposes into six sub-regions, determined by shared characteristics and roadway corridors. Warren is located in the West sub-region consisting of nine towns lying within the Chicopee and Blackstone River valleys, including: Brookfield, East Brookfield, Hardwick, Leicester, New Braintree, North Brookfield, Spencer, Warren and West Brookfield. The Town is located on Route 67, and is approximately midway between Worcester and Springfield.

Massachusetts has a humid continental climate, with maritime influences increasing from northwest to southeast. According to the National Oceanic and Atmospheric Association's National Weather Service, between 2000 and 2022, nearby Sturbridge saw monthly mean temperatures ranging

from 24.9 degrees in January to 71.5 in July. Precipitation over that period averaged 48.91 inches annually, including 60.7 inches of snowfall.[2] Some 70 miles from the Atlantic coast, Warren and its neighboring communities are subject to a variety of severe weather, including hurricanes, nor'easters, thunderstorms, blizzards, as well as occasional tornados. However, as will be discussed later in this report, weather in Warren cannot be easily summarized or generalized. Weather is highly variable across town, so weather data from neighboring communities may not accurately portray the variety of weather experienced in Warren.

Today, Warren is largely a rural and residential community. Located on Route 67 and I-90, the Town is some 30 miles southwest of Worcester, 30 miles east of Springfield, and 60 miles northwest of Providence, RI. Warren lies within the Quaboag River valley and borders Ware to the southeast, Palmer to the east, Brookfield to the west, West Brookfield to the southwest and Brimfield to the north.

Warren has a total area of 27.61 square miles. The number of Warren residents grew from 4,776 in the 2000 US Census to 5,079 in the 2010 US Census. The population stands at around 5,205 individuals today, according to the 2020 US Census. According to the Central Massachusetts Regional Planning Commission's (CMRPC) Population Projections, Warren is expected to see a ~5% increase in total population over the next 20 years to ~5,600 people. Since 1990, the population of Warren has tended to grow slowly compared to surrounding towns like Palmer and Brimfield, both of which have better access to Route 9 from I-90 compared to Warren.

Warren is a predominantly white community, with 91.6% of residents identifying within that group.[3] "Other race" and "Black or African American Alone" are the two largest single-race minority groups in Warren, at 1.7% and 0.66% respectively.[4] Around 94% of the population speaks only English, while roughly 6% primarily speaks other Indo-European languages, Asian and Pacific Island languages, and Spanish.[5] Roughly 37.9% of Warren residents speak limited English.[6] Warren's median age is 37.5 years, which is slightly lower than the state-wide median age (39.6) and county-wide median age (40.2).[7]

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[2] National Weather Service data collected from 2000 through 2021 in nearby Worcester. https://www.weather.gov/wrh/Climate?wfo=box

[3] United States Census Bureau. (2020). *2020 DEC Redistricting Data: Race.* https://data.census.gov/cedsci/table?g=0600000US2502773090&y=2020

[4] Ibid.

[5] United States Census Bureau. (2020). *2020 ACS 5-Year Estimates Subject Tables: Language Spoken at Home.* https://data.census.gov/cedsci/table?t=Language%20Spoken%20at%20Home&g=0600000US2502773090&y=2020

[6] United States Census Bureau. (2020). *2020 ACS 5-Year Estimates Subject Tables: Limited English-Speaking Households.* https://data.census.gov/cedsci/table?t=Language%20Spoken%20at%20Home&g=0600000US2502773090&y=2020&tid=ACSST5Y2020.S1602

[7] United States Census Bureau. (2020). *2020 ACS 5-Year Estimates Subject Tables: Age and Sex.* https://data.census.gov/cedsci/table?t=Age%20and%20Sex&g=0600000US2502773090&y=2020

Housing costs are relatively inexpensive, with a median owner-occupied home valued at $233,800, compared to $398,800 for Massachusetts and $295,300 for Worcester county as of 2020.[8] 62.7% of occupied homes are detached single-unit houses, and the rest of the houses are townhomes or multi-unit structures.[9] At 14.5%, Warren's rental vacancy rate is much higher than the state and county vacancy rates, both at 3.3%;[10] but Warren has a much smaller proportion of units that are renter-occupied, at 26.9%, whereas 73.1% are owner-occupied units.[11] In Warren, older homes still remain highly used, with 28.2% of them being built before 1940.

Population and housing projections from the Central Massachusetts Regional Planning Commission (CMRPC) are based on the 2018 Long Range Transportation Plan. According to CMRPC, in 2030 the population is projected to increase to 5,442. The population will continue to grow to 5,559 by 2040.[12] These projections are based on expected demographic and development trends in Central Massachusetts.

2.2 SOCIETAL FEATURES

The Town of Warren is a rural bedroom community that is filled with small town New England character. Warren is known for its historic town centers, including Center Village and West Warren, as well as its mills, such as the Wrights Mill Complex in West Warren and Dean Grist Mill, (a pre-1826 industrial building). The town is also known for flood control pump design production; Warren Pumps LLC started their operations in 1897 and continues to provide municipal, industrial and commercial pump manufacturing to cities across the globe, including cities like New Orleans, Louisiana.

Today, Warren provides a library in Center Village, a Community Center and a Senior Center both in West Warren for its residents to use. Warren has one main elementary school, Warren Community Elementary School, which is part of the Quaboag Regional School District. Warren Community Elementary educates Warren residents from pre-kindergarten through sixth grade. The Quaboag Regional High School is also located in Warren.

Warren residents pride their Town on its plentiful open space and scenic beauty including working farms, library, historical war monuments, and safety, with Police and Fire Departments. Residents

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[8] United States Census Bureau. (2020). *2020 ACS 5-Year Estimates Data Profiles - Selected Housing Characteristics.* https://data.census.gov/cedsci/table?t=Housing%20Value%20and%20Purchase%20Price&g=0500000US25027&y=2020&tid=ACSDP5Y2020.DP04.

[9] Ibid.

[10] United States Census Bureau. (2020). *2020 ACS 5-Year Estimates Data Profiles: Selected Housing Characteristics.* https://data.census.gov/cedsci/table?t=Vacancy%20Rates&g=0400000US25&y=2020&tid=ACSDP5Y2020.DP04

[11] United States Census Bureau. (2020). *2020 ACS 5-Year Estimates Data Profiles: Selected Housing Characteristics.* https://data.census.gov/cedsci/table?t=Owner%2FRenter%20%28Householder%29%20Characteristics&g=0600000US2502773090&y=2020&tid=ACSDP5Y2020.DP04

[12] Central Massachusetts Regional Planning Commission. (2018). *Population Projections - Warren.* *https://www.dropbox.com/s/lb4wdkcw08n6y8g/Warren.pdf?dl=0*

can enjoy both indoor and outdoor recreation with their children at the many athletic and recreational programs at local playing fields, parks, schools and ponds.[13]

2.2.1 CRB WORKSHOP DISCUSSION OF SOCIETAL FEATURES

Community Resilience Building (CRB) workshop participants identified the features within Warren that are most likely to be impacted by climate change-related natural hazards. The breakout group discussed potentially vulnerable groups of residents, town volunteerism, and specific areas of town that may be especially vulnerable to natural hazards. There are many low-to-moderate income residents in town, including many seniors, who may lack access to transportation or may live in structures that are less resilient to extreme weather. The lack of local services like a grocery store, hospital, and bank, combined with the lack of public transportation add onto the challenges of households without private vehicles. The densely developed downtown neighborhood is believed to be especially exposed to flooding, while more sparsely populated areas like Cutler Road are vulnerable due to their isolation. Warren's mutual aid agreements with neighboring towns help Warren's emergency services and highway department maintain local services. Within Warren, the Senior Center provides a variety of services to older adults and services as the town's heating and cooling shelter. Active volunteer groups like the Community Emergency Response Team and the boy scouts pitch in when needed.

Maps 1-4 identify the numerous locations throughout Warren that are vulnerable to natural hazards or have been impacted by natural hazards in the past, including some specific areas that are not captured in the lists below.

Table 1: Societal features discussed at the Warren CRB Workshop

Strengths

- Lucy Stone Park – A recreational area that has been developed to maximize educational opportunities for nearby QRSD students and the general public.
- Senior Center – provides many local services (cooling/heating center, assists older adults with documents, hosts social gatherings).
- Communication with residents – town already has Reverse 911 system and a free town alert system (My Town Alerts) but more residents need to register. Town also has a Facebook page, a website (though it is not user-friendly for staff), town sign, cable access channel, and Senior Center newsletter.
- CERT Team – very active.
- Community spirit – town works well as a big community.
- Schools – school events are an opportunity to bring the whole town together.
- Mutual aid – police/fire have a regional agreement to answer calls in neighboring communities, as needed.

[13] Town of Warren. (2021). Warren Summer Programs 2021. https://www.warren-ma.gov/parks-recreation-commission/bulletins/warren-summer-programs-2021

Strengths

- Highway System Co-op – the Highway Department shares resources with Brimfield, West Brookfield, and Brookfield.
- Tuttles Farm/ Breezeland Orchard – local farm, provides food to local schools.
- Partnership between Park, Cemetery, and Highway Departments
- Local boy scouts – source of volunteer help. They have worked on restoration projects at Lucy Stone Park and a gate restoration at the cemetery on Apple Road.
- Local businesses – Cercore (provides pumps for naval ships) and Copart (car restorations and auctions) provide local jobs.
- Tourism/Recreation potential - Blue Trail (Quaboag River - kayaking & fishing), potential riverwalk or restaurants along Quaboag River, Wright's Mill revitalization project, walking trails (Marks Mountain), Comins Pond (swimming area - shut down in 2021 for E. Coli/invasives/large tree damage), fall foliage (not as vibrant in 2021 due to drought or lack of water)

Vulnerable features

- Downtown neighborhood – densely developed area in flood plain.
- Emergency shelters – the Senior Center was used as an evacuation center during Halloween storm in 2011. The shelter is reliant on volunteers to function, and there is some public safety concern with so many people concentrated in one place, as well as limited access if major flooding occurs.
- Evergreen Trailer Park and Heritage Association Trail Park – both are located in Central Warren. Residents are often low-income and over age 55.
- Fixed income seniors– there are several locations in town where seniors live on fixed incomes, and may be unable to adapt their living conditions to withstand extreme weather. Seniors on fixed incomes may also have trouble affording food, struggle with isolation and mental health challenges, and lack transportation.
- Housing authority (Old School House Apartments & Winthrop Terrace) – one way in to complex and no clear evacuation route for ~80 units. This is mostly senior housing and some low-income housing. Other locations include Spring Street and DDS Group Home.
- Isolated residential roads (Cutler Road, Cutler Road Extension, O'Neil Road, North Street, Coy Hill, Old West Warren Road, Town Farm Road, potentially others) – some of these roads are one-way in, one-way out, which makes them especially vulnerable to road blockages or damage. Most are in the Warren's Environmental Justice area.
- Low-Moderate income population (primarily concentrated along MA-67 corridor) – households have limited access to transportation. Specific locations: Village Centers, North Street Apartments (1 bathroom to 8 apartments)
- O'Neil Road and North Street – all private wells and septic systems, vulnerable to power outages.
- Seniors with pets – seniors with pets are unwilling to visit cooling or heating shelters because they must leave animals at home.
- Seniors, in general – vulnerable to extreme temperatures, may be unable to adapt homes to more extreme weather or to heat/cool homes. Senior citizens may be reliant on others to deal with other climate related issues. For example, removing the wasps/bees that are becoming an emerging problem in Warren (it's unknown whether this is linked to climate change).

Vulnerable features

Societal factors exacerbating Warren's vulnerabilities:

- Difficulty implementing plans – Warren has a small staff and may need professional grant writing assistance to implement projects identified in plans.
- Floodplain maps – outdated and therefore potentially inaccurate.
- Lack of grocery store– despite having several small towns in Warren, the town has no grocery store. This could make it difficult for residents without a private car to get groceries. West Brookfield has the closest food pantry.
- Lack of ambulance and nearby hospital – Warren lacks an ambulance and the nearest hospital is in Palmer. Residents rely on neighboring towns for these services.
- Limited public transit access– the Quaboag Connector runs through Warren if rides are requested, but does not have a designated time or regular route. The Senior Center has a large van that it uses to transport older adults. The existing transit options are considered a local strength but the general reliance on private vehicles in Warren is a local vulnerability.
- Reliance on volunteers – Volunteers on committees/boards fatigued (same individuals on many boards). The funding and town budget makes it difficult to replace volunteer work with paid staff.

2.3 ECONOMIC FEATURES

From its location within the historic Quaboag River Valley, to its excellent high school student-teacher ratios and comparatively lower costs of living, Warren contains many economic assets. Warren's economy has a variety of industries, but employment indicators show slower growth for the future of Warren. According to the Massachusetts Department of Unemployment Assistance, Warren contains 101 total employers.[14] This is lower than that of Warren's bordering towns, with 506 employers in Palmer, 115 in Brimfield, and 105 in West Brookfield. As of 2018 the town's largest employers are the Quaboag Regional High School (50-99 employees), Quaboag Regional School District (50-99 employees), Warren Community Elementary (50-99 employees), and Circor Naval Solutions LLC (20-49 employees).[15]

Today, the educational services, social assistance, and health care sectors employ the largest number of residents from Warren, at 22.2% of all jobs in the Town. The arts, entertainment, recreation, accommodation and food service industries take up the next largest percentage of jobs in the town, at 15.1%. Following that, the retail trade sector employs 14.8%; transportation, warehousing and utilities employ 10.7%; the professional sector employs 8.8% and manufacturing employs 8.7% of working residents in Warren.[16]

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[14] Massachusetts Department of Unemployment Assistance. (2022). *Employer Locator*. https://lmi.dua.eol.mass.gov/LMI/EmployerLocator#

[15] Massachusetts Department of Unemployment Assistance. (2022). *Largest 25 Employers in Warren*. https://lmi.dua.eol.mass.gov/LMI/LargestEmployersArea

[16] United States Census Bureau. (2020). *2020 ACS 5-Year Estimates Data Profiles - Selected Economic Characteristics*. https://data.census.gov/cedsci/table?t=Industry&g=0600000US2502773090&y=2020&tid=ACSDP5Y2020.DP03

According to the Decennial Census and the American Community Survey, the number of manufacturing jobs declined by 46% in Warren from 2000 to 2015 which shows a very stark decline for Warren's formerly prosperous industry. As of 2020, manufacturing jobs only account for 8.7% of Warren's employment.[17] At the same time during 2000 to 2015, employment in education, healthcare and social services increased by 25.8%. Alongside this decrease in manufacturing jobs, there has also been an increase in service-oriented and professional occupations. This pattern generally reflects the slow decline of manufacturing industries in Central Massachusetts and Massachusetts as a whole, as new residents with largely white-collar occupations have been moving into Central Massachusetts.

The median household annual income in Warren, at $60,616 as of 2020, is much lower than for Worcester County ($77,155) and the state ($84,385).[18] Despite a median household annual income (MHI) that is lower than state and county medians, Warren's costs of living and housing costs are comparatively lower which somewhat mitigates the lower town MHI. Warren's Equalized Valuation (EQV) as of 2020 totals $430,289,400, which is lower than 95% of the towns in Massachusetts, and the sixth lowest EQV in Worcester County.[19] The ability of the Town to pay for larger mitigation projects without outside assistance is lower than other towns in Massachusetts because of the relatively low property tax base in Warren.

2.4 INFRASTRUCTURE FEATURES

Warren's geographic location in the Quaboag River Valley has significantly shaped its industrial development. At least seven or eight dams spanned the Quaboag River when water power was being widely used across the U.S in the 19th century. The first dam in Warren was constructed near the Main Street bridge in Center Village in 1746.[20] From its earliest days of development, Warren was a town of manufacturing, fabrics and textiles. The Town was composed of mills such as the West Warren Cotton Mills and Quaboag River Mills, which mainly focused on manufacturing woolen goods, cotton and gunpowder.[21] As housing demand increased in the mid-1800s, several Warren mills built tenement and cottage housing for workers on Main Street, Furnace Hill, and Quaboag Street in Center Village, as well as adjacently to the mills themselves.[22] Fortunately, the mixture of decentralized patterns of early industrial development in Warren, (as in much of New England), and water-based power for the mills helped to concentrate a smaller population along the valley

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[17] Ibid.

[18] United States Census Bureau. (2020). *2020 ACS 5-Year Estimates Data Profiles - Selected Economic Characteristics.* *https://data.census.gov/cedsci/table?t=Income%20%28Households,%20Families,%20Individuals%29&g=0600000US2502773090&y=2020&tid=ACSDP5Y2020.DP03*

[19] Commonwealth of Massachusetts. (2020). *Equalized Valuation Report - Warren, MA.* https://dlsgateway.dor.state.ma.us/gateway/DLSPublic/LA19/ShowReport

[20] Ibid. p. 10.

[21] Massachusetts Department of Conservation and Recreation (MDCR), Central Massachusetts Regional Planning Commission (CMRPC), and North Quabbin Regional Landscape Partnership. (2008). *Massachusetts Heritage Landscape Inventory Program: Warren Reconnaissance Report*. Department of Conservation and Recreation. https://www.warren-ma.gov/sites/g/files/vyhlif3996/f/uploads/heritage_landscape_inventory.pdf p. 4.

[22] Ibid.

corridor, as compared to the urban centers located on major waterways for transportation. Thus, Warren's private and public lands have primarily remained as open space.[23] As of 2022, all of the mills in Warren have been either closed, demolished, or are awaiting redevelopment.

There are two public water districts that currently serve Warren: The Warren Water District and the West Warren Water District. Both districts serve village areas that are densely developed, as well as surrounding residential neighborhoods.[24] Water and sewer capacity is sufficient on a regional basis, but this infrastructure is in dire need of updates and repairs, especially in both of Warren's town centers.[25] The current Wastewater Treatment Plant is located in West Warren on West Main Street, and treated wastewater is discharged into the Quaboag River.[26] Currently the Warren Water District is in the process of constructing a new Wastewater Treatment Plant and the project is expected to be completed by December 31, 2022.[27]

In 1839, the addition of the Western Railroad through town led to the establishment of a depot at the southwest corner of the common in Warren's Center Village. The mixture of a railroad and exceptional water flow along the town's extent of the Quaboag River led to industrial expansion in Warren that increased into the early 20th century.[28] The railroad exported milk and cheese, apples and berries, wool and cotton textiles out of Warren and returned with other supplies, raw materials, news and salesmen.[29] CSX Transportation, the largest freight railroad company currently operating in central Massachusetts, uses the railroad to transfer commodities such as agricultural products, automobiles & auto parts, chemicals, coal, food, etc., between Albany, NY and Boston, MA.[30]

Today, Warren's primary transportation link is its Main Street via Route 67. Route 67 runs in a southwest-northeast direction through Warren from the Palmer town line to the West Brookfield town line for a total of 6.9 miles. Route 67 provides access to services such as the Fire Department and Library, as well as shopping areas and restaurants, residences and both town centers.

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[23] University of Massachusetts Amherst Project Team, The Town of Warren Open Space and Recreation Committee, The Town of Warren Master Plan Committee (MPC). (2006). *Town of Warren Open Space and Recreation Plan, March, 2006*. p. 7

[24] Town of Warren. (2022). *Infrastructure*. Town of Warren. https://www.warren-ma.gov/economic-development/pages/infrastructure#:~:text=Two%20public%20water%20districts%20serve,view%20our%20Water%20System%20Map.

[25] University of Massachusetts Amherst Project Team, The Town of Warren Master Plan Committee (MPC). (2006). *Town of Warren Master Plan Phase III Final Draft 2006*. https://www.warren-ma.gov/sites/g/files/vyhlif3996/f/uploads/wmass.pdf p. 13.

[26] Ibid. p. 76

[27] Warren Water District. (2022). *Warren Water District Homepage*. Town of Warren. http://warrenwaterdistrict.net/2601.html

[28] *Massachusetts Heritage Landscape Inventory Program: Warren Reconnaissance Report*. p. 4.

[29] Ibid. p. 10

[30] Central Massachusetts Regional Planning Committee (CMRPC). *2007 Regional Transportation Plan - VI. Regional Freight Railroad System*. http://www.cmrpc.org/sites/default/files/download/RTPSection06-RegionalFreightRailroadSystem.pdf
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Interstate-90 also runs southeast through Warren, but there is no exit for the Town of Warren. According to the 2020 U.S. Census, the average commute time for Warren residents is 35.9 minutes, compared to 30 minutes for the state of Massachusetts and 29.8 minutes for Worcester County. Thus, commute times to work are generally higher for many working-class residents living in Warren. Other minor roadways through Warren include Brimfield Road (Route 19), East Road, and Southbridge Road.

Heading east on Main Street in Warren Center, the yellow brick Town Hall that was built in 1900 can be seen on the right. This current structure replaced an older brick building that was constructed in 1878. The Police Department is located on the ground floor of the new Town Hall building and the rest of the building is vacant, as municipal departments moved to the former Elementary School (now Shepard Building) on High Street in 1993.[31] In 2001, the Warren Town Hall was listed on the National Register of Historic Places.[32] Currently Warren's Highway Department is housed on Brimfield Road.

2.4.1 CRB WORKSHOP DISCUSSION OF INFRASTRUCTURE FEATURES

Community Resilience Building (CRB) workshop participants identified the features within Warren that are most likely to be impacted by climate change-related natural hazards. Much of the discussion focused on stormwater and flooding. Undersized culverts, the lack of stormwater infrastructure on most roadways, and the towns hilly topography, contribute to the negative impacts of heavy precipitation on Warren's roads. Culverts at Old West Brookfield Road and O'Neil Road were identified as particularly vulnerable to flooding and secondary impacts from flooding. Stakeholders also discussed the Comins Pond Dam and Spillway but determined it was not a major vulnerability given the frequent inspections and proactive maintenance by the Warren Water District. However, a buried culvert that transports water from the spillway underneath the CSX railroad bridge is vulnerable since it has leaked in the past and may not be big enough to accommodate large volumes of water passing through the spillway. The Levee near Wright's Mill in West Warren is also a major concern given its role in mitigating floods, and the town's responsibility for keeping it up to code. The lack of adequate HVAC systems within public buildings, but especially the schools, was a concern given the increasing likelihood of hot, humid conditions that favor mold growth. Lastly, the Police Stations in Downtown Warren is located in the 1% annual chance flood zone and may inaccessible during severe rainstorms. Severe flooding could prevent first responders from accessing vehicles and technology stored at the station. Additional infrastructure features in Warren that were discussed at the CRB Workshop are listed in Table 2.

Maps 1-4 identify the numerous locations throughout Warren that are vulnerable to natural hazards or have been impacted by natural hazards in the past, including some specific areas that are not captured in the lists below.

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[31] Warren Planning Department. (2009). *Warren, Massachusetts 2010 Downtown Technical Assistance Application Town Hall Reuse Study*. https://www.warren-ma.gov/sites/g/files/vyhlif3996/f/uploads/ta.pdf. p. 1

[32] *Massachusetts Heritage Landscape Inventory Program: Warren Reconnaissance Report*. p. 6

Table 2: Infrastructure features discussed at the Warren CRB Workshop

Vulnerable features

- Access to fuel – the gas line ends downtown. Warren would be dependent on propane emergency generators if anything happened to the gas source.
- Bridge (MA-67 and Old Warren Road) – has been compromised by pipe work.
- Communication antennas – vulnerability to high winds due to location on hill tops. Could impact emergency communications of antennas fail during major storms. Most concerned about Coy Hill, then Southbridge Road (Seventh Day Adventist school nearby), then Mark's Mountain.
- Comins Pond – drinking water source for Warren Water District customers. The water supply is limited during droughts.
- Comins Pond Dam/Spillway – earthen dam, owned by Warren Water District and inspected every 5 years by Tighe & Bond. Spillway can get clogged with debris like cattails and Water District is working on a solution. 100-year inundation zone would flood parts of Downtown Warren and then follow the Quaboag River 100-year floodplain.
- Couture Street – this road was built through a wetland area. The road goes underwater every time it rains for a day or two (around 20 times per year).
- CSX Railway - Sparking has caused wildfires in the past and could again in the future; carries toxic chemicals, which could be an issue if the train was ever derailed. Railway seems to deal with increasing track bending/buckling (during extreme heat) and breaking (during extreme cold).
- Culverts town wide – there are many waterways with undersized culverts in Warren. Due to the town's topography, water flows rapidly downhill via small brooks so adapting to increases in precipitation requires upgrading culverts. Brook Road, Kozoil Road, and many other locations have lost culverts to flooding. Beavers exacerbate culvert issues intentionally by blocking up culverts, or unintentionally when their dams fail and release large quantities of water that has to pass through culverts.
- Culvert/pipes under railroad bridge in Downtown Warren (Rt. 19) – this infrastructure transports water from the Comins Dam spillway to the Quaboag River and directly under the railway. Past flooding has entered the bridge walls but bridge was inspected by CSX and judged to not be a problem. It is undersized for the amount of water that would flow through it if Comins Dam were to burst. A future problem with the culvert might cause flooding in Downtown Warren or compromise the integrity of the rail bridge.
- Cutler Road – steep, poor condition road with one-way in, one-way out.
- Gas stations – Citgo gas station in downtown Warren lies within the Comins Pond dam inundation zone, near the Quaboag River floodplain. The Mobil station on Main Street is also very near the 100-year flood plain.
- Lack of air conditioning in public buildings – could lead to mold and indoor air quality issues or prevent the use of some public buildings during hot summer months.
- Levees – Around the Wright's Mill. Built by Army corps in the 1960s and protect West Warren. Warren is doing a walkthrough with Army Corp very soon. The Town is responsible for maintaining levee if it is not up to code, but if under code the Army Corp would cover repairs.
- MA Turnpike (I-90) – there is no on or off ramp in Warren, though Warren's DPW department has access to a maintenance ramp. A section of the turnpike runs through Warren wetlands and is vulnerable to flooding.

Vulnerable features

- MA-67 (evacuation route) – town's only designated evacuation route. Vulnerable to flooding. Warren would have access to the Mass Pike in serious emergencies.
- Police Station - Located in a floodplain, inaccessible during severe rainstorms, has experienced major flooding in basement, may become compromised from underground river. Town is in the process of finding new public safety facility but need to identify a location out of floodplain.
- O'Neil Road culvert – undersized culvert with beaver dam upstream. Road washed out most recently during storm in 2021. Road has one-way-in and one-way-out, so road damage isolates some residences
- Old W. Brookfield Road culvert (Sullivan Brook)– Culvert is undersized and has flooded within last 10 years. Beaver dam upstream can exacerbate flooding. Road is a major commuter route and a natural gas line runs between culvert and road surface.
- Roadway stormwater drainage – most of Warren has "country" drainage system, meaning that water flows off the side of roads and into ditches or the land surrounding the road. There have been numerous road washouts where extreme precipitation events have caused stormwater to erode the side of roads, underneath roads, or cover roads in mud and debris.
- Quaboag Regional Middle/High School – the building experiences mold issues in the summer due to humidity and lack of ventilation, and the Middle School rooms may not be air conditioned. The building serves as an emergency shelter and has a generator. The school HVAC units and roof is vulnerable to wind and tree damage.
- Sewer – public private sewer system serves some residents, other have septic systems. All could be at risk during major precipitation events and contaminate water sources. The Sewage Commission is inactive and the system has old infrastructure. Waste water treatment plant is in Quaboag River 100-year floodplain in West Warren.
- Telephone and Broadband - Cellphone service poor in downtown & other areas in town, limited radio service for police. Town is working on new system, have contact list, currently lots of dead spots in town. 3 new towers will cover 98% of town.
- Warren Elementary School – built on filled wetland, vulnerable to flooding, parking lot sinking.
- Wickaboag Lake Dam – Warren is downstream from this dam on the Quaboag River. It is rated as a low hazard dam but there is concern about potential impacts on Downtown Warren.

<u>Infrastructure factors exacerbating Warren's vulnerabilities:</u>

- Brush truck availability – the Fire Department currently only has one brush truck. Another has been ordered but supply chain issues have extended the delivery date.
- Highway department challenges – faces aging equipment, rising equipment costs, and growing responsibilities as weather events become more extreme. Staff must be outside in extreme weather to deal with infrastructure issues. The Highway Department building lacks air conditioning.
- Salt on roads – corrodes roadways and drainage systems and could potentially create water quality issues. Citizens are used to driving on cleared roads, so Highway Department must use a lot of salt to meet that expectation. Ice requires significantly more salt than snow, so climate change could cause salt use to increase.

2.5 ENVIRONMENTAL FEATURES

Driving through Warren, one will find mixed farmland, scenic roads, woodlots, stony hills, pastures, ponds, and open fields, as well as a narrow valley carved by the Quaboag River. Through the Warren Open Space and Recreation Plan of 2006, the Town has worked to preserve scenic landscapes, rural land uses, historic sites and community character via active growth management, while prompting the desired denser/more concentrated residential and commercial development to achieve better management of open space, recreation and conservation amenities.[33] For the Town of Warren, some of the most important environmental features are its hills and the Quaboag River, which runs through the town center.

Warren sits within the Upper Quaboag Watershed in the North Quabbin Region, as well as the Quinebaug Watershed in the southeast corner of Warren. Warren also resides within the Quaboag River Valley, which is a key component of the Chicopee River Basin. Most of the Chicopee River basin is considered to be upland, and is also composed of rolling hills and valleys that are arranged along a North-South axis. Warren, though, can be distinguished from other New England regions by the East-West orientation of some of its hills.[34] The Quaboag River provides many ecological and social benefits for Warren, and about 7.6 miles of the river passes through the Town.[35]

Traveling through the Town, one can see the remains of dam structures from historic mills like the Warren Cotton Mills. On River Street, for example, lies the site of Dam #3 where the beautiful stonework used to channel diverted river water. The 400-foot tunnel at the dam site also diverted water from the river to the site of the mill as well, but the archway entrance to the tunnel has been filled in with debris over time. Regardless, dams like these are an important component of Warren's environment and town character.

With the benefits of plentiful water resources and adjacent rivers comes the potential for environmental contamination hazards, such as nonpoint source pollution like runoff from lawn fertilization, and eutrophication of surface water bodies.[36] Gasoline spills or other hazardous chemical spills can occur as construction of roadways, roadway maintenance and high usage of highways occurs. Because impervious surfaces do not absorb stormwater, increased development near water bodies can trigger the process of run-off into rivers. For the Town of Warren, insufficient drainage, corrosion of water pipes, poor road surfaces and outdated water and sewer lines all pose risks for future ground and surface water contamination Hazardous waste contamination from industrial sites and landfills is also a concern, and the Town actively monitors certain waste sites.

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[33] University of Massachusetts Amherst Project Team, The Town of Warren Open Space and Recreation Committee, The Town of Warren Master Plan Committee (MPC). (2006). *Town of Warren Open Space and Recreation Plan, March, 2006*. p. 3

[34] Ibid. p. 10

[35] This estimate includes the length of the river that runs along the town border with Palmer, MA.

[36] University of Massachusetts Amherst Project Team, The Town of Warren Master Plan Committee (MPC). (2006). *Town of Warren Master Plan Phase III Final Draft 2006*. https://www.warren-ma.gov/sites/g/files/vyhlif3996/f/uploads/wmass.pdf p. 42

2.5.1 CRB WORKSHOP DISCUSSION OF ENVIRONMENTAL FEATURES

Community Resilience Building (CRB) workshop participants identified the features within Warren that are most likely to be impacted by climate change-related natural hazards. The impact of increased precipitation and the potential for flooding at hazardous waste sites was noted as a major vulnerability, given the high number of old industrial sites in Warren. Participants were also concerned about tree health and the impact of climate change on this critical natural resource. Participants discussed the effects of the recent gypsy moth infestation and the likelihood that invasive pests could damage trees. Workshop attendees also discussed concerns about beaver dams causing flooding, especially when they break apart after heavy precipitation.

Table 3: Environmental features discussed at the Warren CRB Workshop

Strengths

- Conservation Department – has limited jurisdiction to build infrastructure resilience but is actively working on a new Open Space and Recreation Plan that could lead to land conservation or park improvements.
- Development opportunities – there is still a lot of developable land in Warren. This could benefit the community and local economy but the Town needs to make sure there are adequate environmental regulations in place to prevent any negative environmental impacts of future growth.

Vulnerable features

- Agriculture – there are several working farms in Warren. Changing seasonal temperatures, and unpredictable precipitation, make farming increasingly difficult. Rogers Farm did not have enough corn for cows (affected by drought). Tuttles Farm lost peach trees (affected by flooding/frost). Local farms supply schools, grocery stores, and farm stores may draw visitors to town.
- Beaver dams town-wide – certain dams have blown out during storms, creating sudden downstream floods. Dams also create wetlands upstream, which can create other water-related problems. State beaver dam legislation was cited as a problem that led to local beaver "takeover" because it limited who can touch beaver dams. Particularly problematic dams include one on Sullivan Brook north of Old West Brookfield Road, on O'Neil Brook between Town Farm Road and O'Neil Road, on School Street Brook near the Palmer Line, on Taylor Brook near Walkeen Kozoil Road. Since much of Warren is sloped, flooding can impact large areas downstream/downhill from beaver dams.
- Hazardous waste sites – there are many old mills in Warren as well as several buried waste sites (Reed Street, junkyard north of Old West Warren Road, old dump on South Street, etc.). Increased precipitation, rising groundwater, or flooding could disturb waste that would otherwise be stable, and cause chemicals to leach into surface or groundwater.
- Indoor spaces– many indoor spaces in Warren are vulnerable to mold. Some households, such as seniors on fixed incomes, may save money by not heating or cooling their homes. However, that behavior exacerbates mold growth. Public buildings are also vulnerable to mold growth and resulting indoor air quality problems (discussed in Infrastructure).

Vulnerable features

- Lucy Stone Park – much of the park is within the Quaboag River floodplain, so flooding would render some of the recreation space unusable. The park is also challenged by invasive vegetation such as phragmites, purple loosestrife, and multiflora rose.
- Ponds on private property – flooding is sometimes attributed to ponds (and associated beaver dams) in private ownership. Town is unsure how to handle this situation.
- Privately owned land around Smith Road – One individual owns a very large section of southwest Warren and the Highway Department does not have access to the private road on the property. The area has is in a special commercial zoning district and could have a large impact on environment when development.
- Public parks – all of the major parks in Warren experience flooding. One third of Lucy Stone is on flood plain (now 6 inches below bank, rise of a foot would flood-out area), Dean Park in West Warren is a wet area (fields, recreation area), sidewalks at Dean Park are collapsing due to flooding, and Cutter Park regularly floods. Flooding makes parks unusable and undermines investment made to maintain the parks.
- Reed Street junkyard – an old has impacted the water quality of nearby private wells. Some residents in the junkyard vicinity rely on bottled water.
- Surface water – vulnerable to drought. Boston Road Pond sometimes dries completely.
- Swimming areas (Comins Pond, Quaboag River at Lucy Stone Park) – bacteria levels in the water have closed Comins Pond for swimming in recent years. The river may also experience bacterial surges, and the water moves too quickly for many people to swim there safely. Public swimming areas are a popular way to cool down in the summer.
- Trees – Warren already experiences frequent tree damage and power outages during storms. Oak and Ash trees have been devastated by spongy moths in recent years and have led to many standing dead trees that are vulnerable to wind. Dead trees also fall on healthy trees, creating additional damage. The increasing number of dead trees could make the town more vulnerable to outages and forest fires. National Grid trims trees near their power lines but more trimming is always needed. The town trims trees not in the utility ROW but there is far too much tree damage to keep up with.

<u>Environmental factors exacerbating Warren's vulnerabilities:</u>

- High groundwater – some areas, even at high elevations, have very high groundwater. Warren needs trees to "hold water".
- Hilly topography – encourages runoff in some areas. Also, contributes to significantly different experiences of storms in high vs. low elevations. High elevations can receive much more snowfall. Slopes also increase the towns vulnerability to brush fires and make them more difficult to fight.
- Invasive plants and pests that may damage existing ecosystems or benefit from a changing climate – Spongy moths[37] (tree devastation), ticks, Japanese knotweed, pumpkin/squash bugs, cattails, bittersweet, mosquitos (by Dean Park). Poison ivy is also concern (though it is native to New England).
- Solar arrays – displace stormwater and cause erosion off-site. A large site in West Brookfield was attributed to the rising water table on Coy Hill. Clearcutting of solar fields may also lead to invasive bittersweet growth.

[37] *Lymantria dispar*. The prior name for this species, "gypsy moths", contained a racist term and is no longer used.

2.6 LAND USE, RECENT AND POTENTIAL DEVELOPMENT

According to digital mapping of the community, Warren contains approximately 17,686 acres of land. Most of the land in Warren is zoned for "rural use", which allows agriculture, single-family homes, some accessory residential uses, daycares, and certain public buildings by right rather than special permit. Warren also has Residential, Village, Commercial, Ground Water Protection, and Floodplain districts. A Mill Conversion Overlay District and a Major Development Overlay District cover an area near the former Wrights Mill complex and a large stretch of southwest Warren, respectively. The town's Commercial zoning district traces Route 67.

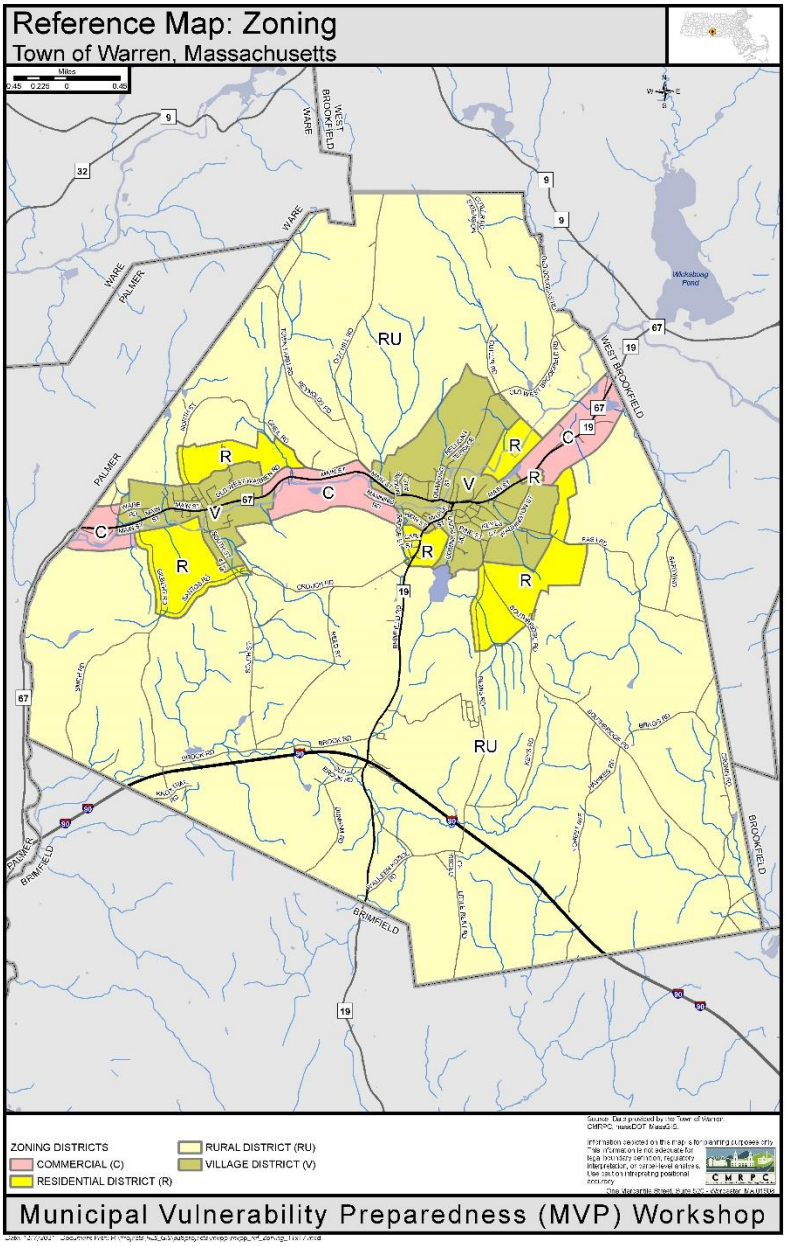

Image 1: Warren Zoning Map.

Much of Warren's existing development is clustered in the villages of Warren and West Warren. These villages are served by Warren's sewer department and two water districts, and many of Warren's local businesses and government offices are located along Route 67, which connects the two village centers. However, these population centers lie at the bottom of valleys that channel water into the Quaboag River. The 1% annual risk and .2% annual risk floodplains follow the path of the Quaboag, and the vast majority of the 50 buildings in Warren that intersect these floodplains are located near one of these two villages.

According to assessor's records from 2016 to 2020, recent development in Warren has occurred across town. Since 2019 when Warren's most recent Hazard Mitigation Plan was published, there has been new construction on 18 parcels in town with total 75.2 acres. Image # and # illustrate the location of new development in Warren. As shown in Image #, one large parcel near I-90 lies within a locally identified flood zone, and another off Coy Hill Road intersect DEP wetland and the regulated 1% annual risk[38] flood zone.

The extent recent and future development may be a greater concern than the location. One of Warren's most concerning hazards is heavy precipitation, which commonly erodes and floods road infrastructure. Increases in impervious surface due to new development could contribute additional runoff. While runoff and erosion can be mitigated with responsible landscaping and construction practices, a large influx of new buildings could compound Warren's stormwater challenges.

[38] Also called the 100-year flood zone.

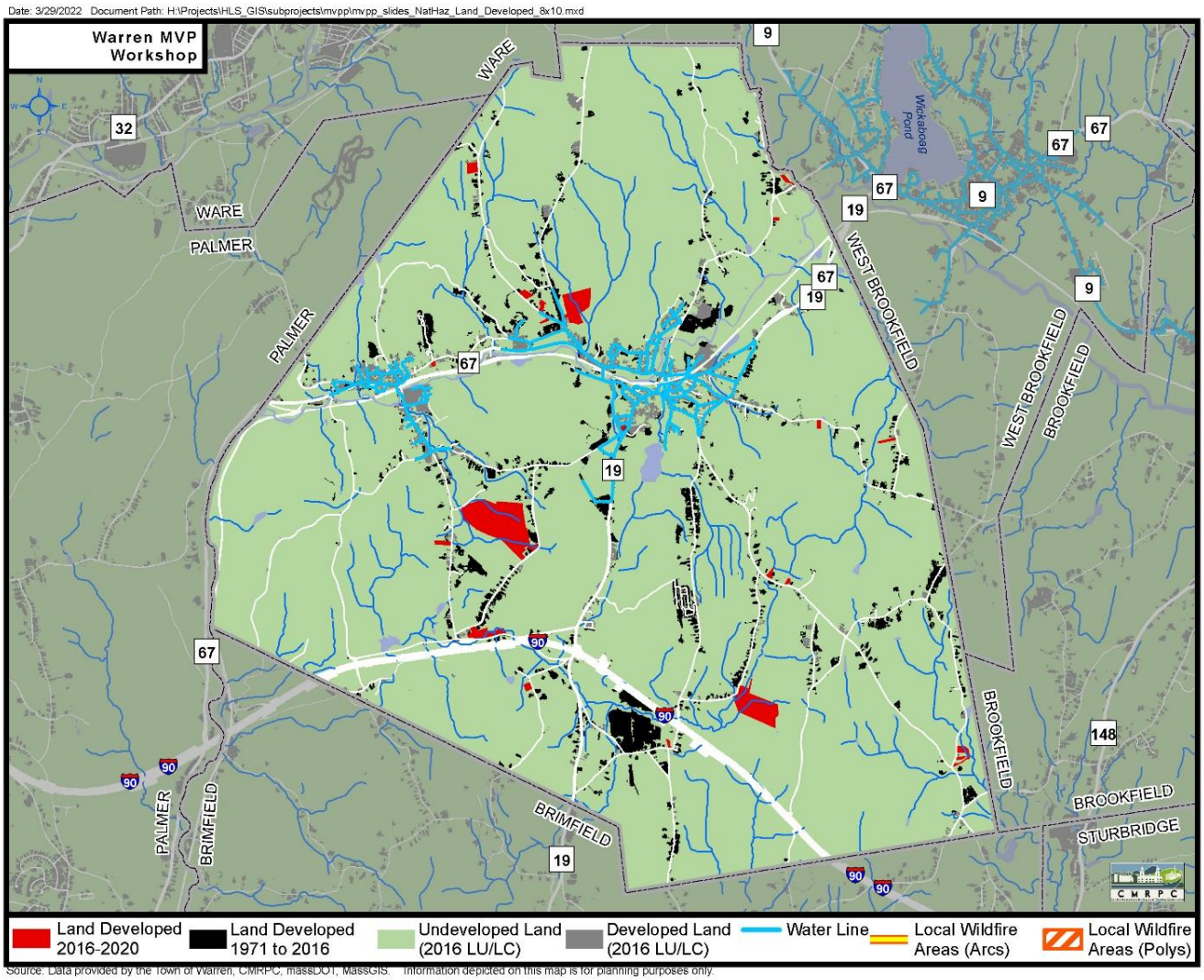

Image 2: Map of Warren development from 2016-2020.

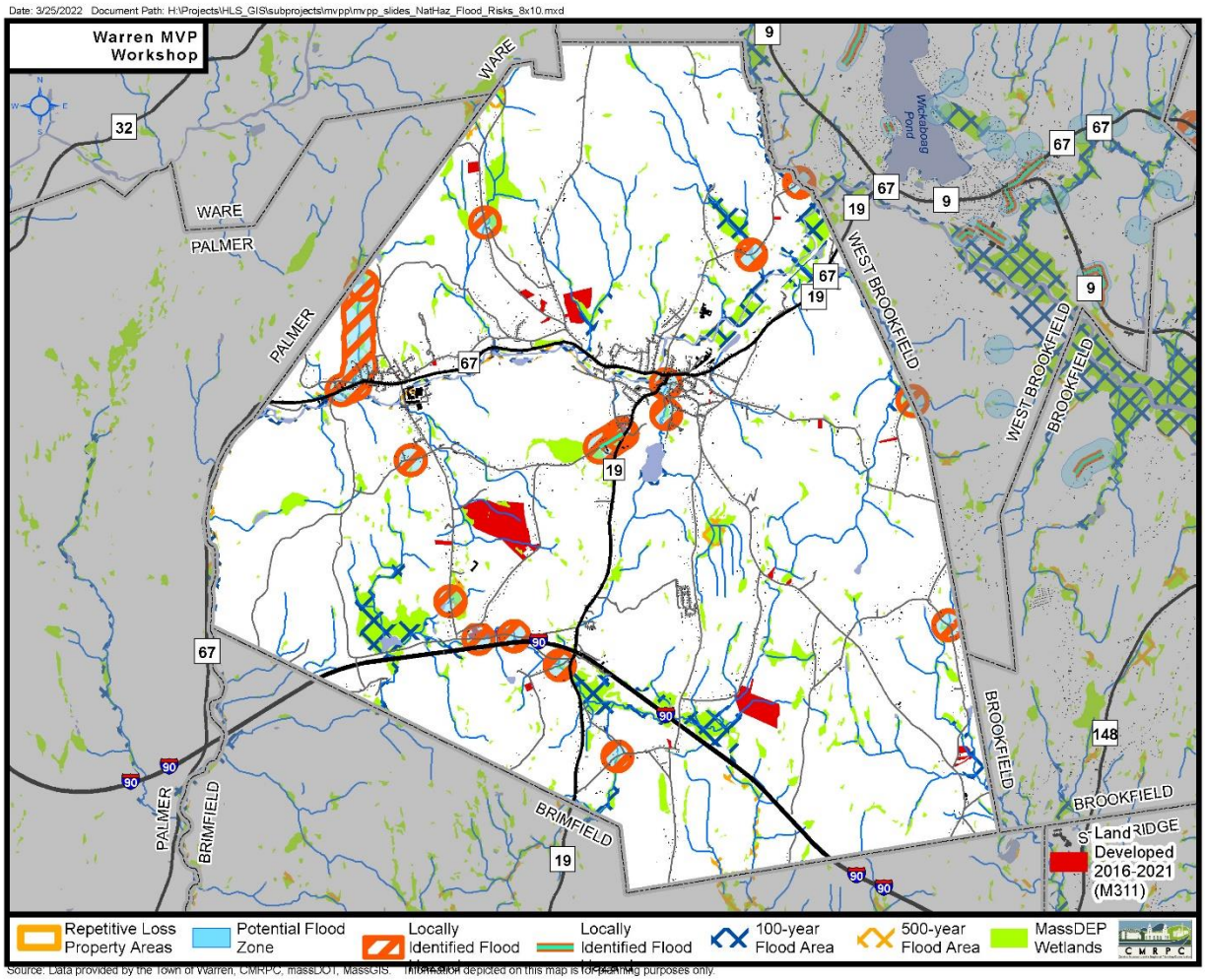

Image 3: Map of Warren development from 2016-2020 overlaid with flood zones and wetland areas.

3.0 CRITICAL FACILITIES & VULNERABLE POPULATIONS

A Critical Facility is defined as a building, structure, or location which:

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

3.1 CRITICAL FACILITIES WITHIN WARREN

The Critical Facilities List for the Town of Warren has been identified utilizing several sources, and the knowledge and expertise of the team:

- Warren's Comprehensive Emergency Management Plan
- MassGIS data
- Critical infrastructure mapping undertaken by CMRPC under contract with the Central Region Homeland Security Advisory Council, which is charged by the Executive Office of Public Safety and Security to administer and coordinate the State Homeland Security Grant for central Massachusetts.

This list of critical facilities was reviewed and updated by the project Core Team, and some critical facilities were also discussed during the Community Resilience Building workshop.

The Hazard Mitigation Team has broken up this list of facilities into four categories:

- Emergency Response Facilities needed in the event of a disaster
- Non-Emergency Response Facilities that have been identified by the Team as nonessential. These are not required in an emergency response event, but are considered essential for everyday Town operations
- Dams
- Facilities/Populations that the Team wishes to protect in the event of a disaster

Critical infrastructure and facilities are mapped in Appendix A.

3.2 CATEGORY 1 – EMERGENCY RESPONSE FACILITIES

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

Type	Name	Address	Details	Has Emergency Generator?
Emergency Operations Center	Warren Fire Department	1012 Main Street, Warren, MA 01083	Within 100-year flood plain.	Yes
Police Station	Warren Police Department	1 Milton O. Fountain Way, Warren, MA 01083	Within 100-year flood plain.	Yes
Fire Station	Warren Fire Department	1012 Main Street, Warren, MA 01083		
Fire Station	Warren Fire Station	20 Albany Street, Warren, MA 01083		Yes
Highway Department	DPW Headquarters	87 Brimfield Road, Warren, MA 01083	Lacks HVAC system.	Yes
Primary Evacuation Routes	Route 67		Crosses 100-year flood zone in some instances. Runs through Warren Center, which is a dense area and vulnerable to flooding.	
Primary Evacuation Routes	Route 19		Crosses 100-year flood zone south of the Pike, though crossing is not a known flood location.	

3.3 CATEGORY 2 – NON-EMERGENCY RESPONSE FACILITIES

The Town has identified these facilities as non-emergency facilities; however, they are considered essential for everyday town operations.

Type	Name	Address	Details
Water Supply	Warren Water District		Comins Pond water source.

Type	Name	Address	Details
Water Supply	West Warren Water District		
Town Facilities	Town Hall & Accountant	48 High Street, Warren, MA 01083	
Town Facilities	Warren Public Library	934 Main Street, Warren, MA 01083	
Utilities	Gas pipeline		National Grid consistently upgrading and installing. Comes into town under Old West Brookfield Road.
Utilities	National Grid power lines		
Flood prevention	Wrights Mill Levee System		Town is working with UACE to bring levee into compliance with UACE regulations.
Transportation	CSX Rail Line	Tracks Route 67 across Warren.	Runs through the center of Warren, including Downtown Warren and West Warren. Rail line intersects the 100-year flood zone, and is potentially vulnerable to flooding.
Transportation	Mobil gas station	1300 Main St, Warren, MA 01083	
Transportation	Citgo gas station	931 Main St, Warren, MA 01083	

3.4 CATEGORY 3 – DAMS

National ID	Dam Name	Owner Type	Hazard Potential
MA00905	Lamberton Brook Dam	DCR - Dept. of Conservation & Recreation	Significant Hazard - maintained regularly.
MA00902	West Warren Mill Pond Dam	Private	Low Hazard
MA00903	Comins Pond Dam	Warren Water District	Significant Hazard - maintained regularly.
MA02045	Farm Pond Dam	Private	N/A
MA02046	Windswept Kennels Pond Dam	Private	N/A
MA02044	Ben Bryla Ranch Pond Dam	Private	N/A
MA00904	Naultaug Brook Pond Dam	Private	Significant Hazard

3.5 CATEGORY 4 – FACILITIES/POPULATIONS TO PROTECT

Type	Name	Address	Details
Special Needs Population/Elderly Housing/Assisted Living	Warren Housing Authority	85 Winthrop Terrace, Warren, MA 01083	
Special Needs Population/Elderly Housing/Assisted Living	Warren Senior Center	2252 Main St, West Warren, MA 01092	Used as an emergency shelter during severe storms and a cooling center during heat waves. Has HVAC and a generator.
Low income/Exposed to natural hazards/Elderly Housing	Heritage Village	Bemis Road, Warren, MA	Mobile home park for people over 55 years of age. Has approximately 50 mobile homes on the site. Has experienced frequent power outages in recent storms.
Low income/Exposed to natural hazards	Evergreen Park	Brimfield Road/Route 19, near I-90	Mobile home park with around 20 homes on the site.
Public Buildings/Areas	St. Paul the Apostle Church	1082 Main Street, Warren, MA 01083	
Schools/Daycares	Warren Elementary School	51 School House Drive, Warren, MA 01083	Constructed on wetlands, so parking area is having problem with subsidence and flooding. No air conditioning.
Schools/Daycares	Quaboag Regional High School	284 Old West Brookfield Road, Warren, MA 01083	Inadequate HVAC.
Schools/Daycares	Warren SDA School	1570 Southbridge Road, Warren, MA 01083	
Schools/Daycares	Upper Room Christian Fellowship	18 Central Street, Warren, MA 01083	Occasionally used as a school building by a private group.
Historic Buildings/Sites	According to the Massachusetts Cultural Resources Information System (MACRIS) online database accessed in March 2018, within Warren there are 9 areas, approximately 267 Buildings, 8 Objects, and 13 Structures listed on the National Register of Historic Places. It should be noted that MACRIS records are not up to date, and therefore do not reflect the total number of resources that are no longer extant.		

EMPLOYMENT CENTERS

Based on data obtained from the Massachusetts Executive Office of Labor and Workforce Development (EOLWD), the following table shows the largest employers in Warren:

Company name	Address	Number of employees
Quaboag Regional School Dist.	Old West Brookfield Rd	50-99
Warren Elementary School	Schoolhouse Dr	50-99
Circor Naval Solutions LLC	Bridge St	20-49
Lizak Bus Svc Inc	Main St	20-49
Town of Warren Fire Dept	Main St	20-49
Warren Police Dept	Milton O Fountain Way	20-49
Breezeland Orchards Inc	Southbridge Rd	10-19
Copart Salvage Auto Auctions	Old West Warren Rd	10-19
Dunkin'	Main St	10-19
Fijol R J Inc	W Warren Rd	10-19
Rybak Engineering Inc	Forest Ave	10-19
Stacy Exposition Svc Inc	Main St	10-19

Source: Department of Unemployment Assistance, Economic Research Department website: https://lmi.dua.eol.mass.gov/LMI/LargestEmployersArea#

ENVIRONMENTAL JUSTICE AND VULNERABLE POPULATIONS

The Massachusetts Executive Office of Energy and Environmental Affairs (EEA) Environmental Justice policy sets the state's office definition for Environmental Justice areas. The policy states that EJ populations are those segments of the population that EEA has determined to be most at risk of being unaware of or unable to participate in environmental decision-making or to gain access to state environmental resources or are especially vulnerable. They are defined as neighborhoods (U.S. Census Bureau census block group data for minority criteria, and American Community Survey (ACS) data for state median income and English isolation criteria) that meet one or more of the following criteria:

- the annual median household income is not more than 65% of the statewide annual median household income;
- minorities comprise 40 % or more of the population;
- 25 % or more of households lack English language proficiency; or
- minorities comprise 25 % or more of the population and the annual median household income of the municipality in which the neighborhood is located does not exceed 150 % of the statewide annual median household income.

According to the EEA's Environmental Justice Map Viewer, there is one environmental justice neighborhood in Warren:

-Coy Hill (Block Group 1, Census Tract 7611): This neighborhood was designated based on income. The median household income in this area is $50,128, or 58.4% of the statewide median income. Approximately 1,659 people live in this area, and 5.9% of this population identifies as a minority[39]. According to town staff, this area includes part of the village of Warren, as well as a large rural residential area. The Coy Hill region of Warren contains several roads that have experienced severe flooding in recent years. Other roads in this area of town are particularly isolated, with few connections to adjoining roads.[40] Additionally, the relatively high elevation of Coy Hill at 356 feet above sea level may increase the exposure of some areas of this neighborhood to severe weather like high winds and lightning strikes.

The location of this environmental justice neighborhood is shown on Map 1 & 3 in Appendix A.

The Community Development Block Grant program considers three of Warren's four census block groups eligible for funding based their percentage of low- to moderate-income residents, indicating that especially vulnerable populations may extend across much of the town. Additionally, the median household income for all of Warren is $61,653, which is 71.8% of the statewide median household income. Lastly, Warren's equalized valuation (EQV) for FY22 was the 335th lowest out of 351 municipalities. EQV is an estimate of local property values, and a low EQV may result in relatively low municipal property tax revenues and greater dependence on state aid.

[39] The minority population percentage is derived from the inverse of the percentage of the population that identifies as white (non-Hispanic or Latino).

[40] Beaman Road, in particular, is only accessible from West Brookfield. Coy Hill Road, Town Farm Road and Cutler Road could be cut off from Warren emergency services in the case of downed trees or road washouts. Coy Hill Road experienced a severe wash out incidence in 2021.

4.0 HAZARD PROFILES, RISK ASSESSMENT & VULNERABILITIES

The following section includes a summary of natural hazards that have affected or could affect Warren in the future. Natural hazards are weather, climate, or environmental threats to lives, property, or other valuable assets to human society. By examining historical data on natural hazard occurrences, and future projections of how climate change will interact with natural hazards, it is possible to approximate the future risk of natural hazards. Historical research, discussions with local officials and emergency management personnel, available hazard mapping and other weather-related databases were used to develop this list.

The most significant identified hazards are the following:

- Flooding
- Severe Snowstorms / Ice storms/ Nor'easters
- Hurricanes
- Severe Thunderstorms / Wind / Tornadoes
- Wildfires / Brushfires
- Earthquakes
- Dam failure
- Drought
- Extreme Temperatures
- Other hazards

4.1 TOP HAZARDS AS DEFINED IN THE CRB WORKSHOP

The top hazards discussed at the CRB workshop were based on the highest rated hazards from the 2019 Hazard Mitigation Plan and a March 2022 Core Team discussion. These hazards were:

- Extreme Temperatures/ swing temps
- Flooding
- Severe winter storms
- Severe wind

4.2 STATE-WIDE OVERVIEW OF HAZARDS

4.2.1 MASSACHUSETTS STATE HAZARD MITIGATION AND CLIMATE ADAPTATION

The state of Massachusetts and Governor Baker's administration has instituted the State Hazard Mitigation and Climate Adaptation Plan (SHMCAP) through Executive Order 569. This plan outlines how the state of Massachusetts must prepare strategies to prevent, respond, and mitigate natural hazards.[41] The plan is the first of its kind to incorporate climate change adaptations into the

[41] https://resilientma.org/shmcap-portal/index.html

mitigation plan. The plan also makes Massachusetts eligible federal disaster recovery and hazard mitigation. The plan is effective under FEMA from September 19, 2018, to September 18, 2023. The Massachusetts SHMCAP is a useful model for incorporating climate change interactions into the natural hazard mitigation planning process.

4.2.2 CLIMATE CHANGE INTERACTIONS

The State Hazard Mitigation and Climate Adaptation Plan (SHMCAP) outlines four major climate change interactions that influence natural hazards in Massachusetts. These four interactions are described as follows on pg.3-4 of the Massachusetts SHMCAP:

1. Changes in precipitation: Changes in the amount, frequency, and timing of precipitation—including both rainfall and snowfall—are occurring across the globe as temperatures rise and other climate patterns shift in response.
2. Sea level rise: Climate change will drive rising sea levels, and rising seas will have wide-ranging impacts on communities, natural resources, and infrastructure along the Commonwealth's 1,519 tidal shoreline miles.
3. Rising temperatures: Average global temperatures have risen steadily in the last 50 years, and scientists warn that the trend will continue unless greenhouse gas emissions are significantly reduced. The 9 warmest years on record all occurred in the last 20 years (2017, 2016, 2015, 2014, 2013, 2010, 2009, 2005, and 1998), according to the U.S. National Oceanographic and Atmospheric Administration (NOAA).
4. Extreme weather: Climate change is expected to increase extreme weather events across the globe, as well as right here in Massachusetts. There is strong evidence that storms—from heavy downpours and blizzards to tropical cyclones and hurricanes—are becoming more intense and damaging and can lead to devastating impacts for residents across the state.

4.3 NATURAL HAZARD IDENTIFICATION AND ANALYSIS

This section examines the hazards in the Massachusetts SHMCAP which are identified as likely to affect Warren. The analysis is organized into the following sections: Hazard Description, Location, Extent, Previous Occurrences, Probability of Future Events, Impact, and Vulnerability. A description of each of these analysis categories is provided below.

4.3.1 HAZARD DESCRIPTION

The natural hazards identified for Warren are: Flooding, Severe snowstorms / Ice storms / Nor'easters, Hurricanes, Severe thunderstorms / Wind / Tornadoes, Wildfire / Brushfire, Earthquakes, Dam Failure, Drought, and Extreme Temperatures. Many of these hazards result in similar impacts to a community. For example, hurricanes, tornadoes, and severe snowstorms may cause wind-related damage.

4.3.2 LOCATION

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

Table 4: Percentage of Town Impacted by Natural Hazard

Land Area Affected by Occurrence	Percentage of Town Impacted
Large	More than 50% of the town affected
Medium	10 to 50% of the town affected
Small	Less than 10% of the town affected

4.3.3 EXTENT

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

4.3.4 PREVIOUS OCCURRENCES

Previous hazard events that have occurred are described. Depending on the nature of the hazard, events listed may have occurred on a local, state-wide, or regional level.

4.3.5 PROBABILITY OF FUTURE EVENTS

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

Table 5: Frequency of Occurrence and Annual Probability of Given Natural Hazard

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

4.3.6 IMPACT

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

Table 6: Impacts, Magnitude of Multiple Impacts of Given Natural Hazard

Impacts	Magnitude of Multiple Impacts
Catastrophic	Multiple deaths and injuries possible. More than 50% of property in affected area damaged or destroyed. Complete shutdown of facilities for 30 days or more.
Critical	Multiple injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of facilities for more than 1 week.
Limited	Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of facilities for more than 1 day.
Minor	Very few injuries, if any. Only minor property damage and minimal disruption on quality of life. Temporary shutdown of facilities.

This section also describes aspects of Warren's infrastructure, environment or society that may experience disproportionate impacts of specific hazards relative to the rest of the town.

4.3.7 POTENTIAL CLIMATE CHANGE EFFECTS

Each natural hazard is influenced by one or more of the climate change interactions listed in *Section 4.2.2 Climate Change Interactions*. Climate change interactions can modify the location, extent, and probability of future events depending on the hazard. The section of the hazard risk assessment lists climate change interactions as described by the 2018 State Hazard Mitigation and Climate Adaptation Plan (SHMCAP).

4.3.8 VULNERABILITY

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

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

The ranking is qualitative and is based, in part, on local knowledge of past experiences with each type of hazard. The size and impacts of a natural hazard can be unpredictable. However, many

of the mitigation strategies currently in place and many of those proposed for implementation can be applied to the expected natural hazards, regardless of their unpredictability.

Table 7: Hazard Identification and Analysis Worksheet for Warren

Type of Hazard	**Location of Occurrence**	**Probability of Future Events**	**Impact**	**Potential Climate Change Effects**	**Hazard Risk Index Rating**
Flooding	Medium	Moderate	Minor	Increase extent; increase probability	4
Severe Snowstorms / Ice Storms/ Nor'easter	Large	Very High	Limited	Increase extent	2
Hurricanes	Large	Low	Limited	Increase extent; increase probability	3
Severe Thunderstorms/	Small	Moderate	Minor	Unclear	2
Tornadoes	Small	Low	Limited	Unclear	4
Wildfire / Brushfire	Small	Moderate	Minor	Increase extent; increase probability	4
Earthquakes	Large	Very Low	Minor	None	5
Dam Failure	Small	Very Low	Limited	Indirect effects related to flooding	4
Drought	Large	Very Low	Minor	Increase extent; increase probability	4
Extreme Temperatures	Large	Moderate	Limited	Increase in average temperature; increase in probability of extreme heat	4

Source: based on Massachusetts State Hazard Mitigation Plan, 2013; modified to reflect conditions in Warren.

4.4 FLOODING

Flooding or excessive stormwater was the most prevalent natural hazard identified by local officials in Warren. Flooding is generally caused by hurricanes, nor'easters, severe rainstorms, and thunderstorms. Global climate change has the potential to exacerbate these issues over time with the potential for more severe and frequent storm and rainfall events. There are several different types of flood hazards – from stormwater inundation and poor drainage infrastructure to riverine flooding and storm surges to dam failures. Riverine and stormwater flooding both occur in Warren, though stormwater flooding is more common. Riverine flooding occurs when the surge of water comes from the top of streams, ponds, and rivers. Stormwater flooding occurs when the amount of precipitation in a storm is greater than the volume that the stormwater drainage system can handle.

FEMA FLOOD ZONES

FEMA creates and manages Flood Insurance Rate Maps (FIRMs) that identify local flood hazard areas. These Special Flood Hazard Areas (SFHA) are locations that will be inundated by a flood event with a 1% or greater chance of occurring in any year. These areas are also referred to as the base flood, or 100-year flood zone. These areas are considered at high risk of flooding, and have around a 1 in 4 chance of flooding during a 30-year mortgage.

FEMA FIRMs also identify areas with a "moderate" flood risk, defined as locations between the 1% annual chance flood and a .2% annual chance flood. These areas are also known as the 500-year flood zone.

LOCATION

Flooding and flood-prone areas in Warren are closely associated to the course of the Quaboag River and associated tributaries and wetlands. According to a GIS analysis performed by CMRPC, there are 332 parcels in Warren in areas that FEMA has assigned a 1% or .2% annual risk of flooding. Buildings on these parcels may be secure depending on their elevation within the parcel, building characteristics, and other factors. However, 25 buildings intersect with the 1% annual risk flood zone, and an additional 25 intersect with the .2% annual risk flood zone. Building footprints that overlap with these flood zones may be impacted by flooding of that magnitude, especially if homeowners have not taken action to mitigate their personal flood risk.

Due to the hilly nature of the Town, much of Warren is upland, away from rivers and ponds and as a result, the location of this hazard is relatively "small". Map 2 in Appendix A illustrates the FEMA FIRM 1% and .2% annual chance flood zones in town, as well as locally-identified flooding areas. Despite much of the town being upland, inadequate drainage systems and steep slopes often leads to localized flooding due to excessive surface water runoff.

At this time the Town of Warren has no repetitive loss structures as defined by FEMA's NFIP. As defined by the National Flood Insurance Program (NFIP), a repetitive loss property is any property which the NFIP has paid two or more flood claims of $1,000 or more in any given 10-year period since 1978. For more information on repetitive losses see https://www.fema.gov/repetitive-flood-claims-grant-program-fact-sheet.

EXTENT

The average annual precipitation for the closest weather station to Warren[42][43] has been 48.91 inches for the period from 2010 to 2022. Annual rainfall levels hit their recent peak in 2011 at 72.84 inches.[44]

Water levels in Warren's rivers, streams, and wetlands rise and fall seasonally and during high rainfall events. High water levels are typical in spring, due to snowmelt and ground thaw. This is the period when flood hazards are normally expected. Low water levels occur in summer due to high evaporation and plant uptake (transpiration). Monthly precipitation levels are highly variable but for the period between 2010 and 2022 Warren received the most precipitation in the months of August and October. At any time, heavy rainfall may create conditions that raise water levels in rivers and streams above bank full stage, which then overflow adjacent lands. Heavy rainfall may also cause excessive runoff that causes the sides of roads to give way, creating a public safety concern and maintenance problem for the town's Highway Department.

Based on past records and the knowledge and experience of members of the Warren Hazard Mitigation team and residents, the extent of the impact of localized flooding would be considered "moderate".

PREVIOUS OCCURRENCES

In addition to the floodplains mapped by FEMA for the 1% and .2% annual chance floods, Warren periodically experiences minor flooding at isolated locations due to drainage problems, or problem culverts. Town staff have reported that flooding events are becoming more frequent in recent years. The following specific flooding locations (mapped in Appendix A) were identified at the Warren CRB Workshop or by the Warren HMP/MVP Core Team:

- Intersection of Route 19 and Reed Street
- Old West Brookfield Road
- O'Neil Road
- Spring Street
- Brook Road
- Kozoil Road
- School Street Brook & Old Route 67
- Southbridge Maple

[42] The East Brimfield Lake weather station in Sturbridge.
[43] The closest weather station to Warren may or may not have the most accurate weather data for Warren. Additionally, the weather in Warren is highly variable within town, likely due to the varied local topography.
[44] National Weather Service. (n.d.). Observed Weather Annual Climate Report. National Weather Service. https://www.weather.gov/wrh/Climate?wfo=box

In the 2022 MVP/HMP survey, Warren residents identified flooding at 41 locations in town. Additionally, undersized culverts and the surface sewer system are a problem town wide. Beaver dams are also a major concern in Warren. In heavy storms, beaver dams can break apart and flood areas downstream. This scenario has occurred repeatedly at Spring Street in West Warren.

In addition to the locations listed here (and mapped in Appendix A, Map 2), there are many areas with no record of previous flood incidents that could be affected in the future by heavy rain and runoff.

July 2021 was an exceptional rainy month for Warren. During the twelve years from 2010-2021, the monthly precipitation in Warren[45] in July averaged to 4.01 inches. However, in July 2021, a series of severe storms led to a monthly rainfall total of 12.30 inches. This volume of precipitation damaged roads and culverts across Warren. In May 2022, Warren was awarded $1.1 million to address the storm damage at nine locations in town.

Image 4: July 2021 flooding washed out the road surface along a stretch of O'Neil Road. Photo credit: James McKeon.

August 2011 was another exceptionally rainy month for Warren, with a monthly rainfall total of 15.30 inches. Another notable severe flood in Warren occurred in 1955. An attendee at the May

[45] These measurements are from the East Brimfield Lake weather station.

26th HMP/MVP listening session observed that a 1955 hurricane led to up to 12 feet of water along route 67.

In recent years, there have been no loss claims in Warren made to FEMA by National Flood Insurance Program (NFIP) participants.

PROBABILITY OF FUTURE EVENTS

Based upon previous data, there is a "moderate" probability of localized flooding occurring in Warren in the next year.

IMPACT

The Town faces a minor impact, with less than 10% of total town area likely to be affected by a 1% annual chance flooding event. Based on the HAZUS analysis described below, an especially severe flood (with a .2% chance of occurrence in any given year) in Warren could completely destroy 4 buildings, including the Police Station/Emergency Operations Center, displace 93 households and come with a significant economic cost.

Utilizing the GIS analysis noted in Location, above, the total building value of the 25 buildings that could be susceptible to a 1% annual chance flood is approximately $4,330,000. The total building value of the 25 buildings that could be susceptible to a .2% annual chance flood is approximately $4,000,000. This approximates the property value at risk of flooding, rather than the estimated financial impact of a major flood event.

HAZUS- MH (multiple-hazards) is a computer program developed by FEMA to estimate losses due to a variety of natural hazards. The HAZUS software was used to model potential damages to the community from a .2% annual chance flood event, assuming a 1 square mile data resolution.

Table 8: Estimated Damages from Flooding

	.2% annual chance flood event
Building Characteristics	
Estimated total number of buildings in Warren	1,880
Estimated total building replacement value (2014 $)	$ 667,000,000
Building Damages	
# of buildings sustaining minor damage (1-10%)	4
# of buildings sustaining moderate damage (11-40%)	4
# of buildings sustaining severe damage (41-50%)	0
# of buildings destroyed	4
Population Needs	

# of households displaced	93
# of people seeking public shelter	62
Value of Damages	
Total property damage (buildings and content)	$ 20,900,000
Total losses due to business interruption	$ 11,890,000
Total Economic loss	**$32,780,000**

This model was included in order to present a reasonable "worst case scenario" that would help planners and emergency personnel evaluate the impacts of flooding that might be more likely in the future, as we enter into a period of more intense and frequent storms. For more information on the HAZUS-MH software, go to http://www.fema.gov/hazus-software.

Warren is also concerned about impacts from excessive water other than flood inundation. Much of Warren's Road infrastructure is unable to handle sudden downpours of heavy precipitation. Erosion, road washouts, and minor flooding is a common problem. These chronic flooding issues are costly for the town to fix. However, rebuilding roads with new stormwater drainage infrastructure can be prohibitively expensive for a small town like Warren without external grant support.

EXPOSURE

Certain features within Warren's community infrastructure, society, and environment may face more exposure to flooding, or be disproportionately impacted by it, relative to the rest of the community. Some of these features may be documented in the list of critical facilities and vulnerable populations in Section 0. These features include:

- Low-lying areas, including but not limited to the FEMA 1% and .2% annual chance flood zones.
- Specific locations with undersized or outdated storm water infrastructure that cannot handle sudden surges in precipitation.
- Residents who may have trouble evacuating from their residence due to age, health concerns, or lack of a vehicle.
- Flood-prone municipal buildings and critical infrastructure including the police department headquarters, which is currently located within the 1% annual chance flood zone.
- Private wells that are subject to flooding and potential contamination from flood waters.
- Septic systems, especially in flood prone areas or locations with high water tables.
- Aquatic ecosystems, which may suffer from erosion, eutrophication, or sedimentation due to stormwater.
- The municipal financial burden of infrastructure maintenance and upgrades meant to address flooding.
- Highway department staff, who sometimes must unclog storm drains during extreme weather events. Due to limited staffing, highway department employees often have to go out alone, making safety a concern.

- Sides of roadways, which may be erode due to excessive rainfall. Lack of funding to make road repairs may compound this issue.
- Hazardous chemicals in the ground, which may be disturbed by flooding or changing groundwater levels.

POTENTIAL CLIMATE CHANGE EFFECTS

According to the 2018 State Hazard Mitigation and Climate Adaptation Plan, there are three major ways that inland flooding can be influenced by climate change:

- Changes in precipitation may lead to more intense and more frequent downpours. Intense downpours that generate a high volume of precipitation in a short period of time may overwhelm stormwater infrastructure, saturate soils, and make them unable to absorb additional moisture, and cause river or stream flows to rise.
- Climate change may result in more frequent severe storms, which would increase the frequency of flooding, and make it more likely for multiple storms in a short duration to cause cumulative damage.
- "Vegetated ground cover" can slow down runoff water, making it more likely to absorb into the ground rather than flow into streams and rivers. Climate change could create more frequent drought conditions, and drought can stress or kill plants, limiting their ability to mitigate runoff from heavy rainfall.

In summary, climate change is likely to increase the extent and probability of future flood events in Warren.

VULNERABILITY

Based on this analysis and the assessment of the Warren Core Team, Warren faces a hazard index rating of "3 - medium risk" from flooding.

4.5 SEVERE SNOWSTORMS / ICE STORMS / NOR'EASTERS

Severe winter storms can pose a significant risk to property and human life. Severe snowstorms and ice storms can involve rain, freezing rain, ice, snow, cold temperatures, and wind. Heavy snowfall and extreme cold can immobilize an entire region. Even areas that normally experience mild winters can be hit with a major snowstorm or extreme cold. Winter storms can result in flooding, storm surge, closed highways, blocked roads, downed power lines and hypothermia. A northeast coastal storm, known as a nor'easter, is typically a large counterclockwise wind circulation around a low-pressure center often resulting in heavy snow, high winds, and rain.

LOCATION

The entire town of Warren is susceptible to severe snowstorms, which means the location of occurrence is "large." Because these storms occur regionally, the entire town is equally vulnerable.

EXTENT

The Northeast Snowfall Impact Scale (NESIS) characterizes and ranks high-impact Northeast snowstorms. These storms have large areas of 10-inch snowfall accumulations and greater. NESIS has five categories: Extreme, Crippling, Major, Significant, and Notable. The index differs from other meteorological indices in that it uses population information in addition to meteorological measurements. Thus, NESIS gives an indication of a storm's societal impacts.

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

Table 9: Northeast Snowfall Impact Scale Categories[46]

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

[46] National Centers for Environmental Information. (n.d.). Regional Snowfall Index (RSI). National Oceanic and Atmospheric Association. Retrieved January 27, 2022, from https://www.ncdc.noaa.gov/snow-and-ice/rsi/nesis

PREVIOUS OCCURRENCES

The 2011 Halloween Nor'easter produced unusually early snowfall on trees that were often still in leaf, adding extra weight, with the ground in some areas still soft from a preceding warm, rainy period that increased the possibility trees could be uprooted. Based on data available from the National Oceanic and Atmospheric Administration, there are 69 high-impact snowstorms since 1958 that have affected the Northeast Corridor. Of these, approximately 34 storms resulted in snow falls in Warren of at least 10 inches. These storms are listed in the table below:

Table 10: Winter Storms Producing over 10 Inches of Snow in Warren, 1958-2021[47]

Start Date	NESIS Value	NESIS Category	NESIS Classification
1/30/2021	4.93	3	Major
3/11/2018	3.16	2	Significant
3/5/2018	3.45	2	Significant
1/3/2018	2.27	1	Notable
3/12/2017	5.03	3	Major
2/8/2015	1.32	1	Notable
1/29/2015	5.42	3	Major
1/25/2015	2.62	2	Significant
3/4/2013	3.05	2	Significant
2/7/2013	4.35	3	Major
10/29/2011	1.75	1	Notable
1/26/2011	2.17	1	Notable
1/9/2011	5.31	3	Major
2/12/2006	4.10	3	Major
1/21/2005	6.80	4	Crippling
2/15/2003	7.50	4	Crippling
3/31/1997	2.29	1	Notable
2/2/1995	1.43	1	Notable
2/8/1994	5.39	3	Major
3/12/1993	13.2	5	Extreme
2/10/1983	6.25	4	Crippling
4/6/1982	3.35	2	Significant
2/5/1978	5.78	3	Major
1/19/1978	6.53	4	Crippling
2/18/1972	4.77	3	Major
12/25/1969	6.29	4	Crippling
2/22/1969	4.29	3	Major

[47] National Centers for Environmental Information. (n.d.). Regional Snowfall Index (RSI).

Start Date	NESIS Value	NESIS Category	NESIS Classification
2/8/1969	3.51	2	Significant
2/5/1967	3.50	2	Significant
2/2/1961	7.06	4	Crippling
1/18/1961	4.04	3	Major
12/11/1960	4.53	3	Major
3/2/1960	8.77	4	Crippling
2/14/1958	6.25	4	Crippling

PROBABILITY OF FUTURE EVENTS

Based upon the availability of records for Worcester County, the likelihood that a severe snowstorm will affect Warren is "very high" (greater than 70 percent in any given year).

Research on climate change indicates that there is great potential for stronger, more frequent storms as the global temperature increases (see *Potential Climate Change Effects*, below).

IMPACT

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

The weight from multiple snowfall events can test the load ratings of building roofs and potentially cause significant damage. Multiple freeze-thaw cycles can also create large amounts of ice and make for even heavier roof loads.

Utilizing the total value of all property, $462,618,951,[48] and an estimated 5 percent of damage to 10 percent of all structures, approximately $2,313,095 worth of damage could occur from a severe snowstorm. This is a rough estimate and likely reflects a worst-case scenario. The cost of repairing or replacing the roads, bridges, utilities, and contents of structures is not included in this estimate.

Other impacts from snowstorms and ice storms include:

- Tree damage and fallen branches that cause utility line damage and roadway blockages
- Disrupted power and phone service
- Unsafe roadways and increased traffic accidents
- Infrastructure and other property are also at risk from severe winter storms and the associated flooding that can occur following heavy snow melt
- Damage to telecommunications structures

[48] MA Department of Revenue Division of Local Services. (2022). Assessed Values by Class. Data Analytics and Resources Bureau. https://dlsgateway.dor.state.ma.us/reports/rdPage.aspx?rdReport=PropertyTaxInformation.AssessedValuesbyClass.assessedvaluesbyclass

- Reduced ability of emergency officials to respond promptly to medical emergencies or fires

The Warren project team also noted that the town uses relatively heavy road salting, which helps prevent winter traffic accidents but may negatively impact groundwater salinity levels and degrade road materials, creating future maintenance problems for the Highway Department.

EXPOSURE

Certain features within Warren's community infrastructure, society, and environment may face more exposure to winter storms, or be disproportionately impacted by them, relative to the rest of the community. Some of these features may be documented in the list of critical facilities and vulnerable populations in *Section 0*. These features include:

- Elderly residents, who may have more difficulty clearly snow and walking on icy or snow-covered sidewalks. Elderly residents may also be more vulnerable to extremely low temperatures.
- Households with low or fixed incomes who may be less able to afford sufficient heating or home improvements to improve energy efficiency and insulation.
- Renters, who may have less control over their living situation and indoor environment than homeowners.
- Public safety, utility, and highway department workers, who are tasked with responding to emergency calls, keeping the heat and power on, and keeping the streets clear during winter storms.

POTENTIAL CLIMATE CHANGE EFFECTS

According to the 2018 State Hazard Mitigation and Climate Adaptation Plan, there are three major ways that severe winter storms (including ice storms and nor'easters) can be influenced by climate change:

- Warming surface waters in the ocean will cause air moving over the water to retain more moisture, and as a result certain winter storms will be capable of dropping more snow than is typical for Massachusetts.
- Rising ocean temperatures may lead to changing atmospheric circulation patterns that make the formation of winter storms along the US East Coast more likely.
- Nor'easters may increase in frequency and intensity and may become more concentrated in the coldest winter months.

In summary, climate change is likely to increase the extent of winter storms in Warren.

VULNERABILITY

Based on the above assessment, Warren has a hazard index rating of "2 — high risk" from snowstorms and ice storms.

4.6 HURRICANES

Hurricanes begin as tropical storms that form over warm ocean waters in the Atlantic Ocean, Pacific Ocean, or off the west coast of Africa. The heated, moist air is drawn up into the atmosphere and begins circulating clockwise or counterclockwise depending on which hemisphere they are in. Tropical storms become hurricanes when their sustained winds exceed 74 miles per hour, or greater. The primary damaging forces associated with these storms are high-level sustained winds and heavy precipitation. Hurricanes winds can reach speeds of up to 200 miles per hour and can grow to 500 miles in diameter. In New England, hurricanes generally occur between August, September, and the first half of October, and can result in flooding and wind damage to structures and above-ground utilities.[49]

LOCATION

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

EXTENT

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

Table 11: Saffir-Simpson Scale[50]

Category	Maximum Sustained Wind Speed
1	74–95 mph: very dangerous winds will produce some damage
2	96–110 mph: extremely dangerous winds will cause extensive damage
3	111–129 mph: devastating damage will occur
4	130–156 mph: catastrophic damage will occur
5	157 + mph: catastrophic damage will occur

[49] 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan.
[50] National Hurricane Center and Central Pacific Hurricane Center. (n.d.). Saffir-Simpson Hurricane Wind Scale. National Oceanic and Atmospheric Association. Retrieved January 31, 2022, from https://www.nhc.noaa.gov/aboutsshws.php

PREVIOUS OCCURRENCES

Hurricanes that have affected the region in which Warren is located are shown in the following table:

Table 12: Major Hurricanes and Tropical Storms Affecting Warren (1970-Present)[51]

Storm Name	Year	Saffir/Simpson Category (when reached MA)
Doria	1971	Tropical Storm
Belle	1976	Tropical Storm
Gloria	1985	1
Henri	1985	Tropical Storm
Chris	1988	Extratropical Storm
Bob	1991	2
Beryl	1994	Tropical Storm
Bertha	1996	Tropical Storm
Floyd	1999	Tropical Storm
Gordon	2000	Extratropical Storm
Barry	2007	Extratropical Storm
Hanna	2008	Tropical Storm
Irene	2011	Tropical Storm
Andrea	2013	Minor Storm
Florence	2018	Extratropical Storm
Elsa	2021	Tropical Storm
Fred	2021	Extratropical Storm
Henri	2021	Tropical Storm

PROBABILITY OF FUTURE EVENTS

Warren's location in central Massachusetts approximately 60 miles inland reduces the risk of extremely high winds that are associated with hurricanes, although it can still experience some high wind events. Based upon past occurrences, it is reasonable to say that there is a "low" probability (1 percent to 10 percent in any given year) of hurricanes in Warren. However, as experienced in Warren during summer 2021, tropical storms absent of extremely high winds may also cause damage due to heavy precipitation and flooding. Additionally, climate change is projected to result in more severe weather, including increased occurrence of hurricanes and tropical storms. Because of this, the occurrence of hurricanes will increase in the future.

[51] Office for Coastal Management. (2021). Historical Hurricane Tracks [Digital]. National Oceanic and Atmospheric Administration.

IMPACT

A description of the damages that could occur due to a hurricane is described by the Saffir-Simpson scale, as shown below:

Table 13: Hurricane Damage Classifications[52]

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

HAZUS- MH (multiple-hazards) is a computer program developed by FEMA to estimate losses due to a variety of natural hazards. The HAZUS software was used to model potential damages to the community from a 100-year and 500-year hurricane event; storms that are 1% and .0.2% likely to happen in a given year, and roughly equivalent to a Category 1 and Category 2 hurricane.

[52] National Hurricane Center and Central Pacific Hurricane Center. (n.d.). Saffir-Simpson Hurricane Wind Scale. National Oceanic and Atmospheric Association. https://www.nhc.noaa.gov/aboutsshws.php

The damages caused by these hypothetical storms were modeled as if the storm track passed directly through the Town, bringing the strongest winds and greatest damage potential.

Table 14: Estimated Damages from Hurricanes

	100-Year storm (89 mph winds)	500-Year storm (102-105 mph winds)
Building Characteristics		
Estimated total number of buildings	1,880	
Estimated total building replacement value (2014 $)	$667,000,000	
Building Damages		
# of buildings sustaining minor damage	11	172
# of buildings sustaining moderate damage	0	18
# of buildings sustaining severe damage	0	0
# of buildings destroyed	0	0
Population Needs		
# of households displaced	0	9
# of people seeking public shelter	0	5
Debris		
Building debris generated (tons)	104	696
Tree debris generated (tons)	4,422	18,573
# of truckloads to clear building debris	4	28
Value of Damages (thousands of dollars)		
Total property damage (buildings and content)	$ 2,290,350	$10,075,650
Total losses due to business interruption	$ 30,920	$520,820

Though there are no recorded instances of a hurricane equivalent to a 500-year storm passing through Massachusetts, this model was included in order to present a reasonable "worst case scenario" that would help planners and emergency personnel evaluate the impacts of storms that might be more likely in the future, as we enter into a period of more intense and frequent storms. For more information on the HAZUS-MH software, go to http://www.fema.gov/hazus-software.

The Town faces a "limited" impact from hurricanes, with 10 percent or less of Warren affected.

EXPOSURE

Certain features within Warren's community infrastructure, society, and environment may face more exposure to hurricanes, or be disproportionately impacted by them, relative to the rest of the community. Some of these features may be documented in the list of critical facilities and vulnerable populations in *Section 0*. Vulnerable community features include:

- The electrical grid is vulnerable to outages from trees falling across power lines. National Grid proactively trims trees in their right of way, but outages are still common. Certain residents, such as people dependent on life support machines or ventilators, may be more vulnerable to power outages. This challenge has been exacerbated by a recent gypsy moth resurgence, which damaged many trees. Climate change is expected to place further stress on local trees, and therefore increase the management burden for the town.

- Public safety, utility, and highway department workers, who are tasked with responding to emergency calls and keeping the streets clear during hurricanes.

In addition to high winds, hurricanes can also bring heavy precipitation and cause flooding. The vulnerable features identified in the Flooding section on page 52 also apply to hurricanes.

POTENTIAL CLIMATE CHANGE EFFECTS

According to the 2018 State Hazard Mitigation and Climate Adaptation Plan, there are two major ways that hurricanes and tropical storms can be influenced by climate change:

- Warming oceans will provide more energy for hurricanes and tropical storms, which could lead to more intense or potentially damaging storms in the future, and larger storms could result in more storms that are likely to impact Massachusetts.
- Warmer air can hold more water vapor and will enable greater precipitation rates during future storms.

In summary, climate change is likely to increase the frequency and extent of hurricanes in Warren.

VULNERABILITY

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

4.7 SEVERE THUNDERSTORMS / WIND / TORNADO

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

Every thunderstorm has an updraft (rising air) and a downdraft (sinking air). Sometimes strong downdrafts known as downbursts can cause tremendous wind damage that is similar to that of a tornado. A small (less than 2.5-mile path) downburst is known as a "microburst" and a larger downburst is called a "macro-burst." An organized, fast-moving line of microbursts traveling across large areas is known as a "derecho." These occasionally occur in Massachusetts. The strongest downburst recorded was a downburst in North Carolina of 175 mph. Winds exceeding 100 mph have been measured from downbursts in Massachusetts.[53]

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

Tornadoes are swirling columns of air that typically form in the spring and summer during severe thunderstorm events. In a relatively short period of time and with little or no advance warning, a tornado can attain rotational wind speeds in excess of 250 miles per hour and can cause severe devastation along a path that ranges from a few dozen yards to over a mile in width. The path of a tornado may be hard to predict because they can stall or change direction abruptly. Within Massachusetts, tornadoes have occurred most frequently in the Connecticut River Valley and in western Worcester County, with Warren some 35 miles east of the zone of most frequent past occurrence. High wind speeds, hail, and debris generated by tornadoes can result in loss of life, downed trees and power lines, and damage to structures and other personal property.

LOCATION

As per the Massachusetts Hazard Mitigation Plan, the entire Town is at risk of high winds, severe thunderstorms, and tornadoes. The plan identifies Warren and its surrounding communities as having a higher-than-average frequency of tornado occurrence within the Massachusetts context. However, the actual area affected by thunderstorms, wind, or tornadoes is "small," with less than 10 percent of the Town generally affected.

EXTENT

[53] 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan.

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

High wind can be linked to a number of different hazards, including hurricanes and winter storms, in addition to thunderstorms and tornadoes. High winds can cause damage to structures, trees, as well as increase the risk of wildfire.

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

Table 15: Enhanced Fujita Scale Levels and Descriptions of Damage[54]

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

[54] National Oceanic and Atmospheric Administration. (n.d.). The Enhanced Fujita Scale (EF Scale). National Weather Service; NOAA's National Weather Service. Retrieved January 31, 2022, from https://www.weather.gov/oun/efscale

Table 16: Extent Scale for Hail[55]

HAIL SIZE (in.)	OBJECT ANALOG REPORTED
.50	Marble, moth ball
.75	Penny
.88	Nickel
1.00	Quarter
1.25	Half Dollar
1.50	Walnut, ping pong
1.75	Golf ball
2.0	Hen egg
2.5	Tennis ball
2.75	Baseball
3.00	Tea cup
4.00	Grapefruit
4.50	Softball

PREVIOUS OCCURRENCES

Because thunderstorms and wind affect the town regularly on an annual basis, there are not significant records available for these events. As per the Massachusetts Hazard Mitigation Plan, there are approximately 10 to 30 days of thunderstorm activity in the state each year.

In Worcester County, there have been several F1 tornadoes over the years. However, a data search for tornadoes rating 3 or above, or resulting in death/injury, or significant property damage, identifies the following events:

- In 1953, an F4 tornado struck Worcester. The event resulted in at least 90 fatalities, and more than 1,200 injured. There was extensive property damage. On the same date, an F3 tornado began in the Town of Sutton.
- In 1981 an F3 tornado struck Westminster, resulting in just 3 injuries and very little reported property damage.
- In June 2011, an F3 tornado struck Massachusetts. Few deaths were reported, all in Hampden County. No deaths were reported in Worcester County.

[55] National Oceanic and Atmospheric Administration. (n.d.). Hail Size as Related to Objects. Storm Prediction Center. Retrieved January 31, 2022, from https://www.spc.noaa.gov/misc/tables/hailsize.htm

With the last 5 years, there have been no tornados in Warren or surrounding communities. The most recent nearby tornado was an EF-3 tornado in 2011 that touched down in Westfield and travelled 38 miles across Hampden County and ended in Sturbridge. Several towns experienced severe damage from this tornado.

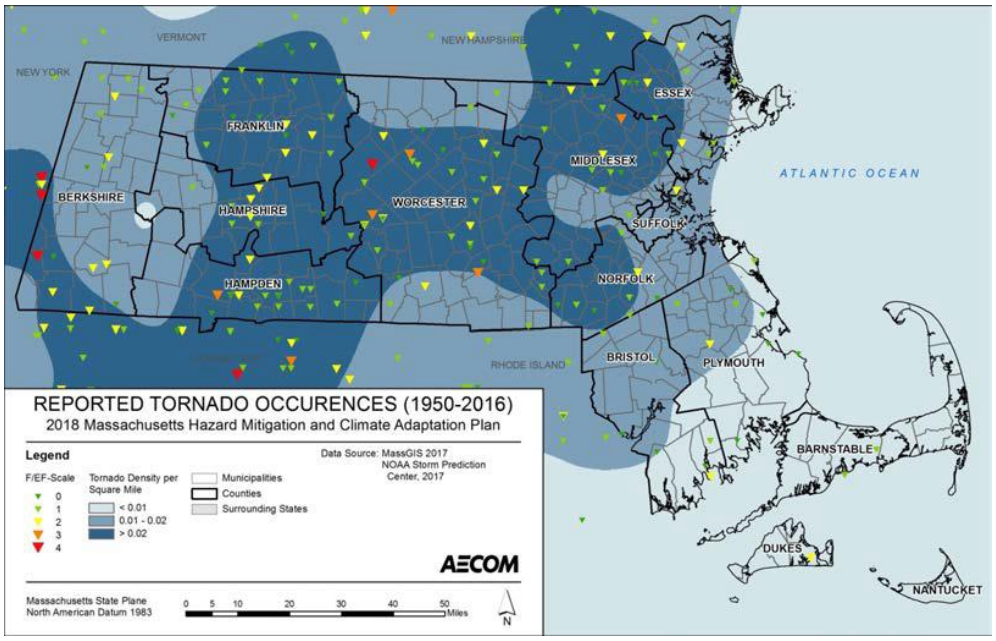

Image 5: Density of Reported Tornados per Square Mile (1950-2016). Source: Massachusetts State Hazard Mitigation and Climate Adaptation Plan, 2018.

Image 6: Above: NASA released this image of part of the 39-mile-long tornado track through south-central Massachusetts. The image was captured on June 5, 2011 by Landsat 5 satellite.

PROBABILITY OF FUTURE EVENTS

According to the 2018 State Hazard Mitigation and Climate Adaptation Plan, Massachusetts experienced 171 tornados between 1950 and 2017, or an average of 2.6 tornado events per year. The report goes on to state that "Massachusetts ranks 35th among the states for the frequency of tornadoes, 14th for the frequency of tornadoes per square mile, 21st for injuries, and 12th for cost of damage." Tornado activity may become more variable due to climate change, so it is difficult to predict the likelihood of future events in Warren (see below, Potential Climate Change Effects).

Based upon the available historical record, as well as Warren's location in a moderate density cluster of tornado activity for Massachusetts, there is a "very low" probability (less than 1 percent chance in any given year) of a tornado affecting the town, and a moderate (10 percent to 40 percent chance in any given year) probability of a severe thunderstorm and/or high winds.

IMPACT

Overall, Warren faces a "minor" impact from severe thunderstorms, and a "limited" impact from severe winds, or tornados, with 10 percent or less of the Town likely to be affected.

The Enhanced Fujita Scale Levels (see above, Extent) for tornados describes the likely impacts of tornados on the physical environment.

The potential for locally catastrophic damage is a factor in any tornado, severe thunderstorm, or wind event. In Warren, approximately half of the residential buildings in the town have been built to Zone 1, Design Wind Speed Codes. The first edition of the Massachusetts State Building Code went into effect on January 1, 1975, and 53.8% percent of the town's 2,215 housing units were constructed in 1979 or earlier.[56] Older homes may be vulnerable to high winds, as well as utility lines throughout town, particularly where trees have not been trimmed recently.

Utilizing the total value of all property, $462,618,951,[57] and an estimated 10 percent of damage to 5 percent of all structures, the estimated amount of damage from a tornado would be $2,313,095. The cost of repairing or replacing the roads, bridges, utilities, and contents of structures is not included in this estimate.

EXPOSURE

Certain features within Warren's community infrastructure, society, and environment may face more exposure to severe thunderstorms/wind/tornadoes, or be disproportionately impacted by them, relative to the rest of the community. Some of these features may be documented in the list of critical facilities and vulnerable populations in *Section 0*. Vulnerable features to severe

[56] US Census Bureau, 2015-2019 American Community Survey 5-year estimates, DP04.
[57] MA Department of Revenue Division of Local Services. (2022). Assessed Values by Class. Data Analytics and Resources Bureau.

thunderstorms/wind/tornadoes overlap with features vulnerable to hurricanes (pg. 62) and flooding (pg. 52).

POTENTIAL CLIMATE CHANGE EFFECTS

The 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP) notes that it is not currently possible to predict how tornados will be impacted by climate change. Tornados are too small to be simulated with accuracy by climate models. Also, they are measured based on their impact rather than inherent physical characteristics, so it's difficult to state whether tornados will increase in frequency and intensity because that depends in part on how many people live in the areas where tornados occur. These challenges make specific predications about the changes to tornadoes from climate change impossible. However, the SHMCAP report goes on to note that "the conditions that are conducive to tornadoes (which are also conducive to other weather phenomena, such as hurricanes and tropical storms) are expected to become more severe under global warming" (pg. 4-246).

The SHMCAP report also does not draw clear conclusions about the impact of climate change on thunderstorms. It notes that while a warming climate will increase the capacity of the atmosphere to hold water vapor, precipitation rates are dependent on other factors that complicate predictions at local scales. It is likely that annual precipitation will increase, and some studies seem to indicate that precipitation rates will increase the temperatures when peak participation rates are likely to occur (pg. 4-465).

VULNERABILITY

Based on the above assessment, Warren has a hazard index rating of "2- high risk" from severe thunderstorms and winds, and a "4 – low risk" from tornadoes.

4.8 WILDFIRES / BUSH FIRES

Wildfires are typically larger fires, involving full-sized trees as well as meadows and scrublands. Brushfires are uncontrolled fires that occur in meadows and scrublands, but do not involve full-sized trees. Typical causes of brushfires and wildfires are lightning strikes, human carelessness, and arson. Relative humidity and wind and two weather-related factors that influence fire danger. Relative humidity refers to "the ratio of the amount of moisture in the air to the amount of moisture necessary to saturate the air at the same temperature and pressure."[58] When relative moisture drops, light fuels like grasses become drier and burn more easily.[59]

FEMA has classifications for 3 different classes of wildfires:

[58] U.S. National Park Service. (2021, January 21). Understanding Fire Danger. National Park Service. https://www.nps.gov/articles/understanding-fire-danger.htm
[59] U.S. National Park Service (2021).

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

Potential vulnerabilities to wildfires include damage to structures and other improvements and impacts on natural resources. Smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations including children, the elderly, and those with respiratory and cardiovascular diseases.

LOCATION

62% of total land area in Southern Worcester County is forested land.[60] Much of this region of Massachusetts, including the Warren area, have a high risk of wildfire. In Warren, an estimated 73.53% of the land is deciduous forest.[61] Warren is developed in a mostly rural/suburban pattern and uninterrupted tracts of forest are present, the substantial tree coverage does present some risk for wildfires and brush fires. The total amount of town that could be affected by a wildfire is categorized as "small," or less than 10 percent of the total area.

[60] Mass GIS. (2016). Land Cover/Land Use [Map]. https://www.mass.gov/info-details/massgis-data-2016-land-coverland-use
[61] Mass GIS (2016).

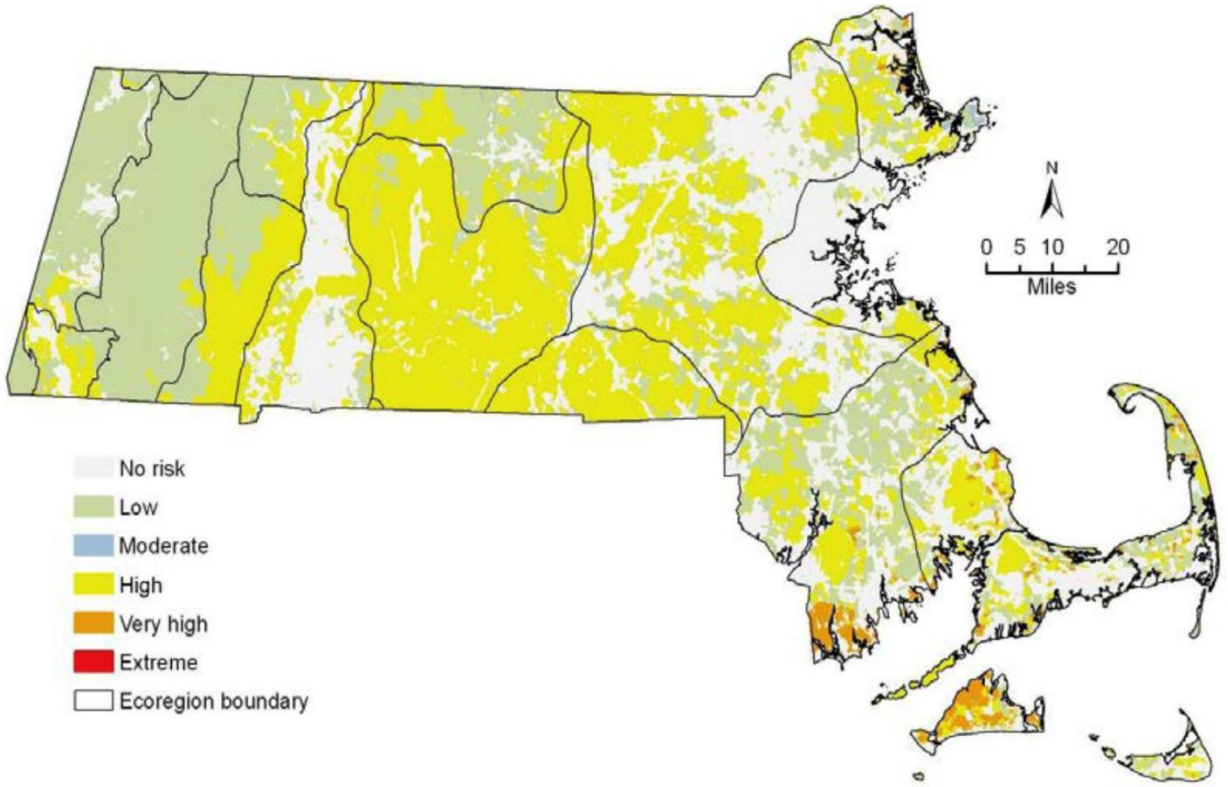

Figure 3: Wildfire Risk Areas for the Commonwealth of Massachusetts. Source: 2018 SHMCAP.

EXTENT

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

In Warren, approximately 73.53% percent of the town's total land area is deciduous forest, and an additional 8.75% of the town consists of grassland or shrub. This forested area is maintained throughout the community, with few developed areas, rivers and minor/minor transportation corridors (I-90, Route 67 and Route 19) breaking up the forest. In drought conditions, a brushfire or wildfire would be a matter of concern.

There have not been any major wildfires in Warren in recent decades. Based on historic data for 2011-2020, the 62 natural vegetation fires in Warren during that period burned 21 acres of land.[62] Therefore, the average fire size over that period was only 2.95 acres per incident.

The National Fire Danger Rating system illustrates the potential extent of wildfires should they occur under the described fire danger conditions:

[62] Massachusetts Department of Fire Services. (2021). Natural Vegetation Fires (2011-2020).

Table 17: National Fire Danger Rating System[63]

Rating	Basic Description	Detailed Description
CLASS 1: Low Danger (L) Color Code: Green	Fires not easily started	Fire starts are unlikely. Weather and fuel conditions will lead to slow fire spread, low intensity, and relatively easy control with light mop up. Controlled burns can usually be executed with reasonable safety.
CLASS 2: Moderate Danger (M) Color Code: Blue	Fires start easily and spread at a moderate rate	Some wildfires may be expected. Expect moderate flame length and rate of spread. Control is usually not difficult and light to moderate mop up can be expected. Although controlled burning can be done without creating a hazard, routine caution should be taken.
CLASS 3: High Danger (H) Color Code: Yellow	Fires start easily and spread at a rapid rate	Wildfires are likely. Fires in heavy, continuous fuel, such as mature grassland, weed fields, and forest litter, will be difficult to control under windy conditions. Control through direct attack may be difficult but possible, and mop up will be required. Outdoor burning should be restricted to early morning and late evening hours.
CLASS 4: Very High Danger (VH) Color Code: Orange	Fires start very easily and spread at a very fast rate	Fires start easily from all causes and may spread faster than suppression resources can travel. Flame lengths will be long with high intensity, making control very difficult. Both suppression and mop up will require an extended and very thorough effort. Outdoor burning is not recommended.
CLASS 5: Extreme (E) Color Code: Red	Fire situation is explosive and can result in extensive property damage	Fires will start and spread rapidly. Every fire start has the potential to become large. Expect extreme, erratic fire behavior. NO OUTDOOR BURNING SHOULD TAKE PLACE IN AREAS WITH EXTREME FIRE DANGER.

[63] U.S. National Park Service (2021). U.S. National Park Service (2021).

PREVIOUS OCCURRENCES

Warren has a full-time and on-call fire department with professional firefighters that was called to 3,322 fire incidences over the period from 2011 to 2020. However, there have not been any major forest fires in Warren in recent decades. From 2011-2020, there were between 2 and 14 natural vegetation fires per year in town, resulting in a financial loss of $20 over that 10-year period.

PROBABILITY OF FUTURE EVENTS

In accordance with the 2018 State Hazard Mitigation and Climate Adaptation Plan, the Warren Hazard Mitigation Team found it difficult to predict the likelihood of wildfires in a probabilistic manner because of the number of variables involved - fuel availability, weather and climate conditions, and human activity all factor into wildfire occurrences. However, based on regular previous occurrences of minor brush fires, the planning team determined the probability of future damaging wildfire events to be "moderate" (10 percent to 40 percent probability in the next year).

Climate scenarios project that by mid-century, the mean summer temperatures in the Chicopee River basin will increase by 5.33° F.[64] Combined with increasingly variable precipitation, rising temperatures could exacerbate summer drought and further promote high-elevation wildfires, releasing stores of carbon and further contributing to the buildup of greenhouse gases.

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

IMPACT

While a large wildfire could in theory damage much of the landmass of Warren, most forested areas are sparsely developed, meaning that wildfire affected areas are not likely to cause damage to property. For this reason, the town faces a "minor" impact from wildfires, with little damage likely to occur.

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

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

[64] Northeast Climate Adaptation Science Center. (n.d.). Datagrapher. ResilientMA. https://resilientma.org/datagrapher

- Impact through the destruction of people and property

Utilizing the total value of all property, $462,618,951,[65] and an estimated 5 percent of damage to 1 percent of all structures, the estimated amount of damage from a wildfire is $231,310. The cost of repairing or replacing the roads, bridges, utilities, and contents of structures is not included in this estimate.

EXPOSURE

Certain features within Warren's community infrastructure, society, and environment may face more exposure to wildfires/brushfires, or be disproportionately impacted by them, relative to the rest of the community. Some of these features may be documented in the list of critical facilities and vulnerable populations in *Section 0*. Vulnerable community features include:

- People who are sensitive to smoke, including children, the elderly, and individuals with other health conditions. Wildfires outside of Warren may also impact the town residents. Air pollution from wildfires can be a severe public health concern. Smoke can exacerbate respiratory conditions like asthma and carry toxic chemicals and particulate matter. In 2021, wildfire smoke from western states and Canada extended across the continental US forced the Massachusetts Department of Environmental Protection to issue an air quality alert.[66]
- First responders, especially the town's firefighter department.

POTENTIAL CLIMATE CHANGE EFFECTS

According to the 2018 State Hazard Mitigation and Climate Adaptation Plan, there are two major ways that wildfires/brushfires can be influenced by climate change:

- Seasonal drought risk is projected to increase and summer temperatures are expected to rise. Rising temperatures and changes in precipitation could cause vegetation to dry out and become more flammable.
- Rising temperatures may cause the frequency of lightning strikes to increase, which could spark more wildfires.

In summary, climate change is likely to increase the frequency and extent of wildfires in Warren.

VULNERABILITY

Based on the above assessment, Warren has a hazard risk index of "4 – low risk" from wildfires. However, this risk assessment is highly dependent on short term weather patterns like wind, lightning, and rainfall, which are impossible for the town to predict with certainty.

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[65] MA Department of Revenue Division of Local Services. (2022). Assessed Values by Class. Data Analytics and Resources Bureau.

[66] McAlpine, K. J. (2021, July 27). Wildfire Smoke in New England Is "Pretty Severe from Public Health Perspective." The Brink. https://www.bu.edu/articles/2021/wildfire-smoke-in-new-england/

4.9 EARTHQUAKES

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

LOCATION

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

EXTENT

The magnitude of an earthquake is sometimes measured using the Richter Scale, which measures the energy of an earthquake by determining the size of the greatest vibrations recorded on the seismogram. On this scale, one step up in magnitude (from 5.0 to 6.0, for example) increases the energy more than 30 times. Earthquakes are also commonly measured using the moment magnitude scale, which provides similar measurements to the Richter scale but more accurately measures earthquakes with magnitudes greater than 8.[67]

Table 18: Richter Scale Magnitudes and Effects

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

[67] Michigan Tech. (n.d.). How Do We Measure Earthquake Magnitude? Michigan Technological University. Retrieved February 3, 2022, from https://www.mtu.edu/geo/community/seismology/learn/earthquake-measure/

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

Table 19: Modified Mercalli Intensity Scale for and Effects[68]

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

[68] U.S. Geological Survey. (n.d.). The Modified Mercalli Intensity Scale. UGGS. Retrieved February 3, 2022, from https://www.usgs.gov/programs/earthquake-hazards/modified-mercalli-intensity-scale?qt-science_center_objects=0#qt-science_center_objects

PREVIOUS OCCURRENCES

The last earthquake to cause major damage in New England occurred in 1755,[69] though seismologists state that another serious earthquake occurrence is possible. There are five seismic faults in Massachusetts, but there is no discernible pattern of previous earthquakes along these fault lines. Additionally, earthquakes that are based in more seismologically active regions like parts of Canada may also impact Massachusetts.[70] Earthquakes occur without warning and may be followed by aftershocks. Image 7 shows the locations of earthquakes that have occurred across the New England region and beyond over the last 45 years.

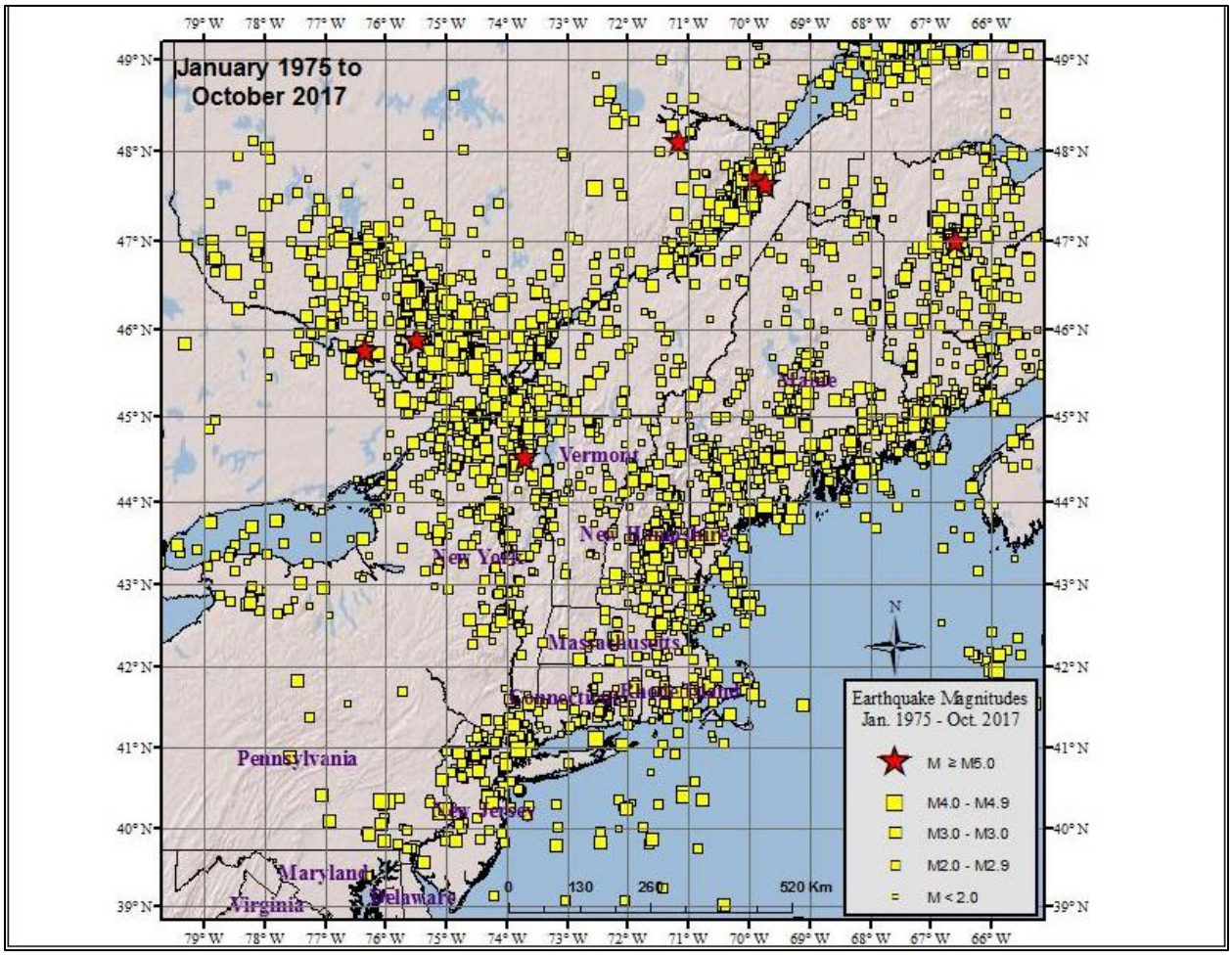


Image 7: Map of Earthquakes of the Northeastern US and Southeastern Canada 1975 to 2017. Source: The Northeast States Emergency Consortium website.

[69] Northeast States Emergency Consortium. (n.d.). Massachusetts Earthquakes. Retrieved February 3, 2022, from http://nesec.org/massachusetts-earthquakes/

[70] 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan.

PROBABILITY OF FUTURE EVENTS

The 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP) notes that "Earthquakes cannot be predicted and may occur at any time." Additionally, the report notes that a strong earthquake could occur anywhere within the New England Region, rather than in specific hotspots. Therefore, it is difficult to estimate the probability of a future damaging earthquake in Warren.

The local Hazard Mitigation Team reports that no earthquakes have been felt in Warren. Based upon existing records, there is a "very low" frequency (less than 1 percent probability in any given year) of a damaging earthquake in Warren.

IMPACT

Massachusetts introduced earthquake design requirements into their building code in 1975 and improved building code for seismic reasons in the 1980s. However, these specifications apply only to new buildings or to extensively modified existing buildings. Buildings, bridges, water supply lines, electrical power lines and facilities built before the 1980s may not have been designed to withstand the forces of an earthquake. The first edition of the Massachusetts State Building Code went into effect on January 1, 1975, and 53.8% percent of the town's 2,215 housing units were constructed in 1979 or earlier.[71] The seismic standards were upgraded with the 1997 revision of the State Building Code. Despite its older housing stock, Warren faces a "minor" impact from earthquakes, with little damage likely to occur due to the extreme rarity of damaging events.

HAZUS-MH (multiple-hazards) is a computer program developed by FEMA to estimate losses due to a variety of natural hazards. The HAZUS earthquake module allows users to define an earthquake magnitude and model the potential damages caused by that earthquake as if its epicenter had been at the geographic center of the study area. For the purposes of this plan, a magnitude 5.0 earthquake was selected for analysis. Historically, major earthquakes are rare in New England, although a magnitude 5 event occurred in 1963.

Table 20 - Estimated Damages from an Earthquake

	Magnitude 5.0
Building Characteristics	
Estimated total number of buildings	1,880
Estimated total building replacement value (2014 $)	$667,000,000
Building Damages	
# of buildings sustaining slight damage	540
# of buildings sustaining moderate damage	325

[71] US Census Bureau, 2015-2019 American Community Survey 5-year estimates, DP04.

# of buildings sustaining extensive damage	109
# of buildings completely damaged	28
Population Needs	
# of households displaced	91
# of people seeking public shelter	49
Debris	
Building debris generated (tons)	26,000
# of truckloads to clear debris (@ 25 tons/truck)	1,040
Value of Damages (dollars)	
Total property damage	$91,246,100
Total losses due to business interruption	$10,092,800

For more information on the HAZUS-MH software, go to www.fema.gov/hazus-software.

EXPOSURE

Certain features within Warren's community infrastructure, society, and environment may face more exposure to earthquakes, or be disproportionately impacted by them, relative to the rest of the community. Some of these features may be documented in the list of critical facilities and vulnerable populations in *Section 0*. Vulnerable community features include:

- Older buildings constructed prior to the first edition of the Massachusetts State Building Code.

POTENTIAL CLIMATE CHANGE EFFECTS

According to the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP), earthquakes in Massachusetts are not influenced by climate change.

VULNERABILITY

Based on the above analysis, Warren has a hazard index rating of "5- lowest risk" from earthquakes.

4.10 DAM FAILURE

Dams and their associated impoundments provide many benefits to a community, such as water supply, recreation, hydroelectric power generation, and flood control. However, they also pose a potential risk to lives and property. Dam failure is not a common occurrence, but dams do represent a potentially disastrous hazard.

When a dam fails, the potential energy of the stored water behind the dam is released rapidly. Some dam failures occur when floodwaters above overtop and erode the material components of the dam. Other failures are caused by foundation defects, inadequate maintenance, internal erosion caused by seepage, and many other specific causes.[72] Dam failure may be influenced by storm floodwaters but most are caused by structural, mechanical, or hydraulic failures.[73] Dam breeches can lead to catastrophic consequences as the water rushes in a torrent downstream flooding an area engineers refer to as an "inundation area." The number of casualties and the amount of property damage will depend upon the timing of the warning provided to downstream residents, the number of people living or working in the inundation area, and the number of structures in the inundation area.

Many dams in Massachusetts were built during the 19th century without the benefit of modern engineering design and construction oversight. Dams of this age can fail because of structural problems due to age and/or lack of proper maintenance, as well as from structural damage caused by an earthquake or flooding. The Massachusetts Department of Conservation and Recreation Office of Dam Safety is the agency responsible for regulating dams in the state (M.G.L. Chapter 253, Section 44 and the implementing regulations 302 CMR 10.00). To be regulated, these dams are in excess of 6 feet in height (regardless of storage capacity) and have more than 15 acre-feet of storage capacity (regardless of height). Dam safety regulations enacted in 2005 transferred significant responsibilities for dams from the Commonwealth of Massachusetts to dam owners, including the responsibility to conduct dam inspections.

[72] Association of State Dam Safety Officials. (n.d.). Dam Failures and Incidents. Association of State Dam Safety Officials. Retrieved December 29, 2021, from https://damsafety.org/dam-failures
[73] FEMA. (2013). Living with Dams: Know Your Risks (FEMA P-956; p. 9). Federal Emergency Management Agency. https://www.fema.gov/sites/default/files/2020-08/fema_living-with-dams_p-956.pdf

LOCATION

According to the Massachusetts Office of Dam Safety, there are 7 dams in Warren, of which 3 are Significant Hazard. The names and hazard levels of dam structures within Warren are:

Table 21: Dams in Warren. Note: This list does not include any dams outside of Warren.

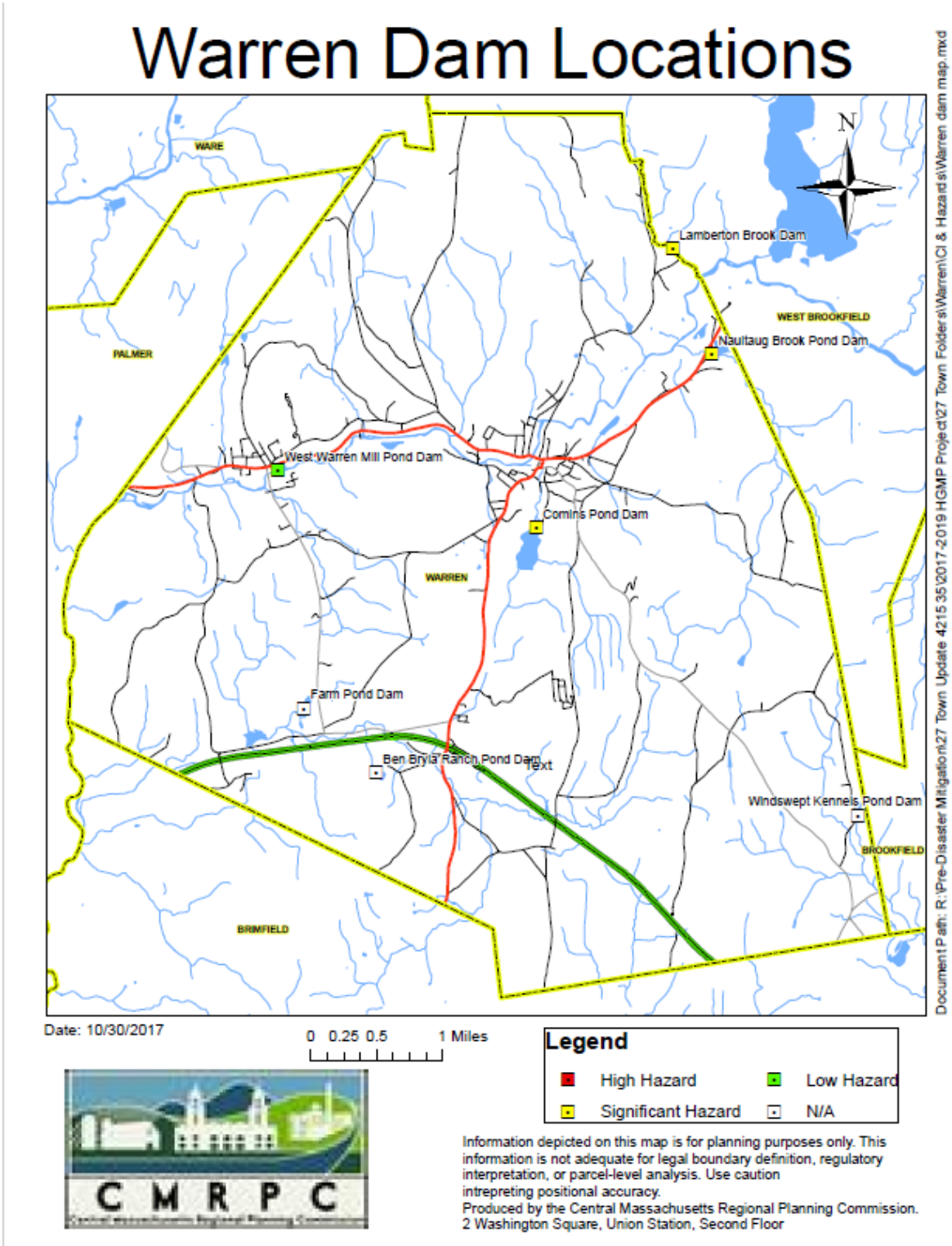
National ID	Dam Name	Owner Type	Hazard Potential
MA00905	Lamberton Brook Dam	DCR - Dept. of Conservation & Recreation	Significant Hazard
MA00902	West Warren Mill Pond Dam	Private	Low Hazard
MA00903	Comins Pond Dam	Warren Water District	Significant Hazard
MA02045	Farm Pond Dam	Private	N/A
MA02046	Windswept Kennels Pond Dam	Private	N/A
MA02044	Ben Bryla Ranch Pond Dam	Private	N/A
MA00904	Naultaug Brook Pond Dam	Private	Significant Hazard

Participants at the Community Resilience Building workshop discussed two dams in detail. The spillway at the Comins Pond, noted above, and the Lake Wickaboag Dam in West Brookfield. Comins Pond Dam is regularly inspected and maintained by the Warren Water District. This dam is a concern because of the damage its floodwaters might cause to other infrastructure. Water from the dam's spillway is channeled through a culvert that passes underneath the CSX railroad bridge in Warren Center. This culvert is in poor condition and has leaked in the past. Large volumes of water passing through the culvert are a concern due to the immediate flood risk if the culvert were to break down and the potential damage to the railroad bridge. This issue has been raised by the Warren Highway Department with CSX, but the railroad company did not express concern.

The Lake Wickaboag Dam was perceived as a risk to Warren because its floodwaters would enter the Quaboag River, potentially impacting Warren Center and development along the river in West Warren. However, the Lake Wickaboag dam is classified as a Low Hazard dam by the Massachusetts Office of Dam Safety, indicating that a dam breach would result in limited damages.

Lastly, portions of West Warren, including the Wright's Mill Complex, are protected from flooding by a levee system. The levee was constructed by the Army Corps of Engineers though it is owned and maintained by the Town of Warren. As of May 2022, the Army Corps of Engineers was writing a report on the status of the levee and any actions that Warren must take to keep the levee in compliance.

Figure 4: Map of Warren Dam Locations.



Inundation areas cover essentially none of Warren, or a "small" portion of its area.

EXTENT

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

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

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

Some dams do not have a hazard rating.

PREVIOUS OCCURRENCES

To date, there have been no catastrophic dam failures in Warren.

PROBABILITY OF FUTURE EVENTS

While Warren has a fairly high number of High and Significant Hazard dams, there are no reported previous dam failure events in the 150-plus years that dams have been present. Probability for future failure events is therefore "very low" with less than 1 percent chance of a dam bursting in any given year.

IMPACT

The town faces a "limited" impact from failure of dams with, with 10 to 25 percent of the affected area likely to see damage.

It is not possible to estimate the property loss impacts of dam failure quantitatively given the large number of variables involved in failure events. Qualitatively, losses from failure of an individual dam could be significant but would be geographically limited to portions of the dam's inundation zone.

POTENTIAL CLIMATE CHANGE EFFECTS

Dam failure through overtopping can be caused by floodwaters flowing into a dammed body of water, exceeding the spillway capacity of the dam, and causing water to flow over dam the top of the dam (overtopping). If the water flowing over the dam erodes the dam itself, then a dam failure can occur. Therefore, the risk of dam failure may be indirectly impacted by climate change through its impacts on flooding. See *Section 4.4: Flooding, Potential Climate Change Effects* for more details.

VULNERABILITY

In accordance with the Massachusetts Hazard Mitigation Plan, a quantitative vulnerability analysis could not be completed to estimate potential losses from a dam failure event. Based on a mostly qualitative assessment, Warren has a hazard index rating of "4 – limited" from dam failure.

4.11 DROUGHT

Drought is a normal, recurrent feature of climate. It occurs almost everywhere, although its features vary from region to region. In the most general sense, drought originates from a deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group, or environmental sector. Reduced crop, rangeland, and forest productivity; increased fire hazard; reduced water levels; increased livestock and wildlife mortality rates; and damage to wildlife and fish habitat are a few examples of the direct impacts of drought. Of course, these impacts can have far-reaching effects throughout the region and even the country.

LOCATION

Because of this hazard's regional nature, a drought would likely impact the entire community, meaning the location of occurrence is "large" or over 50 percent of the town.

EXTENT

The severity of a drought determines the scale of the event. Most of Warren is served by the Warren Water District or the West Warren Water District. There are also many properties using private wells. The National Drought Mitigation Center records information on historical drought occurrences. The National Drought Mitigation Center categorizes drought on a D0-D4 scale as shown below.

Table 22: U.S. Drought Monitor[74]

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

[74] National Drought Mitigation Center. (n.d.). Drought Classification. U.S. Drought Monitor. Retrieved February 3, 2022, from https://droughtmonitor.unl.edu/About/AbouttheData/DroughtClassification.aspx

PREVIOUS OCCURRENCES

In Massachusetts, six major droughts have occurred statewide since 1930, though the Warren area has been spared the most severe impacts in each case according to USGS Water Supply Paper for Massachusetts #2375. These historic major droughts range in severity and in length, lasting from three to eight years. In many of these droughts, water-supply systems around the state were found to be inadequate. Water was piped into urban areas, and water-supply systems were modified to permit withdrawals at lower water levels. The following table displays peak drought severity since 2000, from the National Drought Mitigation Center:

Table 23: Annual Drought Status in Worcester County[75]

Year	Maximum Severity
2000	No drought
2001	D2 conditions in 7% of the county
2002	D2 conditions in 100% of the county
2003	No drought
2004	D0 conditions in 96% of the county
2005	D0 conditions in 92% of the county
2006	D0 conditions in 100% of the county
2007	D1 conditions in 87% of the county
2008	D0 conditions in 98% of the county
2009	D0 conditions in 76% of the county
2010	D1 conditions in 43% of the county
2011	No drought
2012	D2 conditions in 70% of the county
2013	D1 conditions in 91% of the county
2014	D1 conditions in 79% of the county
2015	D1 conditions in 100% of the county
2016	D3 conditions in 57% of the county
2017	D2 conditions in 77% of the county
2018	D1 conditions in 32% of the county
2019	D0 conditions in 57% of the county
2020	D3 conditions in 14% of the county
2021	D1 conditions in 51% of the county

[75] National Drought Mitigation Center. (2016, 2022). Statistics by Threshold. U.S. Drought Monitor. https://droughtmonitor.unl.edu/DmData/DataDownload/StatisticsbyThreshold.aspx

2022 (to 6/16)	D1 conditions in 16% of the county

In Warren, the last known drought event with substantial impacts occurred in 2016. Some private wells have run dry during previous droughts in Warren.

PROBABILITY OF FUTURE EVENTS

In Warren, as in the rest of the state, extreme and exceptional droughts occur at a "very low" probability (1 to 10 percent in the next year). Based on past events and current criteria outlined in the Massachusetts Drought Management Plan, it appears that Central Massachusetts may be slightly more vulnerable than parts of eastern Massachusetts to severe drought conditions. However, many factors, such as water supply sources, population, economic factors (i.e., agriculture-based economy), and infrastructure, may affect the severity and length of a drought event.

In the long-term, the risk of drought may increase in Warren due to climate change influences, which will result in annual increases in consecutive dry days.

IMPACT

The specific impacts of drought in Massachusetts are categorized by the National Drought Mitigation Center in Table 24, below.

Table 24: Historic Impacts of Drought in Massachusetts[76]

Category	Historically observed impacts
D0	Crop growth is stunted; planting is delayed
	Fire danger is elevated; spring fire season starts early
	Lawns brown early; gardens begin to wilt
	Surface water levels decline
D1	Irrigation use increases; hay and grain yields are lower than normal
	Honey production declines
	Wildfires and ground fires increase
	Trees and landscaping are stressed; fish are stressed
	Voluntary water conservation is requested; reservoir and lake levels are below normal capacity
D2	Specialty crops are impacted in both yield and fruit size
	Producers begin feeding cattle; hay prices are high
	Warnings are issued on outdoor burns; air quality is poor
	Golf courses conserve water

[76] National Drought Mitigation Center. (n.d.). State Impacts. U.S. Drought Monitor. Retrieved February 3, 2022, from https://droughtmonitor.unl.edu/DmData/StateImpacts.aspx

	Trees are brittle and susceptible to insects
	Fish kills occur; wildlife move to farms for food
	Water quality is poor; groundwater is declining; irrigation ponds are dry; outdoor water restrictions are implemented
D3	Crop loss is widespread; Christmas tree farms are stressed; dairy farmers are struggling financially
	Well drillers and bulk water haulers see increased business
	Water recreation and hunting are modified; wildlife disease outbreak is observed
	Extremely reduced flow to ceased flow of water is observed; river temperatures are warm; wells are running dry; people are digging more and deeper wells

The 2018 Massachusetts State Hazard Mitigation and Climate Adaptation plan notes that while drought is a naturally occurring climate phenomenon, its impacts can be exacerbated by human behavior. The volume and rate of groundwater withdrawn from underground aquifers can impact the amount of water that flows through surface water bodies, negatively impacting aquatic ecosystems. Additionally, more impervious surface coverage, and some forms of stormwater infrastructure, can prevent natural infiltration of precipitation into groundwater.[77]

Specific impacts in Warren may vary among customers of the water system and private well users. So, while the impact of a drought can be assessed as "minor" overall, with very little damage to people or property likely to occur, impacts may be higher for certain individuals or areas of town.

EXPOSURE

Certain features within Warren's community infrastructure, society, and environment may face more exposure to drought, or be disproportionately impacted by them, relative to the rest of the community. Some of these features may be documented in the list of critical facilities and vulnerable populations in *Section 0*. Vulnerable community features include:

- Residences or businesses with shallow wells.
- Wild plants and animals, including trees.
- Vegetation, which may become more vulnerable to wildfire due to prolonged drought.
- Farmers, who rely on regular precipitation for their livelihoods. Cattle and dairy farms may be especially vulnerable due to the larger volumes of water that they need. During droughts, cattle and dairy farmers may also be unable to grow their own hay or enough pasture feed material and may have to buy hay, which adds an additional cost to their business.

[77] 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan.

Higher water bills or the cost of re-drilling private wells due to drought impacts, could also negatively affect local residents. Other factors like PFAS contamination of water sources could compound drought-related water supply challenges, though PFAS has not been detected in significant quantities in Warren to-date.

POTENTIAL CLIMATE CHANGE EFFECTS

According to the 2018 State Hazard Mitigation and Climate Adaptation Plan, there are two major ways that drought can be influenced by climate change:

- The frequency and extent of droughts are projected to increase in summer and fall as higher temperatures result in more evaporation, snow melts earlier in the year, and precipitation becomes less constant and more extreme.
- Rising temperatures and changes in precipitation will reduce the snowpack and hasten snowmelt. This could result in less snowmelt recharge of groundwater, less snowmelt feeding stream flows, and less snowmelt as a water source for agriculture.

In summary, climate change is likely to increase the frequency and extent of drought in Massachusetts.

VULNERABILITY

Based on the above assessment, Warren has a hazard index rating of "4 – low risk" from drought. Minimal or no loss of property, or damage to people or property is expected due to this hazard. See also Section 4.8 for a discussion on the impacts of drought on wildfires.

4.12 EXTREME TEMPERATURES AND TEMPERATURE SHIFTS

As per the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan, there is no universal definition for extreme temperatures, with the term relative to local weather conditions. Extreme heat in Massachusetts is typically defined as a period of 3 or more consecutive days with temperatures above 90 °F.[78] Extreme heat may also refer to any prolonged period of especially hot weather (a heat wave), which may also be accompanied by high humidity. Extreme cold is a dangerous situation that can result in health emergencies for susceptible people, such as those without shelter or who are stranded or who live in homes that are poorly insulated or without heat.

For Massachusetts, extreme temperatures can be defined as those that are far outside the normal ranges. Normal temperatures for the Warren area are:

Table 25: Monthly Climate Normals (1991-2022) – E. Brimfield, MA[79]

	July (Hottest Month)	January (Coldest Month)

[78] 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan.
[79] National Weather Service. (n.d.). NOAA Online Weather Data (NOWData). National Oceanic and Atmospheric Administration. https://www.weather.gov/wrh/Climate?wfo=box

Mean Max Temperature Normal (°F)	80.5°	34.2°
Mean Min Temperature Normal (°F)	61.5°	16.1°

At the East Brimfield weather station, the highest recorded maximum temperature was 101°F in July 2018 and the lowest recorded minimum temperature was -15°F in February 2016. Specific criteria used by the National Weather Service for issuing extreme heat and extreme cold watches, warnings, and advisories, are described in Extent, below.

The Warren Core Team also expressed concern about sudden temperature shifts (a sudden transition from low to high temperatures, or high to low temperatures), which they think are becoming more common. Rapid freeze-thaw cycles negatively impact infrastructure as water expands and contracts within small cracks in the soil and pavement.

LOCATION

Extreme temperatures can be expected to be uniform across Warren during a given weather event, due to the town's lack of extreme elevations, urban areas, and coastal areas. Therefore, this hazard has a "large" geographic coverage.

EXTENT

2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan notes that the extent (severity or magnitude) of extreme cold temperatures is generally measured through the Wind Chill Temperature Index. Wind Chill Temperature is the temperature that people and animals feel when outside and it is based on the rate of heat loss from exposed skin by the effects of wind and cold. In Massachusetts, a wind chill warning is issued by the National Weather Service (NWS) Norton Forecast Office when the Wind Chill Temperature Index, based on sustained wind, is –25°F or lower for at least three hours. NWS Windchill Chart (shows three shaded areas of frostbite danger. Each shaded area shows how long a person can be exposed before frostbite develops.

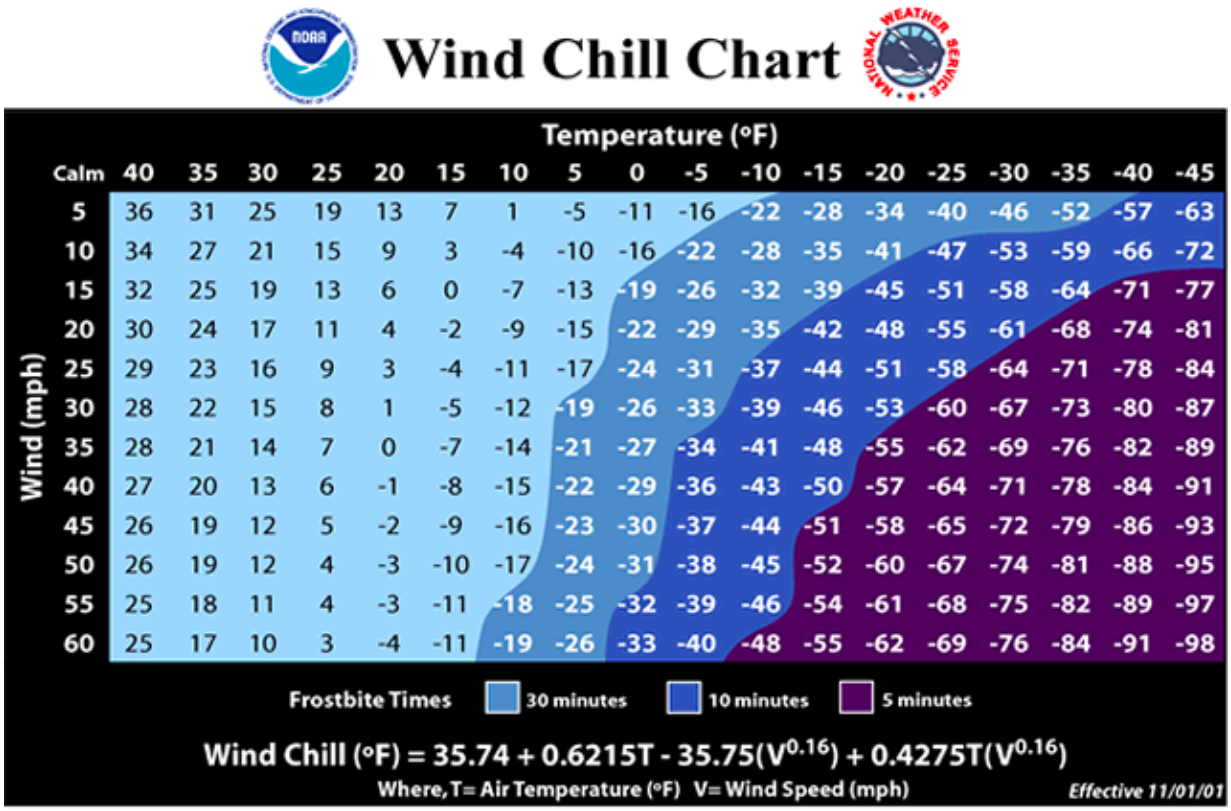


Figure 5: NWS Wind Chill Temperature (WCT) index. Source: https://www.weather.gov/safety/cold-wind-chill-chart

For extremely hot temperatures, the heat index scale is used, which combines relative humidity with actual air temperature to determine the risk to humans. The NWS issues an Excessive Heat Warning when the daytime heat index is forecasted to reach 105 degrees F for 2 or more hours. The NWS issues an Excessive Heat Advisory if the heat index is forecast to reach 95°F-99°F for 2 or more hours over 2 consecutive days, or 100°F-104°F for 2 or more hours over 1 day. The NWS defines a heat wave as 3 or more days of ≥ 90°F temperatures. The following chart indicates the relationship between heat index and relative humidity:

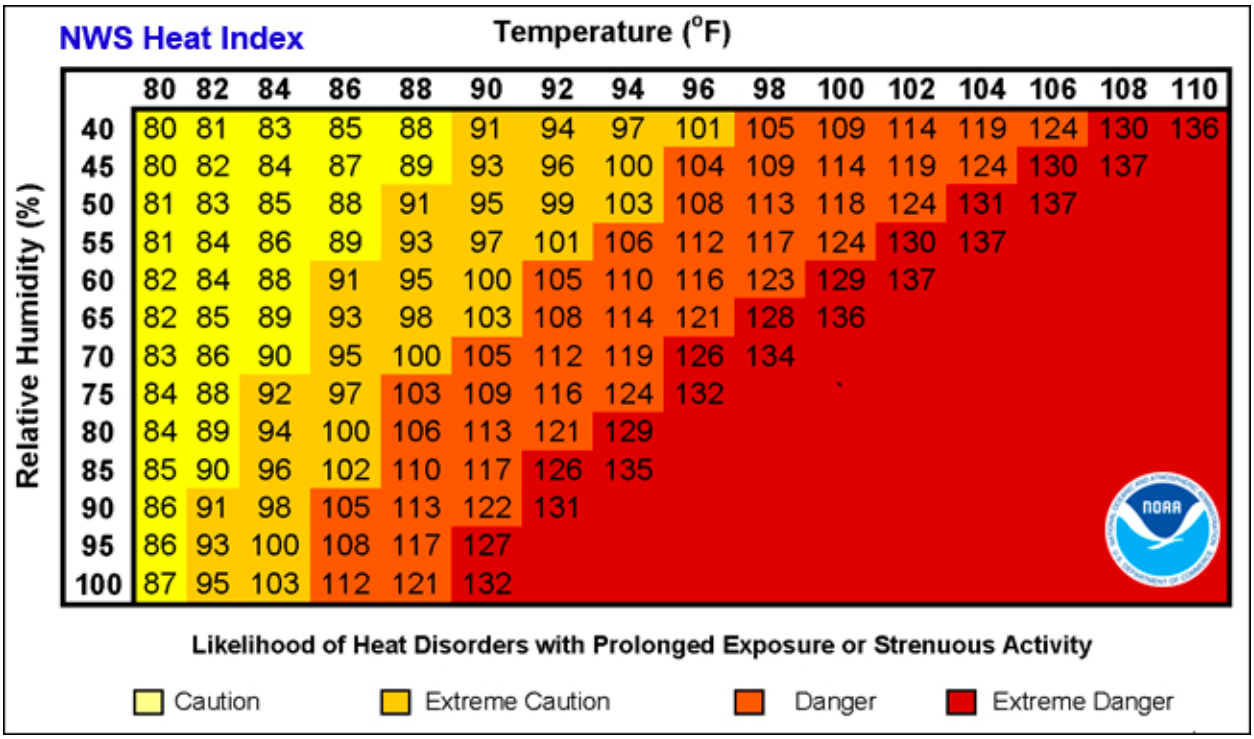


Figure 6: Heat Index. Source: https://www.weather.gov/safety/cold-wind-chill-chart

Extreme heat causes more fatalities in the United States that all other weather-related natural hazards combined.[80] Extreme heat can be the underlying cause of death or can worsen other medical conditions like heart disease, hypertension, alcohol poisoning and drug overdoses.[81] The heat-related mortality rate is higher among males and people aged 65 years and older.[82]

Table 26: Heat Effects on Body lists the effects of the body at different levels of the heat index. It is important to note that while temperatures exceeding 100°F are unusual for Central Massachusetts, high humidity is very common during the summer and can drive the heat index to dangerous levels.

[80] 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan.
[81] Vaidyanathan, A. (2020). Heat-Related Deaths—United States, 2004–2018. MMWR. Morbidity and Mortality Weekly Report, 69. https://doi.org/10.15585/mmwr.mm6924a1
[82] Vaidyanathan, A. (2020).

Table 26: Heat Effects on Body[83]

Classification	Heat Index	Effect on Body
Caution	80°-90°F	Fatigue possible with prolonged exposure and/or physical activity.
Extreme Caution	90°-103°F	Heat stroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity
Danger	103°-124°F	Heat cramps or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity
Extreme Danger	125°F+	Heat strokes highly likely.

Other impacts of high temperatures include drought, wildfire, and the formation of ground-level ozone.[84] Prolonged heat can cause power use to spike and overload the electrical grid, causing outages.[85] Cold temperatures are often combined with winter storms. Individuals may have to deal with the loss of heat and power due to storm damage, which could further subject them to the cold.[86] Carbon monoxide poisoning is another risk during cold weather, especially when households lack adequate power or heat.[87] Extreme heat and cold can both negatively impact transportation infrastructure. Railroad tracks are a particular concern because the metal rails can kink in high temperatures.[88]

PREVIOUS OCCURRENCES

There is not a comprehensive data source listing instances when the National Weather Service has issued extreme heat or cold warnings or advisories in Worcester County. Across Massachusetts as a whole, there were 33 cold weather events between 1994 and 2018, and 43 warm weather events between 1995 and 2018.[89] Inland portions of Massachusetts are more subject to extreme temperatures because they lack the moderating effect of the Atlantic Ocean, and densely developed cities are more likely to be impacted by heat waves than smaller towns like Warren.

PROBABILITY OF FUTURE EVENTS

The probability of future extreme heat or extreme cold is considered to be "moderate," or between 10 and 40 percent in the next year.

[83] National Weather Service. (n.d.). What is the heat index? National Weather Service; NOAA's National Weather Service. Retrieved February 4, 2022, from https://www.weather.gov/ama/heatindex
[84] 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan.
[85] 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan.
[86] 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan.
[87] 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan.
[88] 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan.
[89] 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan.

IMPACT

The impact of extreme heat or cold in Warren is considered to be "limited," with no property damage and a limited effect on humans.

EXPOSURE

Certain features within Warren's community infrastructure, society, and environment may face more exposure to extreme temperatures, or be disproportionately impacted by them, relative to the rest of the community. Some of these features may be documented in the list of critical facilities and vulnerable populations in *Section 0*. Vulnerable community features include:

- Children and elderly residents, who may find it difficult to regulate their body temperatures in extremely hot or cold conditions. Consequently, Warren's ambulance service may be busier during periods of extreme temperature. As a mitigation measure, Warren uses its Senior Center as a cooling center during extreme heat and a warming shelter during severe winter storms.
- Low-income residents who are unable to afford adequate cooling or heating. Warren's Core Team expressed concern about the direct impact of residents from inadequate heating and cooling, as well as the potential for indoor mold growth if households cannot regulate their indoor environment.
- Renters who may have few options for mitigating extreme heat and cold through home improvements.
- People who work outdoors such as construction or farm workers.
- The utility grid, which could be vulnerable to outages due to surges in power during extreme temperatures. Power outages during extremely hot or cold days could cause further problems to those who rely on air conditioners or electric heaters.
- Certain forms of agriculture may be negatively affected by extreme temperatures, especially extreme heat.
- Infrastructure, including roads and pipes, which may face maintenance issues due to extreme temperatures or rapid temperature swings.
- Railroad tracks, which can buckle in extreme heat and snap in extreme cold.

POTENTIAL CLIMATE CHANGE EFFECTS

According to the 2018 State Hazard Mitigation and Climate Adaptation Plan, there are two major ways that temperature in Massachusetts be influenced by climate change:

- High temperatures overall will result in higher extreme temperatures in the summer months. By 2100, extreme heat could occur between 13 and 65 days during the summer.
- By 2100, annual average temperatures are expected in increase by 3.8 to 10.8 degrees compared to the 1971-2000 baseline.

In summary, climate change is likely to increase the frequency of extreme heat in Massachusetts. Changes to average annual temperatures will also impact Warren. Seasonal temperatures may

shift, with spring and summer temperatures extending through more of the year.[90] Winters may also be more mild than historical norms.[91] Changes to average temperatures could impact the agricultural industry and the natural environment. Farmers may need to shift their practices to account for new climate conditions, and certain species of plants and animals may need to migrate to new ranges to find suitable habitat.[92]

VULNERABILITY

Warren's vulnerability from extreme heat and cold is considered to be, "4 - Low Risk."

4.13 OTHER HAZARDS

In addition to the hazards identified in previous sections, the Hazard Mitigation Team reviewed the other hazards listed in the Massachusetts Hazard Mitigation Plan: coastal hazards, atmospheric hazards, ice jams, coastal erosion, sea level rise, and tsunamis. It was determined that these hazards are irrelevant to Warren due to the town's location.

4.13.1 LANDSLIDES

One other hazard that can affect Warren is landslides. Landslides occur in all U.S. states and territories. In a landslide, masses of rock, earth, or debris move down a slope. Landslides may be small or large, slow or rapid. They are generally activated by:

- storms
- earthquakes
- volcanic eruptions
- fires
- alternate freezing or thawing
- steepening of slopes by natural erosion or by human modification

Debris and mud flows are rivers of rock, earth, and other debris saturated with water. They develop when water rapidly accumulates in the ground, during heavy rainfall or rapid snowmelt, changing the earth into a flowing river of mud or "slurry." They can flow rapidly, striking with little or no warning at avalanche speeds. They also can travel several miles from their source, growing in size as they pick up trees, boulders, cars, and other materials.

There are no documented previous occurrences of significant landslides in Warren. The town is relatively hilly but the risk of landslides is considered to be minimal. Most of the town's rivers are slow moving and frequently dammed, which can minimize landslide risk. Roadways are not generally built close to river channels, reducing undercutting risk from stormwater-induced bank erosion. High slope terrain (defined as 15 to 25% grade) cover 3,114 acres, or 17.6% of the town;

[90] 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan.
[91] 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan.
[92] 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan.

very high slopes (higher than 25% grade) cover 697 acres, or 3.9% of the town's area. Development is present in these areas and, should a landslide occur in the future in Warren, the type and degree of impacts would be highly localized. Vulnerabilities could include damage to structures, damage to transportation and other infrastructure, and localized road closures, though our data review and the local planning team noted no specific concerns. Injuries and casualties, while possible, would be unlikely given the low extent and impact of landslides in Warren.

Warren, like nearly all communities in the CMRPC region, has few areas with susceptibility for landscapes based on the Slope Stability Map of Massachusetts (2013)[93]. According to this report, the areas of Warren most susceptible to landslides include parts of Marks Mountain, a slope just to the west of Route 19 and south of Bay Path Road, a slope just to the west of Route 19 and south of Old Brook Road, and a slope above the railroad tracks along the Palmer border. Some of these areas have a high-risk rating for landslides. Route 19 is an official evacuation route for Warren, which elevates the potential impact of landslides along that roadway. However, in general, landslides are considered low frequency events that may occur once in 50 to 100 years (a 1% to 2% chance of occurring per year).

4.13.2 SPONGY MOTH

The spongy moth,[94] first introduced in Massachusetts in 1869 causes tree defoliation severely impacting the health of forest. Spongy moth populations in Massachusetts have generally experienced cyclical patterns; large population booms are interspersed by years of low population density. The 2017 outbreak of spongy moths is considered the worst in several decades. Drought conditions in recent years had limited the effectiveness of a soil borne fungus, *Entomophaga maimaiga*, which has helped keep spongy moth populations in check since the last large outbreaks of the 1980's. This 2017 population boom caused over 923,000 acres of damage statewide in Massachusetts. Weather conditions that stress tree health like drought and high temperatures can intensify the impact of spongy moth defoliation, making trees more likely to die rather than recover from an infestation.

Widespread tree damage in Warren has been attributed to spongy moths. This standing dead wood is vulnerable to high winds and makes it more likely for trees or limbs to fall during storms. Community resilience building workshop participants reported so many trees are ill that even relatively low windspeeds can cause branches to fall on roads, power lines, or buildings. Given the high percentage of forested land cover in Warren, there are more sick trees to trim or remove along public roads than town's Tree Warden[95] can keep up with.

4.13.3 BEAVERS

[93] https://mgs.geo.umass.edu/biblio/slope-stability-map-massachusetts
[94] *Lymantria dispar*. The prior name for this species, "gypsy moths", contained a racist term and is no longer used.
[95] In Warren, the Tree Warden is the Highway Surveyor. The Highway Department regularly marks trees for trimming or removal when they are in the field for road repairs. However, there are too many trees that need trimming for the department's crew size, budget, and equipment, to handle.

Beavers are common and abundant throughout most of Massachusetts. Beavers are native to Massachusetts but were eliminated in the state by 1750 due to widespread trapping and deforestation by European colonists. Beavers returned to Massachusetts in the early 20th century and are becoming increasingly more common.[96] Beavers play an important role in controlling downstream flooding by storing and slowly releasing floodwater. They also improve water quality by removing or transforming excess nutrients, trapping silt, binding and removing toxic chemicals, replenishing groundwater, and filtering out sediment. However, Warren has concerns with the growing number of beavers and the potential hazard of the beaver dams.

Beaver dam failures result in rapid entrenchment downstream of the dam, some evacuation of pond sediments, and rapid colonization of exposed sediments by vegetation. A major storm or rapid snow melt in the region could significantly impact the stability of beaver dams, though the dams are generally solidly built, the risk of multiple breaches at once should be taken into account. Cascade failure of the dams is also a concern, if one dam collapses others downstream might not be able to handle the sudden increase in the surge of water. Catastrophic flooding could occur, and sediment of likely unknown quality would be washed downstream. There are multiple recorded instances of flooding caused by beaver dam failures in Warren. Significant beaver dam flooding, through dam failures or rising water levels, has been reported at School Street Brook (West Warren), O'Neil Brook (near Coy Hill), Sullivan Brook (just above Old West Brookfield Road), Walkeen Kozoil Road, and Tufts Brook (culvert under I-90). Flooding related to the beaver dams above West Warren, such as the dam on School Street Brook, impact relatively densely developed residential streets and Dean Street Park. Culvert upgrades and drainage improvements have helped mitigate beaver dam

[96] Mass Audubon. (n.d.). About Beavers. https://www.massaudubon.org/learn/nature-wildlife/mammals/beavers/about

flooding, but more upgrades are needed given the number of beaver dams and the increasing frequency of extreme precipitation in Warren.

Image 8: School Street Brook beaver dam breach on May 22, 2021.

Image 9: Flooding from School Street Brook beaver dam breach on May 22, 2021.

5.0 EXISTING PROTECTION

The Town of Warren currently makes use of most available locally-controlled tools to mitigate the consequences of natural hazards: zoning regulations, planning, and physical improvements. The Town does plan to research the utility of more public awareness and education programs as a result of this planning process.

Warren has most of the no-cost or low-cost hazard mitigation capabilities in place. Land use zoning, subdivision regulations and an array of specific policies and regulations that include hazard mitigation best practices, such as limitations on development in floodplains, stormwater management, tree maintenance, etc. Warren also has appropriate staff dedicated to hazard mitigation-related work for a community of its size, including an Emergency Management Director, a professionally run Department of Public Works, a Facilities Director, and a Tree Warden. Warren has several relevant plans in place, including a Comprehensive Emergency Management Plan, and a Master Plan. Not only does Warren have these capabilities in place, but they are also deployed for hazard mitigation, as appropriate. The town also has very committed and dedicated volunteers who serve on Boards, Commissions and Committees and in other volunteer positions. The town

collaborates closely with surrounding communities through its Local Emergency Planning Committee and has opted in to fire protection mutual aid agreements through MEMA.

Warren is also an active member community of the Central Massachusetts Regional Planning Commission (CMRPC) and can take advantage of no cost local technical assistance as needed provided by the professional planning staff at CMRPC.

The table in Section 7.0 describes existing mitigation protections in Warren. It includes a brief description of each activity as well as a subjective evaluation of its effectiveness and of any need for modifications.

5.1 EXISTING PROTECTION MATRIX

Existing Measure	**Description**	**Action**	**Effectiveness & Recommendations**
Participation in National Flood Insurance Program (NFIP)	Provides flood insurance for structures located in flood-prone areas. Also, communities participating in the NFIP have adopted and enforce ordinances, bylaws and regulations that meet or exceed FEMA requirements to reduce the risk of flooding.	Warren monitors building activity within the flood plain to ensure compliance with provisions of state building code.	Effective; There are no repetitive loss properties in Warren. Warren should seek to further limit development in the 100-year flood zones. It should continue investigating participation in the Community Rating System (CRS) under NFIP to enable its residents to obtain lower flood insurance rates. Warren should educate its residents about NFIP.
Floodplain Zoning District bylaw	The purpose of the Flood Plain District is to protect the public health, safety, and general welfare, to protect human life and property from the hazards of periodic flooding, to preserve the natural flood control characteristics, and the flood storage capacity of the flood plain and to preserve and maintain the ground water table and water recharge areas within the flood plain.	All development within the floodplain must comply with the Massachusetts State Building Code requirements for constructing in flood plains. Warren Planning Board requires Special Permits for all construction and earth moving in this area.	Effective; Warren should seek to further limit development in the 100-year flood zones, and consider expanding the area regulated under this bylaw as heavy precipitation may become more frequent or severe due to climate change.
Stormwater Management policy and regulations in place	Planning Board or Conservation Commission reviews projects for consistency with MA DEP standards. This helps ensure adequate on-site retention and recharge.	Warren does not have a Stormwater Management Bylaw. The Major Development and Solar sections of the zoning bylaws, as well as the Subdivision and Wetlands Regulations have specific	Existing stormwater regulations within other bylaws are effective; no changes recommended at this time.

Existing Measure	**Description**	**Action**	**Effectiveness & Recommendations**
		requirements for Stormwater Management.	Warren has seen a locally high rate of residential development since 2019, so this topic may need to be revisited in the future.
Local Open Space and Recreation Plan	Local plan identifying significant natural resources and identifying mechanisms to ensure their protection. Following Mass. Department of Conservation and Recreation guidance for development of OSRPs, this document does not focus on specific hazards. Open Space Plans can provide many tools. Towns must commit to making the land acquisitions and regulatory changes, giving increased attention to preserving undeveloped flood-prone areas and associated lands	A new update to Warren's Open Space and Recreation Plan will be completed in 2022.	Effective; Warren's new plan is under review with the Department of Conservation Services as of July 2022.
Local wetlands protection bylaw and regulations	Local bylaw enforced by the Conservation Commission building upon the State's Wetlands Protection Act and Regulations. Adds regulatory oversight provisions for development within the jurisdictional buffer zone, adding increased attention to alteration of wetlands and the opportunity to preserve capacity and quality.	Warren does not have a Wetlands Protection Ordinance and Wetlands Protection Regulations.	Very effective, if Warren implemented. Warren should consider implementing a local Wetlands Protection Bylaw, under the authority of the Conservation Commission, to regulate activities within wetlands not covered by the MA Wetlands Protection Act.

Existing Measure	**Description**	**Action**	**Effectiveness & Recommendations**
Drainage system maintenance and repair program	Plan to keep municipal drainage facilities (storm drains, culverts, etc.) in good order	Warren performs catch basin cleaning from every two years, problem locations more frequently. The Highway Department removes vegetative debris from roadsides when out in the field.	Effective; Warren should examine a public education program for residents on storm drain clearance and other best practices
Tree Trimming	Plan to ensure routine maintenance of trees to reduce likelihood of vegetative debris in response to storm events	Warren conducts roadside mowing from April-November to remove juvenile trees. Tree trimming (take-downs and clearing dead branches) takes place as needed. National Grid performs tree trimming and removal in their right of ways.	Effective; National Grid has increased their tree trimming efforts since 2021. More local funding for tree trimming would be helpful to address hazard trees along roadways outside of National Grid right of way.
Street Sweeping	Sweep streets to increase stormwater management capacity; capture a dispose of debris appropriately.	All roads swept at least once per year.	Effective; no changes recommended.
Culvert Maintenance and Replacement	Maintain existing culverts through regular maintenance and (in some cases) beaver controls; replace/expand culverts where needed to allow for adequate stormwater flow.	Culverts are repaired or upgraded on an as needed basis. An inventory of problem culverts is maintained.	Somewhat effective; Current efforts are piecemeal and are limited by lack of resources and systematic approach. Warren should develop a prioritized inventory of problem culverts for use in seeking external financial support. Planning must comply with 2014 Mass. Wetlands Protection Act update; culverts may not simply be replaced in-kind.

Existing Measure	**Description**	**Action**	**Effectiveness & Recommendations**
Reverse 911 system	Emergency warning system that sends voicemail/text/email alerts to residents (text/email alerts are optional).	Reverse 911 enables the town to provide residents with critical information quickly in a variety of situations, such as severe weather, unexpected road closures, missing persons and evacuation of buildings or neighborhoods.	Very effective. Warren also maintains emergency sirens and tests them on a monthly basis.
Community Emergency Response Team (CERT) and public education about natural hazards	Warren has an active volunteer CERT organization that is ready and willing to assist with public emergencies.	CERT, the Highway Department and the Fire Department actively educate Warren residents about mitigating and preparing for natural hazards through their respective Facebook pages. CERT also hosts in-person events to connect with the community.	Effective; no changes recommended.
Shelter Plan	Warren's Emergency Management Director maintains a Shelter Plan for use during certain natural hazards.	Maintaining the shelter plan requires coordination with numerous local groups like the school district, first responders, and Senior Center. This plan keeps the town prepared for natural hazards and encourages discussion about natural hazards among different stakeholders.	Effective; no changes recommended.

6.0 STATUS OF MITIGATION MEASURES FROM 2019 PLAN

Town staff provided updates on the status of mitigation measures from Warren's 2019 Hazard Mitigation Plan. Certain measures were incomplete as of 2022 and deemed still relevant. These actions were reviewed by the Core Team. Some actions were re-incorporated in the 2022 Hazard Mitigation Plan action strategy based on whether they could be completed in the next 5 years, and their perceived effectiveness (see *Section 7.6: Mitigation Strategies*).

2019 Task	**2022 Status**	**Include in 2022 Plan?**
	High Priority	
Continue to identify and prioritize capital/structural mitigation projects that are cost-effective and technically feasible (stormwater drainage, dam repairs, vegetative debris management, etc.).	Ongoing/Complete – this is an activity that the Highway Department incorporates into all of its decision-making, as frequently as on a daily basis.	This is a vague task and something that the Highway Department always does. It will not be included in the 2022 Action Plan as a specific task.
Continue to pursue funding to mitigate stormwater runoff on Lower Reed Street through drainage installation. Mitigation will stop the roadway from being shut down during heavy storms.	Incomplete – Warren does not have the staff capacity or matching funds to pursue funding for rural road improvements.	Keep, though change to a medium priority task and change timeline to 5+ years. While the flooding on this road is significant and regular, it is a lower priority than other flooding issues.
Sweep streets at least once per year to increase stormwater management capacity; capture and dispose of appropriately.	Complete.	This describes an on-going responsibility of the Highway Dept. It is documented in the Existing Protection Matrix.
Properly clean (at least annually, or more often as may be required) all stormwater structures and basins.	Complete.	This describes an on-going responsibility of the Highway Dept. It is documented in the Existing Protection Matrix.
Continue to monitor beavers and debris from Brookfield Road, Route 19, and Town Farm Road. Remove beavers when allowable and appropriate.	Complete. No beavers have needed to be removed from these areas since 2019.	Remove, task no longer needed.
Study the stormwater drainage at the Waste Water Treatment facility which is located within the flood plain. Develop long term solution to the problem	Incomplete – The Waste Water Treatment facility has not had the staff capacity to address this issue as they have been understaffed for several years.	Keep this issue in plan but update the task description. The new task is for the Highway Surveyor to bring up this topic with the new WWTF director.

Integrate hazard mitigation concerns into transportation projects (e.g., drainage improvements, underground utilities, etc.).	Ongoing/Complete – this is an activity that the Highway Department incorporates into all of its decision-making, as frequently as on a daily basis.	This is a vague task and something that the Highway Department always does. It will not be included in the 2022 Action Plan as a specific task.
Clear and maintain the drainage at the railroad underpass to ensure flooding is mitigated. Ensure drainage in this area is well maintained and repaired/upsized when appropriate.	Complete.	
Investigate the need for lightening protection on all town buildings, install any lightening protection on buildings found lacking the protection.	Complete – the one building that needs lightning protection (the Old Town Hall/Police Station) is protected.	
Continually increase communication/coordination between federal, state, regional, county, municipal, private, and non-profit agencies in the area of pre-disaster mitigation. Become active in the Quaboag Regional Emergency Planning Committee	Partially complete – there is more communication now than pre-2019. Warren has not participated in the QREPC. It's unclear whether than group is still active.	This is a vague and on-going task. Remove.
Continue to develop and enhance working relationships with the utility companies to improve mitigation of threats, and improve communication during events; ensure satellite spaces within each community for temporary emergency headquarters	Complete – Warren and its utilities (esp. National Grid) have improved their communication and collaboration on emergency preparedness. National Grid has been doing a lot of recent tree trimming to mitigate outages.	
Maintain and promote Reverse 911 hazard warning systems and notification to community continue the use of the two warning sirens.	Complete – Reverse 911 system in place. Emergency sirens are tested monthly.	This describes an ongoing responsibility. It is documented in the Existing Protection Matrix.
Promote use of full range of federal and state resources related to hazard mitigation such as educational materials, training, and National Weather Service forecasts.	Complete – these resources are relied on for local decision-making and shared on Facebook or via the emergency alert system. They are used by the EMD and the Highway Department to prepare the public for hazards.	

Continue to actively enforce and comply with the State Building Code Requirements.	Complete.	Remove. This task describes the job of the Building Inspector.
Continue to actively enforce and comply with the Massachusetts Wetlands Protection Act. Consider adoption of a local wetland's bylaw.	Ongoing. The Conservation Commission continues enforcement. Adoption of wetlands by-law to be considered.	
Pursue funding that builds local capacity and supports grant-writing for mitigation actions identified in the local hazard mitigation plan.	Ongoing/Complete. Town applied for and received CDBG funds, Small Communities Grant (OSRP), MVP Planning Grant for MVP/HMP (this plan), OneStop–Rural Development Funds.	Keep.
Continue to enforce seismic standards in the State's Building Code.	Complete.	Remove. This task describes the job of the Building Inspector.
Continue educating locals officials, builders, realtors and individuals' knowledge of how to read and interpret FIRM maps	Complete.	Remove. This task is included in the Building Inspector job duties.
Find funding to review and update the regional and local disaster mitigation plans on a five-year cycle.	Complete.	
Incorporate, where appropriate, hazard mitigation actions into appropriate local and regional plans – Master Plans, land use, transportation, open space, and capital programming.	Ongoing – the specifics of this task will be documented in Section 8.2 of the 2022 HMP.	Keep.
Incorporate disaster mitigation concerns into the MEPA review process.	This status of this task is unknown. The Town of Warren has no control over the MEPA review process, which is overseen by DEP.	This task should be removed as it is out of the control of the Town's control.
Integrate disaster mitigation concerns into subdivision, site plan review, 40B reviews, and other zoning reviews. Require the consideration of downstream flooding impacts caused by new projects—even if the impacts cross town lines. Work on model bylaw language for urban/wildland interface and model parking standards to	To be considered.	

reduce the amount of impervious coverage. Develop a more stringent review process ensure new development conforms to current regulations.		
Maintain up to date Shelter Plan. Inventory shelter/emergency resources. Identify what services are available at the different shelters (e.g., food preparation, potable water, back-up electrical power, heat, showers, etc.) and whether the location of different shelters will be impacted by different hazards (i.e., whether flooding will make the shelter inaccessible to some residents). This would help ensure that suitable shelters are available for different types of natural hazards.	Ongoing – Warren reviews its shelter plan on an annual basis. They will revisit it next in August 2022 when the regional school district's staff are in place. Warren also collects data on shelter usage to improve future planning.	This is an ongoing task that has been documented in the Existing Protection Matrix section.
Medium Priority		
Develop a formal vegetative debris management program to reduce debris and thereby mitigate risk of stormwater flooding, riverine flooding, winter storm damage, etc., consider joining the Central Massachusetts Mosquito Control Project.	In progress/Ongoing – vegetative debris management by the Highway Department has ramped up significantly since 2019. This debris is consistently collected when the department works in the field. Warren has not joined the Central Massachusetts Mosquito Control Project.	This is a relatively vague task. It is documented in the Existing Protection Matrix.
Repair and improve the Gilbert Road and CSX underpass, improve the drainage in this area.	Complete – the Highway Department cleared out and repaired the drainage so the area no longer floods. Additional improvements are not needed at this time.	Remove.
Find funding to repair the Pulasky Bridge at South Street, an identified evacuation route.	Incomplete- the Town has not found funding for this repair.	Keep. This will be the next small bridge that Warren will request funding to repair. 3-year timeline.
Purchase a generator for the Town Hall	Complete.	
Develop a means for sharing information on a regional basis about successful disaster mitigation planning and programs. Create a feedback loop to improve pre-disaster	Incomplete – Warren does not have the staff time to devote to facilitating regional dialogue or a formal post-disaster assessment process.	Remove.

planning by establishing a formal post-disaster assessment process		
Identify hazard mitigation actions that are consistent with the objectives of other interest groups. Collaborate with others to undertake initiatives and achieve success. Work with the Lucy Stone Park and the Quaboag Blue Trail	Complete – a broad group of stakeholders participated in the 2022 Community Resilience Building workshop hosted by Warren.	Remove, as this is a relatively vague and ongoing task.
Expand the use and role of annual Capital Improvement Program. Educate the Capital Planning Committee about hazard mitigation and the benefit of long-term actions the town could make addressing threats	Incomplete – Warren does not have a Capital Improvement Committee due to a lack of volunteers to staff the committee.	Keep, but change the focus of the task to creating and maintaining a Capital Improvement Planning Committee.
Continue to encourage the adoption of underground utility requirements in local subdivision regulations, and retrofitting of existing infrastructure. Consider updating zoning bylaws incorporating modern methods to address stormwater drainage and other hazards.	Ongoing. Retrofit existing infrastructure all the time with grants. Town encourages underground utility requirements where appropriate.	Keep.

7.0 MITIGATION STRATEGY

The Warren hazard mitigation planning team developed a list of mitigation strategies (both new and previously identified by local officials) and prioritized them using the criteria described below. This list of factors is broadly derived from FEMA's STAPLE+E feasibility criteria.

7.1 OBJECTIVE

Objectives are based on background information on natural hazards in Warren, the list of critical infrastructure and facilities, and notes from the Community Resilience Building workshop, to generate a list of objectives for Warren's natural hazard mitigation strategy. Each objective includes one or more mitigation actions. General objectives for Warren include:

- Address current stormwater drainage issues and proactively incorporate resilience to extreme precipitation
- Address roadway erosion and maintenance issues and proactively incorporate resilience to extreme precipitation
- Protect the natural environment and ecosystem services
- Maintain and improve flood mitigation infrastructure
- Ensure hazard mitigation and emergency preparedness is an ongoing community process
- Complete other actions that build community resilience

7.2 PRIORITY

Following the ranking of each strategy for its mitigation impact, real world considerations were brought back into the analysis to inform the priority ranking process. Factors considered in this step include costs and cost effectiveness (including eligibility and suitability for outside funding), timing, political and public support, and local administrative burden.

- High Priority – strategies that have obvious mitigation impacts that clearly justify their costs and to a large degree can be funded, can be completed in a timely fashion, can be administered effectively, and are locally supported
- Medium Priority – strategies that have some clear mitigation impacts that generally justify their costs and generally can be funded, can be completed in a timely fashion, can be administered effectively, and are locally supported
- Low Priority – strategies that have relatively low mitigation impacts that do not necessarily justify their costs and that may have difficulty being funded, completed in a timely fashion, administered effectively, and locally supported

Costs and cost effectiveness – in order to maximize the effect of mitigation efforts using limited funds, priority is given to low-cost strategies. For example, regular tree maintenance is a relatively low-cost operational strategy that can significantly reduce the length of time of power outages during a winter storm. Strategies that have clear and viable potential funding streams, such as FEMA's Hazard Mitigation Grant Program (HMGP), are also given higher priority.

Time required for completion - Projects that are faster to implement, either due to short work duration, current or near-term availability of funds, and/or ease of permitting or other regulatory procedures, are given higher priority.

Political and public support - Strategies are given higher priority if they have demonstrated political and/or public support through positive involvement by the public, prioritization in previous regional and local plans, initiatives that were locally initiated or adopted are given higher priority, or prioritization in the Community Resilience Building workshop process.

Administrative burden – Strategies that are realistically within the administrative capacity of the town and its available support network are prioritized. Considerations include grant application requirements, grant administrative requirements (including audit requirements), procurement, and staff time to oversee projects.

Impact - The team's consideration of each strategy included an analysis of the mitigation impact each can provide, regardless of cost, political support, funding availability, and other constraints. The intent of this step is to separately evaluate the theoretical potential benefit of each strategy to answer the question: if cost were no object, what strategies have the most benefit? Factors considered in this analysis include the number of hazards each strategy helps mitigate (more hazards equals higher impact), the estimated benefit of the strategy in reducing loss of life and property (more benefit equals higher impact) based on the relevant hazard(s) as assessed in Chapter 4, and the geographic extent of each strategy's benefits (other factors being equal, a larger area equals higher impact).

- High Impact – actions that help mitigate several hazards, substantially reduce loss of life and property (including critical facilities and infrastructure), and/or aid a relatively large portion of the community
- Medium Impact – actions that help mitigate multiple hazards, somewhat reduce loss of life and property (including critical facilities and infrastructure), and/or aid a sizeable portion of the community
- Low Impact – actions that help mitigate a single hazard, lead to little or no reduction in loss of life and property (including critical facilities and infrastructure), and/or aid a highly localized area

7.3 ESTIMATED COST

Each implementation strategy is provided with a rough cost estimate based on available third party or internal estimates and past experience with similar projects. Each includes hard costs (construction and materials), soft costs (engineering design, permitting, etc.), and where appropriate Town staff time (valued at appx. $25/hour for grant applications, administration, etc.). Projects that already have secured funding are noted. Detailed and current estimates were not generally available, so costs are summarized within the following ranges:

- Low – less than $50,000

- Medium – between $50,000 – $100,000
- High – over $100,000

7.4 TIMELINE

Each strategy is provided with an estimated length of time it will take for implementation. Where funding has been secured for a project, a specific future date is provided for when completion is expected. However, most projects do not currently have funding and thus it is difficult to know exactly when they will be completed. For these projects, an estimate is provided for the amount of time it will take to complete the project once funding becomes available. Strategies are grouped by 1–2-year timeframe, 3–5-year timeframe, 5+ year timeframe, and ongoing items.

7.5 STRATEGY TYPES

Mitigation strategies were broken into four broad categories to facilitate local implementation discussions, especially regarding budget considerations and roles/responsibilities:

Structure and Infrastructure Projects - Construct "bricks & mortar" infrastructure and building improvements in order to eliminate or reduce hazard threats, or to mitigate the impacts of hazards. Examples include drainage system improvement, dam repair, and generator installation. Structure and infrastructure improvements tend to have the greatest level of support at the local level, but are highly constrained by funding limits.

Preparedness, Coordination and Response Actions - Ensure that a framework exists to facilitate and coordinate the administration, enforcement and collaboration activities described in this plan. Integrate disaster prevention/mitigation and preparedness into every relevant aspect of town operations, including Police, Fire, EMD, EMS, DPW, Planning Board, Conservation Commission and Board of Selectmen; coordinate with neighboring communities where appropriate. Recommendations in this category tend toward standardizing and memorializing generally-practiced activities.

Education and Awareness Programs - Integrate education and outreach into the community to raise awareness of overall or hazard-specific risk and generate support for individual or community-wide efforts to reduce risk. Awareness and education seek to affect broad patterns of behavior, essentially altering a culture. Awareness-building activity tends to have a fairly slow effect, although in the end it can provide extraordinary benefits with relatively little cash outlay.

Local Plans and Regulations - Review and propose updates to local bylaws, ordinances and regulations to protect vulnerable resources and prevent further risk to those resources. Formally adopt these updates into the local regulatory framework. Review the effectiveness of past mitigation projects, programs procedures and policies. Incorporate mitigation planning into master plans, open space plans, capital improvement plans, facility plans, etc.

Planning and regulatory activity tends to provide extraordinary benefits with relatively little cash outlay. However, in smaller communities where planning activities are largely the purview of volunteers, outside assistance from the state or regional levels may be required to maximize its benefits. Political support may be difficult to achieve for some planning and regulatory measures, especially those that place new constraints on land use.

In addition to describing action items in each of these categories, for each strategy we also identify what hazard(s) it is intended to address, as described in *Section 0* of this plan. Each strategy also identifies the lead organization who serves as the primary point of contact for coordinating efforts associated with that item, and identifies potential funding sources for implementation. See *Section 8.4* for more information on potential funding.

7.6 MITIGATION STRATEGIES

Objective	Action Plan/Descriptions	Who agencies involved	Priority High/Med/Low	Estimated Cost High/Med/Low	Timeline
Address current stormwater drainage issues and proactively incorporate resilience to extreme precipitation	Replace the culvert at Old West Brookfield Road and pursue grant funding to pay for this improvement	Highway department	High – Top Priority	High	1-3 years
	Upsize culvert on O'Neil Road, rebuild road bed, and ensure culvert can handle beaver activity and potential blockages	Highway department	High – Top Priority	High	1-3 years
	Develop comprehensive town-wide plan to prioritize stormwater improvements	Highway department	High	Medium	1-3 years
	Modernize drainage infrastructure that channels Comins Pond spillway water through downtown Warren and through CSX overpass bridge	Highway department, CSX railway	High	High	3-5 years
Address roadway erosion and maintenance issues and proactively incorporate resilience to extreme precipitation	Develop solution to address heavy runoff coming off of Coy Hill	Highway department	High	More information needed	3-5 years
	Present cost/benefit analysis of changing road salting practices to town decision makers	Highway department	High	Low	1 year
	Study regulatory solutions to prevent new development from making stormwater runoff worse	Planning Board, Conservation Commission, Board of Selectmen, Highway Department	Medium	Low	3-5 years

Objective	Action Plan/Descriptions	Who agencies involved	Priority High/Med/Low	Estimated Cost High/Med/Low	Timeline
	Find funding to repair the Pulasky Bridge at South Street, an identified evacuation route	Highway Department	Medium	High	3-5 years
	Continue to pursue funding to mitigate stormwater runoff on Lower Reed Street through drainage installation. Mitigation will stop the roadway from being shut down during heavy storms	Highway Department	Low	More information needed	5+ years
Protect the natural environment and ecosystem services	Continue hand pulling effort at Lucy Stone Park to manage invasive vegetation, and use town communication channels to promote this volunteer project	Lucy Stone Park Committee, volunteers	Medium	Low	1 year and ongoing
Maintain and improve flood mitigation infrastructure	Bring Wrights Mill Levee into compliance with Army Corps of Engineers	Board of Selectmen	High - Top Priority	More information needed	1-3 years
	Provide letters of support as needed to help West Brookfield's efforts to upgrade dam infrastructure at the Lake Wickaboag	Board of Selectmen	High	Low	1-3 years
	Develop solution to prevent reeds and debris from blocking Comins Pond spillway	Warren Water District	Low	More information needed	5+ years
Ensure hazard mitigation and emergency	Make municipal vulnerability preparedness a regular	Warren Community Development Committee	Medium	Low	1 year and ongoing

Objective	Action Plan/Descriptions	Who agencies involved	Priority High/Med/Low	Estimated Cost High/Med/Low	Timeline
preparedness is an ongoing community process	line item of the Warren Community Development Committee, which will enable the ongoing review and updating of the plan				
	Improve signage for evacuation routes	Highway Department, Emergency Management Director	Medium	Low	1-3 years
	Create and maintain a Capital Improvement Planning Committee, which will incorporate hazard mitigation and climate change into the town's capital plans	Board of Selectmen	Medium	Low	1-3 years
Other actions that build community resilience	Pursue Green Communities grant funding to improve HVAC systems in public buildings to prevent interior mold growth	Warren Green Communities Committee	High	More information needed	1-3 years
	Create a systematic and prioritized plan for hazard tree removal in consultation with National Grid	Tree Warden, National Grid	High	More information needed	1 year
	Create a prioritized list of potential hazardous waste sites that could become a future problem for the town given flooding or water level changes. Conduct a survey of historical records and DEP records to develop list. Use that list to	Board of Selectmen, CMRPC, Conservation Commission	High	More information needed	1-3 years

Objective	Action Plan/Descriptions	Who agencies involved	Priority High/Med/Low	Estimated Cost High/Med/Low	Timeline
	determine whether to install monitoring wells				
	Discuss the current status of stormwater drainage with new Waste Water Treatment Facility director, including the potential for future precipitation increases given climate change	Highway department, Waste Water Treatment Facility	Low	Low	1 year

8.0 PLAN ADOPTION, IMPLEMENTATION, AND MAINTENANCE

8.1 PLAN ADOPTION

A public meeting was held on May 26, 2022 as part of the Board of Selectmen's meeting in order detail the planning process to date and to solicit comments and feedback from the public on the draft Warren Hazard Mitigation Plan then being developed. The draft plan was provided to the Town for distribution and posted on CMRPC's website from April 11th, 2023 for public review and input. The Plan was then submitted to the Massachusetts Emergency Management Agency (MEMA) and the Federal Emergency Management Agency (FEMA) for their review. Upon receiving conditional approval of the plan by FEMA, the final plan was presented to the Warren Board of Selectmen and certified on [Insert Date].

8.2 PLAN IMPLEMENTATION

The implementation of this plan began upon its formal adoption by the Board of Selectmen and approval by MEMA and FEMA. Those Town departments and boards responsible for ensuring the development of policies, ordinance revisions, and programs as described in *Section 5.0* and *Section 6.0* of this plan will be notified of their responsibilities immediately following approval. The Hazard Mitigation Team will oversee the implementation of the plan.

Incorporation with Other Planning Documents

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

> ***Warren Comprehensive Emergency Management Plan*** (particularly the Critical Infrastructure Section) – the Critical Infrastructure section was used to help identify infrastructure components in Town that have been identified as crucial to the function of the Town; this resource was also used to identify potentially vulnerable populations and potential emergency response shortcomings.
>
> ***Regional Evacuation Plan*** – Funded by Homeland Security via the Commonwealth of Massachusetts and the Central Regional Homeland Security Advisory Council, the regional evacuation plan prepared by CMRPC was used to identify evacuation routes and shelters.
>
> ***Warren Zoning Bylaw*** – Zoning was used to gather identify those actions that the town is already taking that are reducing the potential impacts of a natural hazard (i.e., floodplain regulations) to avoid duplicating existing successful efforts.
>
> ***Warren Master Plan (2006)*** – The Town is currently planning to update its Master Plan. We encourage the future Master Plan committee to incorporate the recommendations provided by the Warren Local Hazard Mitigation Team in the final Warren Master Plan.

***Warren Open Space and Recreation Plan* (2022) –** this Plan was used to identify the natural context within which mitigation planning would take place. This proved useful insofar as it identified water bodies, rivers, streams, open spaces, as well as population trends. This was included to ensure that the Town's mitigation efforts would be sensitive to the surrounding environment.

Massachusetts State Hazard Mitigation and Climate Adaptation Plan (2018) - This plan was used to ensure that the town's HMP was consistent with the State's Plan.

After this plan is approved by both FEMA and the local government, links to the plan will be emailed to all Town staff, boards, and committees, with a reminder to review the plan periodically and work to incorporate its contents, especially the action plan, into other planning processes and documents. In addition, during annual monitoring meetings for the Hazard Mitigation Plan implementation process, the Hazard Mitigation Team will review whether any of these plans are in the process of being updated. If so, the Hazard Mitigation Team will remind people working on these plans, policies, etc., of the Hazard Mitigation plan, and urge them to incorporate the Hazard Mitigation plan into their efforts. The Hazard Mitigation Team will also review current Town programs and policies to ensure that they are consistent with the mitigation strategies described in this plan. The Hazard Mitigation Plan will also be incorporated into updates of the Town's Comprehensive Emergency Management Plan.

8.3 PLAN MONITORING AND EVALUATION

The Town's Emergency Management Director will call meetings of all responsible parties to review plan progress as needed, based on occurrence of hazard events. The public will be notified of these meetings in advance through a posting of the agenda at Town Hall. Responsible parties identified for specific mitigation actions will be asked to submit their reports in advance of the meeting.

Meetings will involve evaluation and assessment of the plan, regarding its effectiveness at achieving the plan's goals and stated purpose. The following questions will serve as the criteria that is used to evaluate the plan:

PLAN MISSION AND GOAL

- Is the Plan's stated goal and mission still accurate and up to date, reflecting any changes to local hazard mitigation activities?
- Are there any changes or improvements that can be made to the goal and mission?

HAZARD IDENTIFICATION AND RISK ASSESSMENT

- Have there been any new occurrences of hazard events since the plan was last reviewed? If so, these hazards should be incorporated into the Hazard Identification and Risk Assessment.

- Have any new occurrences of hazards varied from previous occurrences in terms of their extent or impact? If so, the stated impact, extent, probability of future occurrence, or overall assessment of risk and vulnerability should be edited to reflect these changes.
- Is there any new data available from local, state, or Federal sources about the impact of previous hazard events, or any new data for the probability of future occurrences? If so, this information should be incorporated into the plan.

EXISTING MITIGATION STRATEGIES

- Are the current strategies effectively mitigating the effect of any recent hazard events?
- Has there been any damage to property since the plan was last reviewed?
- How could the existing mitigation strategies be improved upon to reduce the impact from recent occurrences of hazards? If there are improvements, these should be incorporated into the plan.

PROPOSED MITIGATION STRATEGIES

- What progress has been accomplished for each of the previously identified proposed mitigation strategies?
- How have any recently completed mitigation strategies affected the Town's vulnerability and impact from hazards that have occurred since the strategy was completed?
- Should the criteria for prioritizing the proposed mitigation strategies be altered in any way?
- Should the priority given to individual mitigation strategies be changed, based on any recent changes to financial and staffing resources, or recent hazard events?

REVIEW OF THE PLAN AND INTEGRATION WITH OTHER PLANNING DOCUMENTS

- Is the current process for reviewing the Hazard Mitigation Plan effective? Could it be improved?
- Are there any Town plans in the process of being updated that should have the content of this Hazard Mitigation Plan incorporated into them?
- How can the current Hazard Mitigation Plan be better integrated with other Town planning tools and operational procedures, including the zoning bylaw, the Comprehensive Emergency Management Plan, and the Capital Improvement Plan?

Following these discussions, it is anticipated that the planning team may decide to reassign the roles and responsibilities for implementing mitigation strategies to different Town departments and/or revise the goals and objectives contained in the plan. The team will review and update the Hazard Mitigation Plan every five years.

Public participation will be a critical component of the Hazard Mitigation Plan maintenance process. The Hazard Mitigation Team will hold all meetings in accordance with Massachusetts open meeting laws and the public invited to attend. The public will be notified of any changes to the Plan via the

meeting notices board at Town Hall, and copies of the revised Plan will be made available to the public at Town Hall.

8.4 POTENTIAL FEDERAL AND STATE FUNDING SOURCES

8.4.1 FEDERAL FUNDING SOURCES

The following is a summary of the programs which are the primary source for federal funding of hazard mitigation projects and activities in Massachusetts:

Table 27: Federal Hazard Mitigation Funding

Program	Type of Assistance	Availability	Managing Agency	Funding Source
National Flood Insurance Program (NFIP)	Pre-disaster insurance	Any time (pre & post disaster)	DCR Flood Hazard Management Program	Property Owner, FEMA
Community Rating System (CRS) (Part of the NFIP)	Flood insurance discounts	Any time (pre & post disaster)	DCR Flood Hazard Management Program	Property Owner
Flood Mitigation Assistance (FMA) Program	Cost share grants for pre- disaster planning & projects	Annual pre-disaster grant program	MEMA	75% FEMA/ 25% non- federal
Hazard Mitigation Grant Program (HMGP)	Post-disaster cost-share grants	Post disaster program	MEMA	75% FEMA/ 25% non- federal
Building Resilient Infrastructure and Communities	National, competitive grant program for projects & planning	Annual, pre-disaster mitigation program	MEMA	75% FEMA/ 25% non- federal
Assistance to Firefighters Grants (AFG)	Training & equipment for wildfire-related hazards	Annual	FEMA	FEMA
Small Business Administration (SBA) Mitigation Loans	Pre- & Post- disaster loans to qualified applicants	Ongoing	MEMA	Small Business Administration
Public Assistance	Post-disaster aid to state & local governments	Post Disaster	MEMA	FEMA/ plus a non-federal share

The FEMA web pages identify several funding opportunities. Please refer to https://www.fema.gov/grants. Some programs are described in more detail below:

HAZARD MITIGATION ASSISTANCE

The HMA grant programs provide funding opportunities for pre- and post-disaster mitigation. While the statutory origins of the programs differ, all share the common goal of reducing the risk

of loss of life and property due to Natural Hazards. Brief descriptions of the HMA grant programs can be found below. For more information on the individual programs, or to see information related to a specific Fiscal Year, please click on one of the program links.

Hazard Mitigation Grant Program (HMGP)

HMGP assists in implementing long-term hazard mitigation measures following Presidential disaster declarations. Funding is available to implement projects in accordance with State, Tribal, and local priorities. Please refer to http://www.fema.gov/hazard-mitigation-grant-program for additional information.

HMGP funds may be used to fund projects that will reduce or eliminate the losses from future disasters. Projects must provide a long-term solution to a problem, for example, elevation of a home to reduce the risk of flood damages as opposed to buying sandbags and pumps to fight the flood. In addition, a project's potential savings must be more than the cost of implementing the project. Funds may be used to protect either public or private property or to purchase property that has been subjected to, or is in danger of, repetitive damage. Examples of projects include, but are not limited to:

- Acquisition of real property for willing sellers and demolition or relocation of buildings to convert the property to open space use
- Retrofitting structures and facilities to minimize damages from high winds, earthquake, flood, wildfire, or other natural hazards
- Elevation of flood prone structures
- Development and initial implementation of vegetative management programs
- Minor flood control projects that do not duplicate the flood prevention activities of other Federal agencies
- Localized flood control projects, such as certain ring levees and floodwall systems, that are designed specifically to protect critical facilities
- Post-disaster building code related activities that support building code officials during the reconstruction process

Building Resilient Infrastructure and Communities (BRIC)

The Building Resilient Infrastructure and Communities program aims to categorically shift the federal focus away from reactive disaster spending and toward research-supported, proactive investment in community resilience. Examples of BRIC projects are ones that demonstrate innovative approaches to partnerships, such as shared funding mechanisms, and/or project design. For example, an innovative project may bring multiple funding sources or in-kind resources from a range of private and public sector partners. Or an innovative project may offer multiple benefits to a community in addition to the benefit of risk reduction. The BRIC program is replacing the Pre-Disaster Mitigation grant program. More information on the BRIC program can be found here: https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities.

The Massachusetts Emergency Management Agency (MEMA) coordinates BRIC applications for municipalities within the Commonwealth. Links to MEMA resources and BRIC application materials can be found here: https://www.mass.gov/service-details/building-resilient-infrastructure-and-communities-bric-flood-mitigation-assistance-fma-grant-programs.

FLOOD MITIGATION ASSISTANCE (FMA)

Flood Mitigation Assistance (FMA) provides funds on an annual basis so that measures can be taken to reduce or eliminate risk of flood damage to buildings insured under the National Flood Insurance Program. Please refer to the FMA website: http://www.fema.gov/flood-mitigation-assistance-grant-program.

Three types of FMA grants are available to States and communities:

- **Project Scoping Grants** are designed to develop mitigation strategies and obtain data to prioritize, select, and develop complete applications in a timely manner that result in either an improvement in the capability to identify appropriate mitigation projects or in the development of an application-ready mitigation project for FMA or another.
- **Planning Grants** to prepare Flood Mitigation Plans. Only NFIP-participating communities with approved Flood Mitigation Plans can apply for FMA Project grants.
- **Technical Assistance Grants** are awards of up to $50,000 federal cost share for Recipients to which FEMA obligated at least $1 million federal share the previous FMA cycle.
- **Project Grants** to implement measures to reduce flood losses, such as elevation, acquisition, or relocation of NFIP-insured structures. States are encouraged to prioritize FMA funds for applications that include repetitive loss properties; these include structures with 2 or more losses each with a claim of at least $1,000 within any ten-year period since 1978.

MEMA coordinates FMA applications for municipalities within the Commonwealth. Links to MEMA resources and FMA application materials can be found here: https://www.mass.gov/service-details/building-resilient-infrastructure-and-communities-bric-flood-mitigation-assistance-fma-grant-programs.

DISASTER ASSISTANCE

Disaster assistance is money or direct assistance to individuals, families and businesses in an area whose property has been damaged or destroyed and whose losses are not covered by insurance. It is meant to help with critical expenses that cannot be covered in other ways. This assistance is not intended to restore damaged property to its condition before the disaster. While some housing assistance funds are available through FEMA's Individuals and Households Program, most disaster assistance from the Federal government is in the form of loans administered by the Small Business Administration.

Disaster Assistance Available from FEMA

In the event of a Declaration of Disaster, assistance from FEMA is grouped in 3 categories:

A. Housing Needs

- **Temporary Housing** (a place to live for a limited period of time): Money is available to rent a different place to live, or a government provided housing unit when rental properties are not available.
- **Repair**: Money is available to homeowners to repair damage from the disaster to their primary residence that is not covered by insurance. The goal is to make the damaged home safe, sanitary, and functional.
- **Replacement**: Money is available to homeowners to replace their home destroyed in the disaster that is not covered by insurance. The goal is to help the homeowner with the cost of replacing their destroyed home.
- **Permanent Housing Construction**: Direct assistance or money for the construction of a home. This type of help occurs only in insular areas or remote locations specified by FEMA, where no other type of housing assistance is possible.

B. Other than Housing Needs

Money is available for necessary expenses and serious needs caused by the disaster, including:

- Disaster-related medical and dental costs.
- Disaster-related funeral and burial cost.
- Clothing; household items (room furnishings, appliances); tools (specialized or protective clothing and equipment) required for your job; necessary educational materials (computers, school books, supplies)
- Fuels for primary heat source (heating oil, gas).
- Clean-up items (wet/dry vacuum, dehumidifier).
- Disaster damaged vehicle.
- Moving and storage expenses related to the disaster (moving and storing property to avoid additional disaster damage while disaster-related repairs are being made to the home).
- Other necessary expenses or serious needs as determined by FEMA.
- Other expenses that are authorized by law.

C. Additional Services

- Crisis Counseling
- Disaster Unemployment Assistance
- Legal Services
- Special Tax Considerations

ASSISTANCE TO FIREFIGHTERS' GRANTS

The FEMA Assistance to Firefighters Grants (AFG) program provides funds to equip and train emergency personnel to recognized standards, enhance operations efficiencies, foster interoperability, and support community resilience. Under AFG, funds may be available for equipment, vehicles and/or training that can be used to mitigate and/or respond to wildfire-related hazards. AFG also has a Fire Prevention and Safety (FPS) component which funds public outreach programs and prevention activities, which can emphasize wildfire mitigation. Please refer to: https://www.fema.gov/welcome-assistance-firefighters-grant-program.

DISASTER LOANS AVAILABLE FROM THE SMALL BUSINESS ADMINISTRATION

The U.S. Small Business Administration (SBA) can make federally subsidized loans to repair or replace homes, personal property or businesses that sustained damages not covered by insurance. The Small Business Administration can provide three types of disaster loans to qualified homeowners and businesses:

- Physical damage loans: Loans to cover repairs and replacement of physical assets damaged in a declared disaster.
- Mitigation assistance: Funding to cover small business operating expenses after a declared disaster.
- Economic injury disaster loans: This loan provides economic relief to small businesses and nonprofit organizations that have suffered damage to their home or personal property.
- Military reservist loans: SBA provides loans to help eligible small businesses with operating expenses to make up for employees on active duty leave.

For many individuals the SBA disaster loan program is the primary form of disaster assistance. Please find more information about this loan program here: https://www.sba.gov/funding-programs/disaster-assistance.

DISASTER ASSISTANCE FROM OTHER ORGANIZATIONS AND ENTITIES

DisasterAssistance.gov is a secure, user-friendly U.S. Government web portal that consolidates disaster assistance information in one place. If individuals need assistance following a presidentially declared disaster— which has been designated for individual assistance— they can now to go to DisasterAssistance.gov to register online. Local resource information to help keep citizens safe during an emergency is also available. Currently, 17 U.S. Government agencies, which sponsor almost 70 forms of assistance, contribute to the portal.

DisasterAssistance.gov speeds the application process by feeding common data to multiple online applications. Application information is shared only with those agencies individuals identify and is protected by the highest levels of security. DisasterAssistance.gov will continue to expand to include forms of assistance available at the federal, state, tribal, regional and local levels.

8.4.2 STATE FUNDING SOURCES

The following is a summary of state funding opportunities for hazard mitigation projects and activities in Massachusetts:

Table 28: State Hazard Mitigation Funding

Program	Type of Assistance	Availability	Managing Agency	Funding Source
604b	Grants focused on nonpoint source pollution assessment and watershed planning	Annual	Mass DEP	State funding
Chapter 90	Reimbursable grants	On-going	Mass DOT	State funding
Community Development Block Grants	Competitive community development grants	Annual grant program	HCD	US Department of Housing and Urban Development
Community Preservation Act (CPA)	Grants for local projects that preserve local open space or historic sites, create affordable housing, or develop outdoor recreational facilities	Annual program	Department of Revenue (DOR)	Statewide Community Preservation Trust Fund / local Community Preservation Fund
Culvert Replacement Municipal Assistance Grant Program	Competitive grants for replacing an undersized, perched, and/or degraded culvert located in an area of high ecological value	Annual program	DER	State funding
Dam and Seawall Repair or Removal Program	Competitive grants for dam and seawall repair and removal, as well as construction loans	Annual program	EEA	State funding
Division of Ecological Restoration Priority Project	Competitive grants for wetland and river restoration projects	Annual Program	DER	State funding
Land and Recreation Grants and Loans	Varies, though primarily grant funding	Varies, generally annually	EEA Division of Conservation Services	Varies
Mass Works	Competitive infrastructure grants	Annual	EOHED	State funding
Municipal Small Bridge Program	Competitive grants for small bridge replacement, preservation, and rehabilitation projects	Annual	Mass DOT	State funding
Municipal Vulnerability Preparedness Action Grants	Competitive climate adaptation grants	Annual grant program	EEA	75% EEA/ 25% non-state match

Planning Assistance Grants	Competitive grants that support efforts to plan, regulate (zone), and act to conserve and develop land consistent with the Massachusetts' Sustainable Development Principles	Annual grant program	EEA	75% EEA / 25% non-state match
Section 319 Nonpoint Source Competitive Grants Program	Competitive grant program funding projects that address the prevention, control, and abatement of nonpoint source (NPS) pollution	Annual grant program	Mass DEP	State funding
Special appropriations and legislative earmarks	Varies	Infrequent, after natural disasters or legislature vote	State Legislature	State funding
State Revolving Fund	Low-interest loans	Annual program	Mass DEP	Municipal funding with state loan

The Community Grant Funder web page includes the municipal grant programs listed above, as well as other funding opportunities: https://www.mass.gov/lists/community-grant-finder. Some programs in Table 28 are described in more detail on the following pages.

CHAPTER 90 FUNDS

This statewide program reimburses communities for roadway projects, such as resurfacing and related work and other work incidental to the above such as preliminary engineering including State Aid/Consultant Design Agreements, right-of-way acquisition, shoulders, side road approaches, landscaping and tree planting, roadside drainage, structures (including bridges), sidewalks, traffic control and service facilities, street lighting (excluding operating costs), and for such other purposes as the Department may specifically authorize. Maintaining and upgrading critical infrastructure and evacuation routes is an important component of hazard mitigation. Chapter 90 funds could be used for roadway improvements.

COMMUNITY DEVELOPMENT BLOCK GRANT (CDBG)

CDBG remains the principal source of revenue for communities to use in identifying solutions to address physical, economic, and social deterioration in lower-income neighborhoods and communities. CDBG is primarily a housing and community development program administered through the Executive Office of Housing and Community Development (HCD). The program can fund certain critical infrastructure projects, and necessary housing improvements that benefit populations that may be more vulnerable to certain natural hazards. The program can also fund the rehabilitation of municipal buildings such as town halls, which in many cases, also serve as Emergency Operations Centers for their communities.

COMMUNITY PRESERVATION ACT (CPA)

The Community Preservation Act (CPA) is a smart growth tool that helps communities preserve open space and historic sites, create affordable housing, and develop outdoor recreational facilities. CPA also helps strengthen the state and local economies by expanding housing opportunities and construction jobs for the commonwealth's workforce, and by supporting the tourism industry through preservation of the commonwealth's historic and natural resources. All communities in Massachusetts pay into statewide Community Preservation Trust fund through a real estate excise tax. However, communities must set up a local Community Preservation Fund and governing committee to utilize the trust fund. CPA projects can build local resilience by protecting open spaces, and by creating affordable housing, which benefits residents who may be most vulnerable to natural hazards. More information on the CPA program can be found here: https://www.communitypreservation.org/about.

DAM AND SEAWALL REPAIR OR REMOVAL PROGRAM

The EEA funds projects for the repair and removal of dams, levees, seawalls, and other forms of inland and coastal flood control. For additional information, please refer to https://www.mass.gov/service-details/dam-and-seawall-repair-or-removal-program-grants-and-funds.

DER PRIORITY PROJECTS

The Division of Ecological Restoration selects wetland and river restoration projects through a state-wide, competitive process. DER chooses high-priority projects that bring significant ecological and community benefits to the commonwealth. DER's most recent call for applications solicited projects located in Massachusetts that focus on cranberry bog wetland restoration, dam removal and river restoration, coastal wetland restoration projects, or a combination of these topics. More information on the Priority Projects program can be found here: https://www.mass.gov/how-to/become-a-der-priority-project. This program can be used to remove significant or high hazards dams that communities no longer want to maintain, which may improve the health and resilience of aquatic systems.

LAND AND RECREATION GRANTS AND LOANS

The Division of Conservation Services (DCS) manages several grant or loan programs that enable land preservation, natural resources conservation, and public recreation. Municipalities with an active Open Space and Recreation Plan are generally eligible to apply for these programs. Preserving natural open space can buffer natural systems from development impacts, protect open spaces from future development, and maintain ecosystem services like natural flood mitigation. The full list of DCS grant programs can be found here: https://www.mass.gov/land-and-recreation-grants-loans/need-to-know.

MASSWORKS INFRASTRUCTURE PROGRAM

The MassWorks Infrastructure Program provides a one-stop shop for municipalities and other eligible public entities seeking public infrastructure funding to support economic development and job creation. Although not specific to natural hazards per se, these infrastructure enhancements under MassWorks could also address identified needs for hazard mitigation. The MassWorks Infrastructure Program is administered by the Executive Office of Housing and Economic Development, in cooperation with the Department of Transportation and Executive Office for Administration & Finance. Please refer to http://www.mass.gov/hed/economic/eohed/pro/infrastructure/massworks/ for additional information.

MUNICIPAL VULNERABILITY PREPAREDNESS ACTION GRANT PROGRAM

The MVP Action Grant offers financial resources to municipalities that are seeking to advance priority climate adaptation actions to address climate change impacts resulting from extreme weather, sea level rise, inland and coastal flooding, severe heat, and other climate impacts. Towns are eligible for this competitive grant program after successfully completing an MVP planning grant. A variety of project types are eligible for funding, but projects must address local vulnerabilities to climate change and incorporate MVP Core Principles. Grant application information can be found here: https://www.mass.gov/service-details/mvp-action-grant. MVP Core Principles can be found here: https://www.mass.gov/doc/mvp-core-principles/download.

SPECIAL APPROPRIATIONS AND LEGISLATIVE EARMARKS

Although there is no separate state disaster relief fund in Massachusetts, the state legislature may enact special appropriations for those communities sustaining damages following a natural disaster that are not large enough for a Presidential disaster declaration. Since 2011, Massachusetts has issued 12 state of emergency declarations. Additionally, individual legislators may seek specific project funding for projects through the legislative budgeting and appropriations process.

STATE REVOLVING FUND

This statewide loan program through the Massachusetts Department of Environmental Protection assists communities in funding local drinking water, wastewater, and storm water infrastructure improvements.