WELLFLEET

2022 Hazard Mitigation Plan

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Introduction

The purpose of hazard mitigation is to reduce loss from future natural disasters. Storms and other natural disasters can cause loss of life, damage to buildings and infrastructure and have devastating consequences to a community's economic, social and environmental well-being. Planning for future hazards represents an important step towards reducing loss in a community, and many develop a local (or "single jurisdiction") Hazard Mitigation Plan to protect people and community assets. Town officials, residents, and other stakeholders develop the plan and submit the document once completed to the Massachusetts Emergency Management Agency (MEMA) and the Federal Emergency Management Agency (FEMA) for their review and approval.

The purpose of the Wellfleet Hazard Mitigation Plan is to reduce the community's vulnerability to natural hazards by implementing sustained actions to reduce or eliminate long-term risk to human life and property. Wellfleet's Hazard Mitigation Plan also helps build a successful, long-term outreach strategy both to educate residents about natural hazards that could affect the town and create a resilient community that can recover after a storm event.

The Town of Wellfleet completed a FEMA-certified Hazard Mitigation Plan in 2016 (approved by FEMA in 2017). This 2022 Plan builds on the previous plan and reflects changes in in the Town's priorities and mitigation needs since 2016. Completion of this five-year update is critical for the Town to maintain its Community Rating System level which reduces flood insurance cost for property owners.

When the 2022 Wellfleet Hazard Mitigation Plan update is approved by FEMA and adopted by the Select Board, Wellfleet will continue its eligibility for funding from FEMA's Hazard Mitigation Assistance (HMA) program, which includes the following programs:

- **Hazard Mitigation Grant Program (HMGP):** assists in implementing long-term, "forward thinking" hazard mitigation measures following a major disaster
- **Building Resilient Infrastructure and Communities (BRIC):** provides funds for hazard mitigation planning and projects on an annual basis
- **Flood Mitigation Assistance (FMA):** provides funds for projects to reduce or eliminate risk of flood damage to buildings that are insured under the National Flood Insurance Program (NFIP) on an annual basis.

Review Tool Description:

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FEMA developed a "Local Mitigation Review Guide" to help Federal and State officials assess Local Hazard Mitigation Plans in a fair and consistent manner and to ensure approved local plans meet the requirements of the Stafford Act and Title 44 Code of Federal Regulations (CFR) 201.6. The "Local Mitigation Review Guide" was used as guidance in updating the Wellfleet Hazard Mitigation Plan. When text in the Plan meets an element identified in the Review Guide, it is called out in a colored box in the margin.

The Planning Process

Chapter One

Developing a municipal hazard plan involves expertise from a core team of town officials and input from stakeholders, the public, and neighboring communities. When a community-wide plan is supported by a diverse cross section of stakeholders, residents, and town officials, it becomes a "living" document that is useful for the community on a long-term basis. A successful municipal hazard plan educates residents about risk and vulnerability related to natural hazards and builds support for local policies, actions and tools that reduce future losses from natural hazards.

Chapter 1 is a narrative on the hazard planning team and the outreach process used to develop the 2022 Wellfleet Hazard Mitigation Plan.

Planning Process

Since completion of the 2016 Wellfleet Hazard Mitigation Plan, town officials recognized the need both to update its hazard planning strategy and align its efforts to increase the community's resilience to climate change. As a seaside community, Wellfleet has a history of dealing with a dynamic coastal environment. The town is highly susceptible to natural hazards such as coastal flooding, storm surge and erosion. The effects of climate change will continue to exacerbate these hazards. The town has obtained funding for several studies and projects to address coastal hazards currently impacting the community, including roadway flooding and shoreline change.

In addition to completion of a FEMA-certified Hazard Mitigation Plan, Wellfleet (together with the Town of Truro) received a planning grant from Massachusetts Executive Office of Energy and Environmental Affairs through the Municipal Vulnerability Preparedness (MVP) program to complete a community resiliency planning process that examines the town's vulnerabilities and strengths and identifies priority actions to increase the community's resilience to climate change. Town staff, comprised of representatives from several departments, worked with the Cape Cod Commission (CCC) as its certified MVP provider to complete the prescribed MVP process in 2019. Following completion of the MVP workshop and submittal of a final report to the Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA), the town became an MVP certified community and is eligible for action grants to address coastal resiliency and hazards related to climate change.

The MVP program, through its community engagement and participation process, supports and informs the Hazard Mitigation Plan that advances the community's "conversation" around hazard impacts and climate change. The 2022 Hazard Mitigation Plan references the MVP Workshop and incorporates MVP actions.[1]

Planning Team

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Members and Responsibilities

The Planning Team is an interdisciplinary group of town staff members with expertise and authority to develop the plan and the authority and expertise to implement its action items. Several of these town staff members also participated in the 2019 MVP workshop. Cape Cod Commission staff provided technical support to the Planning Team during development of the hazard plan. Assistant Town Administrator Rebecca Roughley and Chief of Police Michael Hurley co-led Planning Team. This group was responsible for developing and reviewing drafts of the Hazard Plan, creating a mitigation strategy,

[1] For information on the MVP process, see https://www.wellfleet-ma.gov/healthconservation-department/news/municipal-vulnerability-preparedness-documents

and submitting the plan for Federal Emergency Management Agency (FEMA) approval and adoption by the Wellfleet Select Board.

As noted above, the Assistant Town Administrator, who also serves as Town Planner, was a member of the local hazard planning team. The town planner oversees the Planning Board, which is the primary local agency for regulating development in the town, and the Zoning Board of Appeals, which also acts on requests for special permits. The Assistant Town Administrator/Town Planner's participation in the hazard mitigation plan ensured information sharing with these boards. Both were included as stakeholders in the MVP and Hazard Mitigation Plan processes. The Conservation Agent, also a member of the hazard planning team, provided a liaison to the Conservation Commission, which has regulatory authority over development in wetland resource areas. Its members were also targeted as stakeholders in both the MVP and Hazard Mitigation Plan processes.

Table 1.1 lists the members of the Wellfleet Hazard Planning Team and their responsibilities.

Name	Title	Responsibilities
James Badera	Building Commissioner	Attended team meetings, reviewed critical facilities list, developed mitigation actions, provided new development and building data
Hillary Greenberg-Lemos	Health and Conservation Agent	Attended team meetings, reviewed critical facilities list, developed mitigation actions
Michael Hurley	Police Chief	Project co-lead, coordinated town staff tasks, reviewed critical facilities list, developed actions, assisted with public outreach strategy, attended team meetings.
Jay Norton	Director of Public Works	Attended team meetings, reviewed critical facilities list, developed capabilities assessment, developed mitigation actions, reviewed drafts.
Richard Pauley	Fire Chief	Attended team meetings, reviewed critical facilities list, developed mitigation actions
Nancy Civetta	Shellfish Constable	Attended team meetings, developed mitigation actions
Rebecca Roughley	Assistant Town Administrator	Project co-lead, coordinated staff tasks, assisted with public outreach strategy, attended team meetings
William Sullivan	Harbormaster	Attended team meetings, developed mitigation actions
Suzanne Grout Thomas	Director of Community Services	Attended team meetings, reviewed critical facilities list, developed mitigation actions
Martha Hevenor	Planner II, Cape Cod Commission	Facilitated meetings, managed and coordinated plan development, updated data and text.
Gary Prahm	GIS Analyst, Cape Cod Commission	Prepared maps; used GIS software to conduct a risk assessment

Table 1.1 | Wellfleet Hazard Planning Team

Meeting Schedule and Involvement

The Planning Team met regularly between November 2021 and February 2022 to develop a five-year update to the 2016 Wellfleet Hazard Mitigation Plan. Cape Cod Commission staff also consulted with project leads throughout the plan's development and sought input from Shannon Hulst, Floodplain Specialist & CRS Coordinator, on matters related to repetitive loss properties, CRS, and floodplain regulations.

Below is a list of dates and topics covered at each of the Planning Team meetings.

- **December 1, 2021**: Kick-off meeting between Cape Cod Commission staff & local planning team. Overview of the Hazard Mitigation Plan update elements; scope of work between Cape Cod Commission and Town.
- **December 15, 2021**: Follow-up of Meeting 1 agenda items; draft public survey; hazard profiles.
- **January 5, 2022**: Follow-up on 2016 Actions status; public survey; hazard profiles; capabilities assessment; new development since 2016; changes in Town priorities; relevant plans and documents
- **February 2, 2022**: New actions for 2022; check-in on outreach and other plan elements. Review of survey results.

Outreach Strategy

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With the Public

The public was engaged at multiple times during the planning stages: during the MVP process; during plan development, and just prior to submission of the draft hazard plan for MEMA/FEMA review.

During MVP Process

Prior to undertaking the Hazard Mitigation Plan update, the towns of Wellfleet and Truro together engaged community members and stakeholders through the MVP/Community Resilience Building (CRB) effort. The keystone of the MVP Process was an eight-hour Community Resilience Building Workshop on March 12, 2019 at Preservation Hall. About 42 people attended this workshop. Participants listed flooding, sea level rise, coastal erosion, extreme/severe weather, high winds/hurricane, and climate change as the most critical natural hazards the town faces. Participants recommended ways to improve resiliency on each of these. Following the workshop, the towns of Wellfleet and Truro held a Listening Session at the Truro Community Center and invited the public to attend and comment. The Listening Session included presentation of a draft summary of workshop process and findings.

Figure 1.1 | Wellfleet and Truro Municipal Vulnerability Preparedness (MVP), eight-hour Community Resilience Building Workshop on March 12, 2019 at Preservation Hall, Wellfleet.

During Plan Development

The Planning Team developed an online survey to gather data on the significance/relevance of the natural hazards identified in the Massachusetts State Hazard and Climate Adaptation Plan to Wellfleet; the impact of natural hazard; and actions taken to protect people's property and themselves. The survey also gathered data on residents' communication preferences. The survey was launched on January 4, 2021 and closed on February 5, 2021, giving the public one month to complete it.

A link to the survey was shared with stakeholders and posted on the Town website and the Police Department's Facebook page. The Planning team received 225 responses to the public survey.

For a copy of the survey, see "Public Survey on Hazard Mitigation" in ***Appendix***.

The process for incorporating public input into the hazard plan was as follows:

1. Planning Team members considered public input from the MVP Workshop and public survey during top hazard identification and development of mitigation actions. Several members of the planning team participated in the workshop.
2. The Planning Team incorporated MVP workshop input and public survey responses/comments into the hazard plan in the following ways:

- **At the December 15, 2021** Planning Team meeting, the members reviewed the top hazards

identified in the 2016 Hazard Mitigation Plan and from MVP workshop participants and used that to help inform/support their determination of hazards most relevant to the community. The hazards assessed in the Hazard Mitigation Plan include the top hazards identified during the MVP process.

- **At the January 5, 2022** Planning Team meeting, members considered recommendations from the MVP workshop and incorporated them into new mitigation actions.
- The group discussed public survey results at the **February 2022** team meeting. The survey asked people to identify specific hazards they experienced or are most concerned about while living or working in Wellfleet. These selections helped confirm/support the Planning Team's determination whether a particular hazard is significant to the town.
- The survey asked people to identify steps that the local government could take to reduce risk from natural hazards and protect the buildings and people of Wellfleet. It included a list of mitigation actions to reduce risk and loss plus an opportunity to suggest additional actions. The public responses helped indicate level of support and identify new actions where needed. Overall, the survey input provided strong support for addressing hazards and climate change impacts.
- The survey asked how respondents get their information. Their responses showed that the Town website and email are critical information sources for residents. The responses also show that some residents get community information from social media. The team discussed the pros and cons of using social media for emergency planning and hazard education

Prior to Submission to MEMA/FEMA

- The Town of Wellfleet posted a link to the draft 2022 Wellfleet Hazard Mitigation Plan on the Town of Wellfleet website and on the Town Police Department Facebook page. The sites included information for providing comments on the plan.
- The draft Wellfleet Hazard Mitigation Plan was presented at the May 24, 2022 Select Board meeting. During the meeting, the public had the opportunity to provide comments. Several people provided written comments. Some comments noted errors in the text. One commenter provided additional hazard events for inclusion and additional culverts to add to the map, plus description about a failed culvert. Some comments included questions. Members of the planning team reviewed the suggested corrections and questions and updated the draft as appropriate to improve the content and clarity. (Copies of written comments are provided in the Appendix.)

With Stakeholders

A stakeholder for the Wellfleet Hazard Mitigation Plan is someone who may be affected by or have an interest in the plan and its implications but was not part of the Planning Team. Stakeholders for hazard planning efforts can be public officials, agency heads, members of neighborhood/civic organizations, business associations or staff from academic institutions.

The stakeholder process for updating the 2022 Wellfleet Hazard Mitigation Plan involved the following steps:

1. Stakeholders were identified during development of the 2016 hazard mitigation plan and the MVP process and reviewed for inclusion in the 2022 plan.
2. The Planning Team designed a strategy to engage and gather input from stakeholders.
3. Stakeholders provided input during the planning process and just prior to plan approval.

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Identification of Stakeholders

Stakeholders include the following organizations and groups in Wellfleet and from across the region:

- Wellfleet Chamber of Commerce
- Wellfleet Non-Resident Taxpayers Association
- Barnstable County Regional Emergency Planning Committee
- Cape Cod Cooperative Extension
- National Park Service/Cape Cod National Seashore
- SPAT
- Marina Advisory Committee
- Wellfleet Conservation Commission
- Wellfleet Open Space Committee
- Wellfleet Planning Board
- Wellfleet Energy & Climate Action Committee
- Wellfleet Adult Community Center
- Wellfleet Chamber of Commerce
- Wellfleet Emergency Management Team
- Woods Hole Sea Grant
- Chequessett Golf and Country Club
- Wellfleet Bay Audubon

Stakeholder Participation

Stakeholders were engaged multiple times– both during the MVP process and hazard mitigation plan development and again just prior to submission of the draft hazard mitigation plan to MEMA and FEMA.

- Stakeholders participated in the MVP workshop and identified top hazards of concern strengths and vulnerabilities related to hazards, and mitigation actions to increase the strengths or reduce the vulnerabilities. Input from the MVP workshop has been incorporated into the 2022 Hazard Mitigation Plan relevant hazard determination and mitigation actions.
- Stakeholders were invited to review and comment on the draft MVP Workshop Summary of Findings which was posted on the Town website and presented at a public listening session in May 2019.
- Stakeholders were invited to participate in the December 8, 2021 Wellfleet Low Lying Roads project workshop.[2]
- Stakeholders were invited to take a hazard survey during plan development in January 2022. The survey provided an opportunity for the Planning Team to gather data on the significance/ relevance of natural hazards identified in the Massachusetts State Hazard Plan to Wellfleet; the impact of the hazards, and effort to improve resiliency. The survey also gathered data on how stakeholders would like to be engaged in hazard related issues in the future. As discussed in the Public Participation section, survey responses helped support the planning team's determination of relevant hazards and also understand which outreach methods are most effective.

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Prior to submission of the draft Hazard Mitigation Plan Update to MEMA, the Planning Team invited stakeholders to review and comment on the plan.

Stakeholders from the Herring River Restoration Project; Wellfleet Conservation Trust; Wellfleet Open Space Committee; Wellfleet Climate and Energy Committee; and Cape Cod Cooperative Extension/Woods Hole Sea Grant submitted comments. Several noted errors in the text to be corrected. Comments from the National Park Service/ Cape Cod National Seashore identified shared action items and opportunities for working together. Cape Cod Cooperative Extension/Woods Hole Sea Grant suggested including reference to the Storm Tides Pathways project and provided information on Repetitive Loss properties data. A seventh grade teacher at Nauset Middle School called the Police Chief (project co-lead) to say that her class was studying hazard mitigation plans and would get extra credit for providing comments. (None were received.) Members of the planning team reviewed the

[2] For more information about the Low Lying Roads Project, see https://www.capecodcommission.org/our-work/low-lying-roads-project/

stakeholder comments and edited the text accordingly. (Written comments are provided in the Appendix.)

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With Neighboring Communities

The draft Plan was sent to Town Planners in Truro and Eastham for review and comment. A copy of the email sent to these neighboring towns soliciting their feedback on the Plan is provided in the Appendix. No comments were received from neighboring towns.

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Continuing Outreach Efforts During Plan Maintenance

Once the 2022 Wellfleet Hazard Mitigation Plan is approved by MEMA and FEMA, it will be forwarded to the Wellfleet Select Board for adoption. Once adopted, the plan enters into the "Maintenance Period" and will be active for five years. During this maintenance period, FEMA requires the Planning Team to continue public engagement.

The following is a list of engagement activities that the Planning Team will complete during this five-year maintenance period:

- Online surveys to gather data on whether Wellfleet residents are prepared for nor'easters, hurricanes and severe winter weather.
- Presentations to community groups about the science of hazards and/or how to prepare for specific hazard events.
- Press releases, social media, and public service announcements to inform the public of hazard related educational workshops and hazard planning information.

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Incorporation with Other Town Plans and Report

Technical Information Used in the Plan

The 2022 Wellfleet Hazard Mitigation Plan builds on the 2016 Hazard Mitigation Plan and was drafted based on the 2016 plan and other existing plans, studies, reports and technical information from local, county, state and federal agencies. Technical data used to formulate the hazard profiles is cited under each profile and is not explicitly cited in the list below.

Below is a list of the resources from federal, state and local agencies that were used and incorporated into the 2022 Wellfleet Hazard Mitigation Plan:

Technical Information from Federal Agencies:

- Local Mitigation Planning Handbook (2013) prepared by FEMA
- How-To Guide: Getting Started – Building Support for Mitigation Planning (FEMA 386-1, 2002) prepared by FEMA
- How-To Guide: Understanding Your Risks – Identifying Hazards and Estimating Losses (FEMA 386-2, 2001) prepared by FEMA
- How-To Guide: Developing the Mitigation Plan (FEMA 386-3, 2003) prepared by FEMA
- How-To Guide: Bringing the Plan to Life – Implementing the Hazard Mitigation Plan (FEMA 386-1, 2002) prepared by FEMA

- Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards (2013) prepared by FEMA
- Hazard Mitigation Assistance Guidance (2015) prepared by FEMA
- National Flood Insurance Program Community Rating System Coordinator's Manual (FIA-15/2013 prepared by FEMA
- National Flood Insurance Program Floodplain Management Requirements: Study Guide and Desk Reference for Local Officials (FEMA 480, February 2005) prepared by FEMA
- Risk Management Series Design Guide for Improving Critical Facility Safety from Flooding and High Winds (FEMA 543, January 2007) prepared by FEMA
- Mitigation Assessment Team Report Hurricane Ike in Texas and Louisiana : Building Performance Observations, Recommendations, and Technical Guidance (FEMA P-757, April 2009) prepared by FEMA
- Recommended Residential Construction for Coastal Areas: Building Strong and Safe Foundations (FEMA P-550, 2nd Edition, December 2009) prepared by FEMA
- Wind Retrofit Guide for Residential Buildings (FEMA P-804, December 2010) prepared by FEMA
- Home Builder's Guide to Coastal Construction Technical Fact Sheets Series (FEMA P-499, December 2010) prepared by FEMA
- Coastal Construction Manual: Principles and Practices of Planning, Siting, Designing, Constructing, and Maintaining Residential Buildings in Coastal Areas Volume I and II (4th edition, FEMA P-55, August 2011) prepared by FEMA
- Highways in the Coastal Environment: Assessing Extreme Events (2014) prepared by the U.S. Department of Transportation and the Federal Highway Administration
- National Climate Assessment (2014)

Technical Information from State Agencies:

- 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan
- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas: A Guide for Planners, Designers, and Municipal Officials (2003) prepared by Franklin, Hampden, Hampshire Conservation Districts
- *Massachusetts Climate Change Adaptation Report* (2011) prepared by Executive Office of Energy and Environmental Affairs and the Adaptation Advisory Committee
- Sea Level Rise: Understanding and Applying Trends and Future Scenarios for Analysis and Planning (2013) prepared by the Massachusetts Office of Coastal Zone Management
- *Massachusetts Coastal Erosion Commission Report* (draft released in 2015) prepared by Coastal Erosion Commission
- Commonwealth of Massachusetts All Hazards Disaster Debris Management Plan (2010) prepared

by the Massachusetts Emergency Management Agency

- *Massachusetts Homeowner's Handbook to Prepare for Coastal Hazards* (2014) prepared by Barnstable County, Woods Hole Sea Grant and MIT Sea Grant

Technical Information from County Agencies:

- *Barnstable County Wildfire Preparedness Plan* (2012) prepared by Barnstable County and the Cape Cod Cooperative Extension
- 2018 Cape Cod Regional Policy Plan (Cape Cod Commission)

Technical Information from Wellfleet:

- Wellfleet Local Comprehensive Plan (2005)
- Town of Wellfleet Zoning Bylaws
- 2016 Wellfleet Hazard Mitigation Plan
- Mayo Creek Restoration Committee Recommendations Final Report
- Town of Wellfleet and Truro Community Resource Building Workshop Summary of Findings [MVP], June 2019
- Intermunicipal Shoreline Management Report (2020)
- Wellfleet Harbor Management Plan 2021

How Technical Information was incorporated

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The technical information listed above was incorporated into the 2022 Wellfleet Hazard Plan in the following ways:

Federal documents, especially all FEMA documents, were used to:

- guide the activities of the planning process
- provide technical guidance on successful mitigation practices in coastal communities
- help the Planning Team develop mitigation actions
- provide current data on climate change and adaptation strategies

State and County documents were used to:

- provide current data on hazard events affecting Massachusetts and Barnstable County
- guide the Planning Team on current state mitigation actions and plans

Wellfleet specific documents were used to:

- ensure that mitigation actions in the plan update were consistent with current activities and plans already in place in Wellfleet
- help inform development of new actions

The Mitigation Goals identified in the 2022 Wellfleet Hazard Mitigation Plan will be incorporated into the following plans:

Local Comprehensive Plan (LCP) - The Wellfleet LCP describes the town's goals, policies and actions on land use, growth management, natural resources, open space and recreation, historic preservation and community character, economic development, housing, and community facilities and services. Mitigation Goals and Actions will be incorporated into the next LCP update, which is currently underway. Below are a few examples

of Mitigation Goals that should be integrated into the LCP update:

- Reduce the potential for loss of life, property, infrastructure, and environmental, cultural and economic resources in Wellfleet from natural disasters.
- Ensure that mitigation measures are sensitive to the natural features, historic resources, and community character of Wellfleet.

Open Space and Recreation Plan – the next OSRP update should incorporate information from the 2022 hazard plan to help inform and guide potential future land acquisition and conservation opportunities.

Local Emergency Plan - the Town will incorporate relevant actions from the 2022 hazard plan into its emergency plan.

Plan Integration Status

New FEMA guidance requires that the 2022 Hazard Mitigation Plan describe how the plan was integrated with other plans over the last five years. The following plans resulted from and/or built upon actions from the 2016 Wellfleet Hazard Mitigation Plan:

- **2019 Community Resource Building Workshop/MVP Summary of Findings** – hazard information and priority actions from the 2016 hazard plan were integrated into the workshop presentations.
- **2021 Harbor Plan Update** – Updating the Harbor Management Plan was an action item in the 2016 Hazard Mitigation Plan. The updated harbor plan reflects hazard and climate change impacts and actions from the hazard mitigation plan.
- **Local Emergency Management Plan** – the emergency plan incorporated actions from the 2016 hazard plan.
- **Low Lying Roads Project** – this project grew out of MVP and the 2016 Hazard Mitigation Plan

Going forward, the town will maintain a list of the new and updated town plans on its website and Planning Team members will work with the town administration to ensure that town planning efforts are consistent with the 2022 Wellfleet Hazard Mitigation Plan.

Natural Hazards

Chapter Two

Wellfleet is vulnerable to a range of natural hazards that threaten life and property. FEMA regulations and guidance under the Disaster Mitigation Act of 2000 require, at a minimum, an evaluation of a full range of natural hazards identified in the most recent Massachusetts State Hazard Plan. An evaluation of human-caused hazards (e.g. technological hazards, terrorism, etc.) is encouraged but not required for plan approval. The 2022 Wellfleet Hazard Mitigation Plan, like the 2016 plan, provides an assessment of natural hazards. **Chapter 2 provides a detailed description of the natural hazards that could impact Wellfleet in the future or have impacted Wellfleet in the past.**

Hazard Identification

State Hazards

Wellfleet is vulnerable to a range of natural hazards that can threaten the people, economy, infrastructure and natural resources of the town. As suggested under FEMA planning guidance, the Planning Team reviewed the full range of natural hazards identified in the most recent Massachusetts State Hazard and Climate Adaptation Plan (2018), which include:

Changes in precipitation:

- Inland flooding
- Drought
- Landslide

Sea Level Rise

- Coastal Flooding
- Coastal Erosion
- Tsunami

Rising Temperatures

- Average/extreme temperatures
- Wildfire
- Invasive Species

Extreme Weather

- Hurricanes/tropical storms
- Severe winter weather/Nor'easters
- Tornadoes
- Other extreme weather

Non-climate related hazards:

- Earthquake

In addition to the hazards identified in the 2018 state hazard plan, the Planning Team also included dam/culvert failure, a technological hazard, which was included as a relevant hazard in the 2016 Wellfleet Hazard Mitigation Plan.

Selection of Hazards that affect Wellfleet

The Planning Team reviewed the natural hazards identified in the 2018 Massachusetts State Hazard and Climate Adaptation Plan and identified those that could impact Wellfleet in the future or that have impacted Wellfleet in the past (***Table*** 2.1). The Planning Team members made this determination based on the current Wellfleet Hazard Mitigation Plan, their own expertise and experience, input from the 2019 MVP workshop, data from the Massachusetts state hazard plans and other resources. All resources are referenced in the text of each hazard profile.

Selection of Hazards that affect Wellfleet

Table 2.1 | List of Relevant Hazards for Wellfleet

Type of Natural Hazard	Possible Here?	Why/how was this determination made?	What resources were used to make that determination?
Coastal Erosion/Shoreline Change	Yes	History of erosion and shoreline change in Wellfleet	Massachusetts Coastal Zone Management MVP Workshop Local knowledge from Town Staff
Dam (culvert) Failure	Yes	There are aging culverts in Wellfleet therefore increasing the probability of failure	2016 Wellfleet Hazard Mitigation Plan; MA Department of Dam Safety Local knowledge from Town Staff
Earthquake	Yes	No history of earthquakes In Wellfleet (but there is a history of earthquakes in Massachusetts)	Local knowledge from Town Staff
Fire (urban and wild)	Yes	Fire-adapted vegetation puts the town at risk for wildfire and there is a history of urban fires in Wellfleet	2018 Massachusetts Hazard and Climate Adaption Plan Barnstable County Wildfire Protection Plan Local knowledge from Town Staff
Flood	Yes	History of flooding in Wellfleet and its geographic location.	2018 Massachusetts Hazard and Climate Adaption Plan MVP Workshop Local knowledge from Town Staff
Hurricanes and Tropical Storms	Yes	History of hurricanes and tropical storms in Wellfleet.	2018 Massachusetts Hazard and Climate Adaption Plan National Hurricane Center. MVP, Local knowledge from Town Staff
Landslide	Yes	No history of event, but sandy soils could be destabilized from water saturation.	2018 Massachusetts Hazard and Climate Adaption Plan Local knowledge from Town Staff.
Nor'easters	Yes	History of nor'easters in Wellfleet and New England.	2018 Massachusetts Hazard and Climate Adaption Plan MVP Workshop Local knowledge from Town Staff

Selection of Hazards that affect Wellfleet

Type of Natural Hazard	Possible Here?	Why/how was this determination made?	What resources were used to make that determination?
High winds	Yes	History of high winds in Wellfleet	2018 Massachusetts Hazard and Climate Adaption Plan MVP Workshop Local knowledge from Town Staff
Thunderstorms	Yes	History of thunderstorms in Wellfleet.	2018 Massachusetts Hazard and Climate Adaption Plan MVP Workshop Local knowledge from Town Staff
Extreme temperatures	Yes	History of extreme cold and hot temperatures in Wellfleet.	2018 Massachusetts Hazard and Climate Adaption Plan; MVP Workshop; Local knowledge from Town Staff
Tornados	Yes	Wellfleet does not have a history of tornados, but a tornado occurred in Harwich and Yarmouth in July 2019 and tornado warnings have been issued in Barnstable County in recent years.	2018 Massachusetts Hazard and Climate Adaption Plan; Local knowledge from Town Staff
Drought	Yes	History of drought in Wellfleet.	2018 Massachusetts Hazard and Climate Adaptation Plan Local knowledge from Town Staff
Severe winter weather	Yes	History of severe winter weather in Wellfleet	2018 Massachusetts Hazard and Climate Adaptation Plan MVP Workshop; Local knowledge from Town Staff
Tsunami	Yes	The probability of a damaging tsunami impacting Massachusetts is unknown	2018 Massachusetts Hazard and Climate Adaptation Plan; Local knowledge from Town Staff
Sea Level Rise	Yes	History of sea level rise in Wellfleet	2018 Massachusetts Hazard and Climate Adaptation Plan; Local knowledge from Town Staff MVP Workshop Cape Cod Commission Sea Level Rise Viewer

Type of Natural Hazard	Possible Here?	Why/how was this determination made?	What resources were used to make that determination?
Invasive Species[3] (associated with higher temperatures)	Yes	History of invasive species in Wellfleet (relative to marine species and impacts on local shellfish resources)	2018 Massachusetts Hazard and Climate Adaptation Plan; Local knowledge from Town Staff

Table 2.1 | List of Relevant Hazards for Wellfleet

[3] Invasive Species is identified as a potential hazard in the 2018 Massachusetts Hazard and Climate Adaptation Plan

Hazard Profiles

Coastal Erosion and Shoreline Change

Overview

Coastal shorelines—especially beaches, dunes and banks—change constantly in response to wind, waves, tides and other factors including seasonal variation, sea level rise and human alterations to the shoreline system.[4] Every day, wind, waves and currents move sand, pebbles and other materials along the shore or out to sea. This dynamic and continuous process of erosion, transport and accretion shape the coastal shoreline. Shorelines change seasonally, tending to accrete gradually during the summer months when sediments are deposited by relatively low energy waves and erode dramatically during the winter when sediments are moved offshore by high energy storm waves, such as those generated by nor'easters.

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Hazard Location

Data and imagery from the Shoreline Change Project[5] and presented the 2016 Hazard Mitigation Plan shows the entire coastline of the planning area is vulnerable to shoreline change. ***Figure*** 2.2 through ***Figure*** 2.4 provide a series of three maps of the planning area showing how the shoreline has changed from the mid-1800s to 2009. Several recent storms have accelerated erosion on the outer ocean beaches and contributed to overwash and loss of dunes at Duck Harbor.

Figure 2.1 | Overwash of Dunes at Duck Harbor

[4] Report of the Massachusetts Coastal Erosion Commission, December 2015

[5] https://www.mass.gov/service-details/massachusetts-shoreline-change-project

Coastal Erosion and Shoreline Change

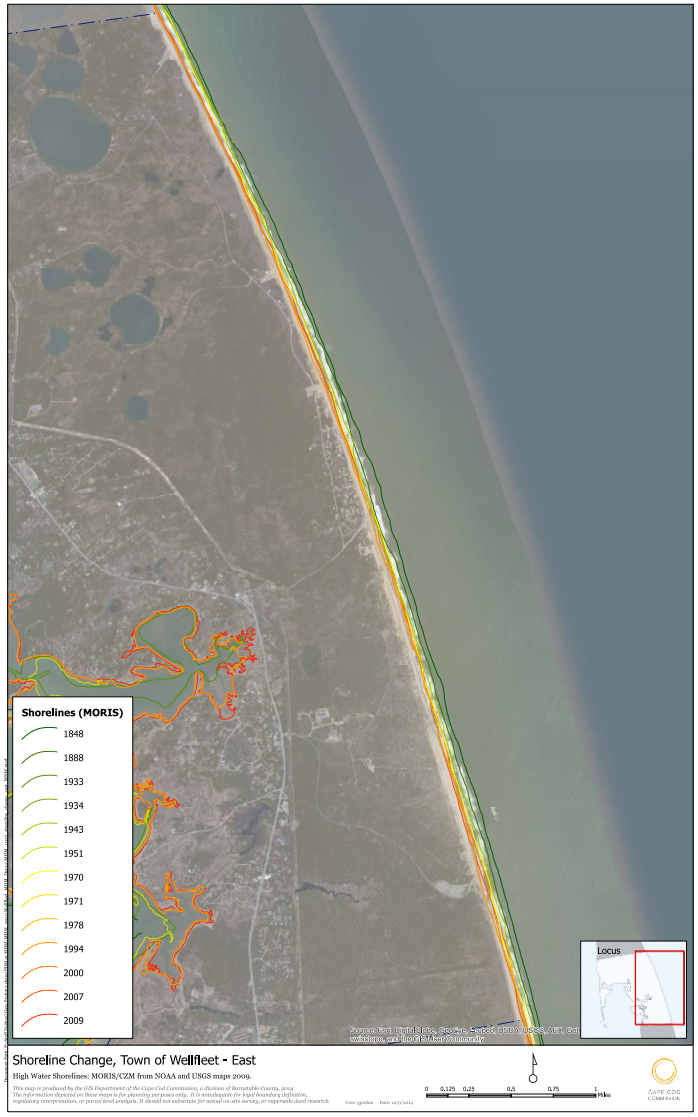


Figure 2.2 | Historic shoreline change along the coast of Wellfleet. Map was created using data from the Massachusetts Ocean Resource Information System

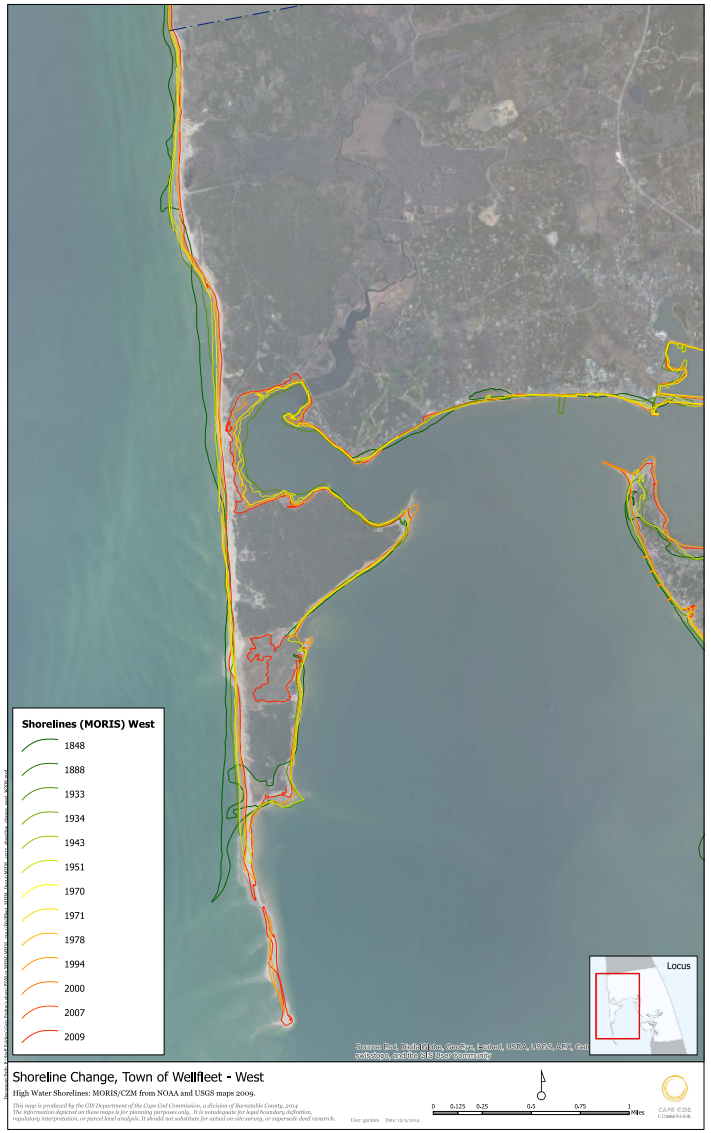


Figure 2.3| Historic shoreline change along the coast of Wellfleet. Map was created using data from the Massachusetts Ocean Resource Information System.

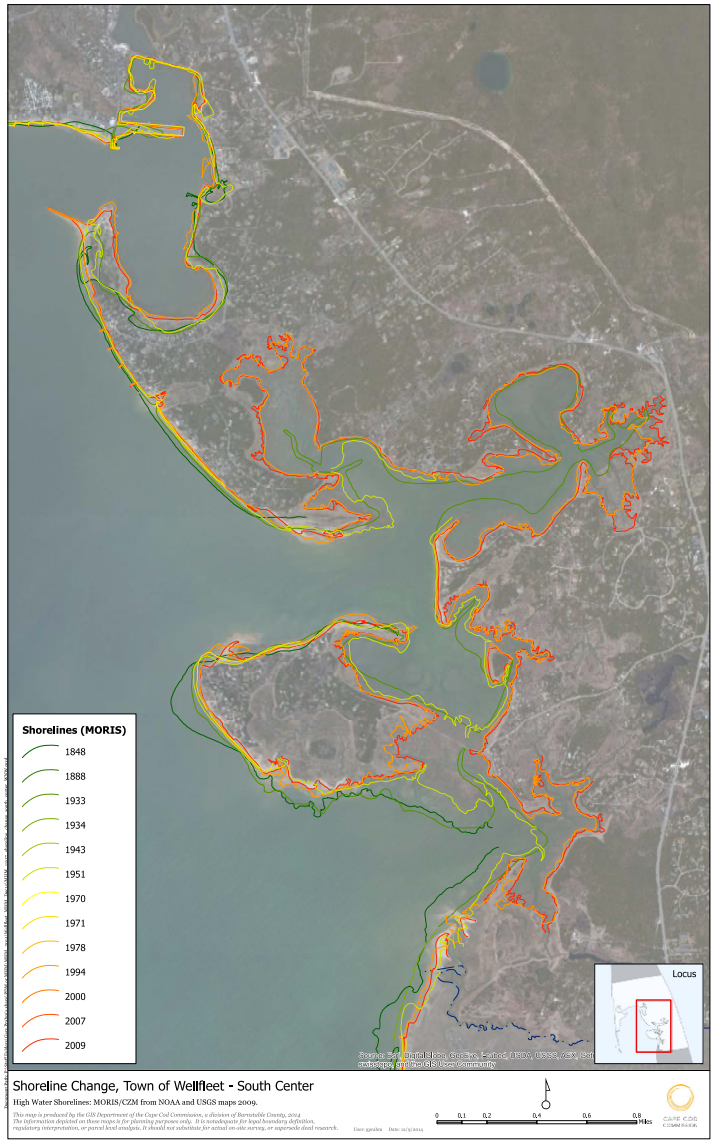


Figure 2.4 | Historic shoreline change along the coast of Wellfleet. Map was created using data from the Massachusetts Ocean Resource Information System

Previous Occurrences and Extent

Coastal erosion is measured as the horizontal displacement of a shoreline over a specific time period, measured in units of feet or meters per year. Shoreline change can be monitored over short-term and long-term time scales. Monitoring on a relatively short period of record may not reflect actual conditions and can misrepresent long-term erosion rates, but long-term patterns of coastal erosion are difficult to detect because of substantial, rapid changes in coastlines over days or weeks from storms and natural tidal processes.

The Massachusetts Coastal Erosion Commission's 2015 Report states the average shoreline change rates for Wellfleet – for the entire town, the Cape Cod Bay, and the Outer Cape Coast - where positive values indicate accretion and negative values indicate erosion, as follows:

Entire Town:

- Short-Term Rate: -2.3 ± 3.2 ft/year
- Long-Term Rate: -1.6 ± 1.8 ft/year

Cape Cod Bay Shoreline:

- Short-Term Rate: -2.0 ± 3.6 ft/year
- Long-Term Rate: -1.2 ± 2.0 ft/year

Atlantic Ocean Shoreline:

- Short-Term Rate: -3.1 ± 1.7 ft/year
- Long-Term Rate: -2.8 ± 0.3 ft/year

It is important to note that this data represents averages for shoreline change throughout Wellfleet, and that there might be areas within town with greater or lesser erosion and accretion rates. In recent years, for example,

locations along the Atlantic shore eroded more than the average yearly short term rate.

Figure 2.5 | Cahoon Hollow parking lot and dune erosion.

Impact

While erosion is a natural process, it causes damage to coastal property and related infrastructure—particularly when development is sited close to the shoreline on unstable ground or low-lying areas[6]. Below is a list of possible damages that could result from shoreline change:

People: public safety is jeopardized when buildings collapse or water supplies are contaminated; erosion can cause roadways to collapse which would increase the response time of emergency vehicles.

Infrastructure: erosion can expose septic systems and sewer pipes, risking contamination of shellfish beds and other resources; accreting sand can block storm water pipes, causing urban drainage issues.

Buildings: erosion reduces the embedment of foundations in the soil, causing shallow foundations to collapse and making buildings on foundations more susceptible to settlement, lateral movement or overturning; once a building moves or is overturned, construction materials and other debris can be swept out to sea; seawalls and other hard structures open downdrift property owners to similar or greater losses

Economy: if businesses are affected by coastal erosion, there could be loss of business function; damage to inventory; relocation costs; wage loss.

Natural Systems: where engineered structures are used to stabilize shorelines, the natural process of erosion is altered, changing the amount of sediment available and erosion rates at adjacent areas; the town's natural ecosystem attractions—beaches, dunes, barrier beaches, salt marshes and estuaries—would also be threatened

[6] Report of the Massachusetts Coastal Erosion Commission, December 2015

and could slowly disappear as sand sources that supply and sustain them are eliminated; under conditions of reduced sediment supply, the ability of coastal landforms to provide storm damage and flooding protection would be diminished, increasing the vulnerability of infrastructure and development.

Transportation: roadways can become damaged due to shoreline recession

The Planning Team determined that it is **HIGHLY LIKELY** that shoreline change will impact the planning area. High probability was defined based on the frequency of occurrence:

- **Unlikely**: less than a 1% probability over the next 100 years
- **Possible**: 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely**: 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely**: near 100% probability in the next year

The Team used the 2016 Wellfleet Hazard Mitigation Plan, data from the Shoreline Change Project, and local knowledge to make this probability determination.

(Dam) Culvert Failure

Overview

A dam is an artificial barrier that can impound water, wastewater, or any liquid-borne material for the purpose of storage or control of water.[7] Dam failure is a catastrophic type of failure characterized by a sudden, rapid and uncontrolled release of impounded water.[8] A culvert is a structural opening under a roadway that allows water to pass from one side of a roadway to the other.[9]

Wellfleet has no dams but has several culverts and one dike that could act like dams during flooding events. This section focuses on the impacts of culvert failure.

Water flowing under a road typically comes from two sources – streams and road runoff – and these water resources require different types of culverts:[10]

A stream crossing culvert is located where the roadway crosses over a stream channel and the culvert allows water to pass downstream.

[7] FEMA Dam Safety Fact Sheet https://www.fema.gov/sites/default/files/2020-08/damsafety_fs1.pdf

[8] Ibid.

[9] Massachusetts Highway Department: Project Development and Design Guide 2006

[10] Failing culverts: Structural problems and economic considerations, Tenbusch, Inc, June 2013, https://www.tenbusch.com/underground_equipment/files/FailingCulvertsStructuralAndEconomicConsiderations.pdf

(Dam) Culvert Failure

A runoff management culvert is a strategically placed culvert to manage roadway runoff along, under and away from the roadway. These culverts are used to transport upland runoff that accumulates in ditches to the lower side of the roadway for disposal.

Culverts are typically made of concrete, steel or aluminum and can have various cross-sectional shapes, (i.e. oval, circular, arched or rectangular). The size of the culvert opening is calculated using location-specific data on the amount of precipitation, snow accumulation and the probability of hurricanes impacting the area. The primary function of a culvert is to prevent flooding during normal and extreme weather conditions and provide proper road and highway drainage.

When culvert failure occurs, it can be catastrophic. Culverts may fail for several reasons, including but not limited to:[11]

Buildup of flood waters on the upstream side of the culvert that exceed the capacity of the culvert (video of a culvert failure in Maine, see: https://www.youtube.com/watch?v=NTbhyHNA1Vc)

The pipe inside the culvert becomes occluded because of debris or improper maintenance.

The pipe inside the culvert loses its structural integrity and begins to cave in.

The culvert and road are washed out during a heavy rain event or from snowmelt runoff.

The soil/material around the culvert pipe begins to move. Without support from such material, the culvert will buckle or sag and the culvert will collapse.

[11] Ibid.

Hazard Location

Fourteen culverts and one dike are located in Wellfleet (locations shown in ***Figure*** 2.6).

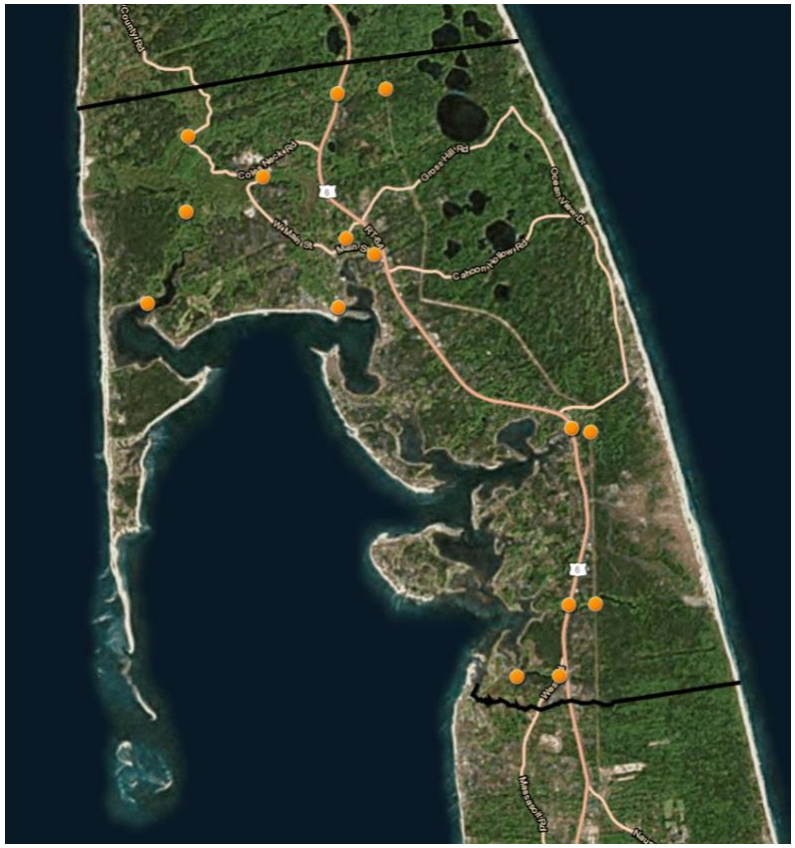


Figure 2.6 | Map of Wellfleet showing the locations of culverts and one dike.

Previous Occurrences and Extent

The Briar Lane culvert drains the watershed behind Town Hall. This culvert is undersize (eight inches) and failing. In heavy storms it backs up and floods the area behind the Box Lunch. The Town applied for grant funding from the state and is seeking additional funds at 2022 Annual Town Meeting for its repair/replacement.

The culverts on Pole Dike Road and the Chequesset golf course will be replaced as part of the Herring River Restoration Project.

The culvert on the Cape Cod Rail Trail failed and flooded the area behind it and was replaced in the early 1990s as part of the rail trail construction. The current drop structure was built there to create an artificial pond.

B3a

Impact

Below is a list of additional possible impacts from culvert failure:

People: community isolation from impassable roads, often leaving residents without power and water.

Infrastructure: power outages from disruption of underground utilities; no water due to disruption of pipes near the failed culvert; the high cost of relief and recovery may adversely affect investment in infrastructure or other development activities.

Economy: impacted traffic flow and impassable roads may prevent people from returning to work and tourists from visiting the area; expensive infrastructure repairs, residents will bear the extra cost of circumventing damaged roads.

Natural Systems: bank erosion, debris in waterways and other natural systems.

Transportation: impaired traffic flow and impassable roads.

B2b

Probability

The Planning Team determined that it is POSSIBLE that a culvert failure will impact the planning area. This determination was defined based on the frequency of occurrence:

- **Unlikely**: less than a 1% probability over the next 100 years
- **Possible**: 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely**: 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely**: near 100% probability in the next year

Culvert age was used to make this probability determination.

Earthquake

Overview

An earthquake is movement or trembling of the ground produced by a sudden displacement of rock in the Earth's crust. Scientists have formulated several theories about the causes of earthquakes, but the theory of plate tectonics is commonly used to explain much of the earthquake activity in the world.[12]

The theory of plate tectonics postulates that, at one point, the earth was covered by a single crust, or plate, with no oceans. Over time, this plate started to split and drift into separate plates of land or ocean crusts. The earth's surface now looks much like a spherical jigsaw puzzle; all the plates fit together. The plates over the earth are in constant slow motion. They generally move in one of three ways—they collide, spread, or slide. Any one of these plate movements can cause an earthquake. Maps of earthquake activity throughout the world show that earthquakes most frequently occur at the boundaries of plates.

Plate movement or other forces create tremendous stress on rocks that make up the earth's outer shell. When rock is strained beyond its limit, it will fracture, and the rock mass on either side will move. This fracture is called a fault. Not all faults will cause earthquakes, but if there is a sudden rupture, energy is released that creates the motions associated with an earthquake. Once the sudden rupture occurs, the earth begins to shake. This shaking is caused by a series of waves known as seismic waves moving from the center of the earthquake outward to surrounding areas. Two scales are frequently used to measure earthquakes:

THE MODIFIED MERCALLI INTENSITY SCALE measures the intensity or impact of an earthquake on people and the built environment. It is determined by trained observers who look at the damage to the built environment and the earth (landslides, etc.), and at the reaction of people to the event (***Table*** 2.2).

THE RICHTER SCALE measures the maximum recorded amplitude of a seismic wave. This measurement quantifies the ground motion and the energy released at the source of an earthquake, which is referred to as its magnitude.

Richter Magnitude of 3.5 -5.4: often felt but rarely causes damage

Richter Magnitude of 5.5 - 6.0: slight damage to well-designed buildings, major damage to poorly constructed buildings

Richter Magnitude of 6.1 – 6.9: destructive

Richter Magnitude of 7.0 – 7.9: major earthquake, causes serious damage over large areas

[12] Earthquake Causes and Characteristics, FEMA Emergency Management Institute Training Guide, https://training.fema.gov/emiweb/is/is8a/is8a-unit3. pdf

Richter Magnitude of 8.0 or higher: named Great Earthquakes, cause serious damage over extremely large areas

Both the Modified Mercalli Intensity Scale and Richter Scale are used to describe earthquakes because they utilize different data sets; the Richter Scale describes an earthquake's magnitude while the Modified Mercalli Intensity Scale describes the earthquake's impact on people and structures.

Table 2.2 | Modified Mercalli Scale, from Earthquake Causes and Characteristics, Chapter 3 of Emergency Management Institute Training Guide

Level	Description
I	Not felt except by a very few under especially favorable circumstances.
II	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III	Felt quite noticeably indoors, especially on upper of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing of truck. Duration estimated.
IV	During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.
VI	Felt by all, many frightened and run indoors. Some heavy furniture moves; a few instances of fallen plaster or damaged chimneys. Damage slight.
VII	Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.
VIII	Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motor cars disturbed.

Level	Description
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rail bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.
XI	Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.
XII	Damage total. Practically all works of construction are damaged greatly or destroyed. Waves seen of ground surface. Lines of sight and level are distorted. Objects are thrown into the air.

Table 2.2 | Modified Mercalli Scale, from Earthquake Causes and Characteristics, Chapter 3 of Emergency Management Institute Training Guide

B1c

Hazard Location

The greatest earthquake threat in the United States is along tectonic plate boundaries and seismic fault lines in the central and western states. The eastern United States does experience earthquakes, but they are less frequent and less intense than those in the central and western U.S. Figure 2.7 shows relative long term seismic risk for the United States. [13]

B1c, B2a,c

Previous Occurrences and Extent

Although the zone of greatest seismic activity in the U.S. is along the Pacific Coast in Alaska and California, an average of six earthquakes a year are felt in the New England area. Historically, only 35 earthquakes in New England were considered significant.[14] Most of Massachusetts' earthquakes have been small in magnitude and caused little damage; however, 104 earthquakes between 1924 and 2012 were measured at a magnitude of 4.5 or greater on the Richter scale. Due to the geologic composition and rock structure in the Northeast seismic shaking for many of these larger earthquakes was felt throughout New England.

Below is a list of earthquakes that affected eastern Massachusetts:[15]

August 8, 1847: no data available on extent of hazard

November 27, 1852: no data available on extent of hazard

December 10, 1854: no data available on extent of hazard

September 21, 1876: no data available on extent of hazard

May 12, 1880: no data available on extent of hazard

January 21, 1903: no data available on extent of hazard

April 24, 1903: no data available on extent of hazard

October 15, 1907: no data available on extent of hazard

January 7, 1925: earthquake occurred off of Cape Ann and the reported felt area extended from Providence, RI to Kennebunk, ME

April 24, 1925: no data available on extent of hazard

January 28, 1940: no data available on extent of hazard

[13] Image from USGS earthquakes hazards website: https://www.usgs.gov/natural-hazards/earthquake-hazards/hazards

[14] Massachusetts State Hazard and Climate Adaptation Plan 2018

[15] Massachusetts State Hazard Plan, 2013 and Weston Observatory website https://bcesp.org/

October 16, 1963: Intensity VI, caused plaster to fall in a house, a wall cracked, stones fell from a building foundation, dishes were broken, windows cracked

October 30, 1963: no data available on extent of hazard

October 24, 1965: slight damage to homes on Nantucket, house timbers creaked, doors, windows and dishes rattled

December 30, 2012: Magnitude 1.2 earthquake about 7 miles south of Gardner, MA. No extent data available.

April 2012: a collection of 12 or more earthquakes occurred off of the New England coast about 250 miles east of Boston. The largest of these earthquakes measured a magnitude of 4.4 on the Richter Scale. This collection of earthquakes was of particular concern because of the major earthquake on the continental shelf further north in 1929 that produced a deadly and damaging tsunami in Nova Scotia.

December 22, 2018: a small earthquake measured at 2.0 on the Richter scale occurred in the vicinity of Templeton and Gardner, Massachusetts.

No earthquake declared disasters have been declared for Massachusetts. No data is available on the history of earthquakes in Wellfleet.

B3a

Impact

Earthquakes can affect hundreds of thousands of square miles, cause damage to property, result in loss of life and injury and disrupt the social and economic functioning of the affected area. Most property damage and earthquake related deaths are caused by the failure and collapse of structures during ground shaking.

Earthquakes can also cause large and sometimes disastrous landslides. Sand dunes, like those in Wellfleet, are vulnerable to slope failure during an earthquake. This process, called sand liquefaction, occurs when water-saturated sands, silts or gravelly soils are shaken so violently that the individual grains lose contact with one another and move freely, turning the ground into a liquid.

Probability

B2b

Earthquakes cannot be predicted and may occur at any time of the day and any time of the year. The Planning Team determined that it is **POSSIBLE** that an earthquake will impact TOWN. Probabilities were defined based on the frequency of occurrence:

- **Unlikely**: less than a 1% probability over the next 100 years
- **Possible**: 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely**: 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely**: near 100% probability in the next year

The Planning Team used the 2016 Wellfleet Hazard Mitigation Plan and historical earthquake data in Massachusetts to make this probability determination.

Earthquake

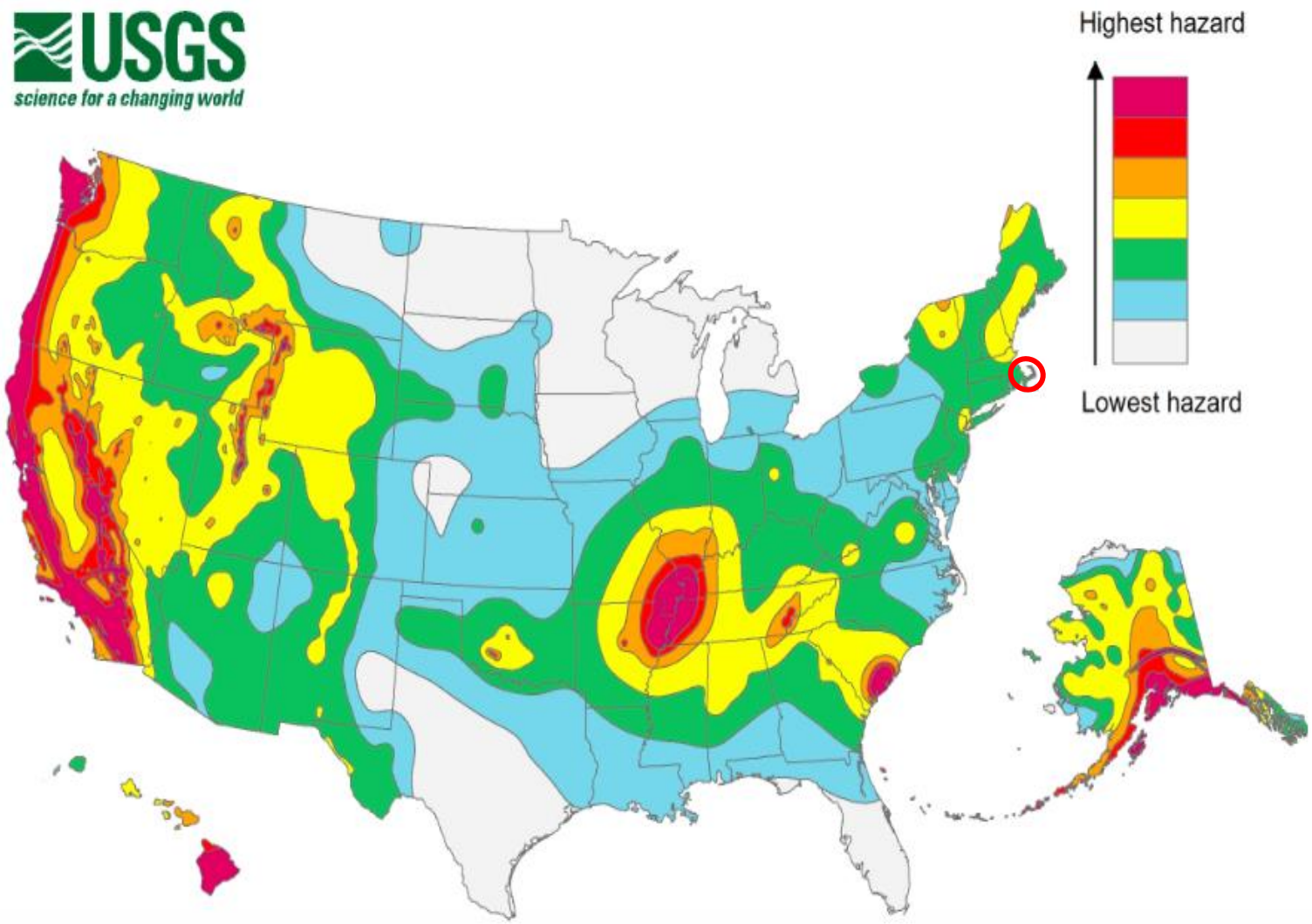


Figure 2.7 | Map of relative long term seismic risk for the United States.

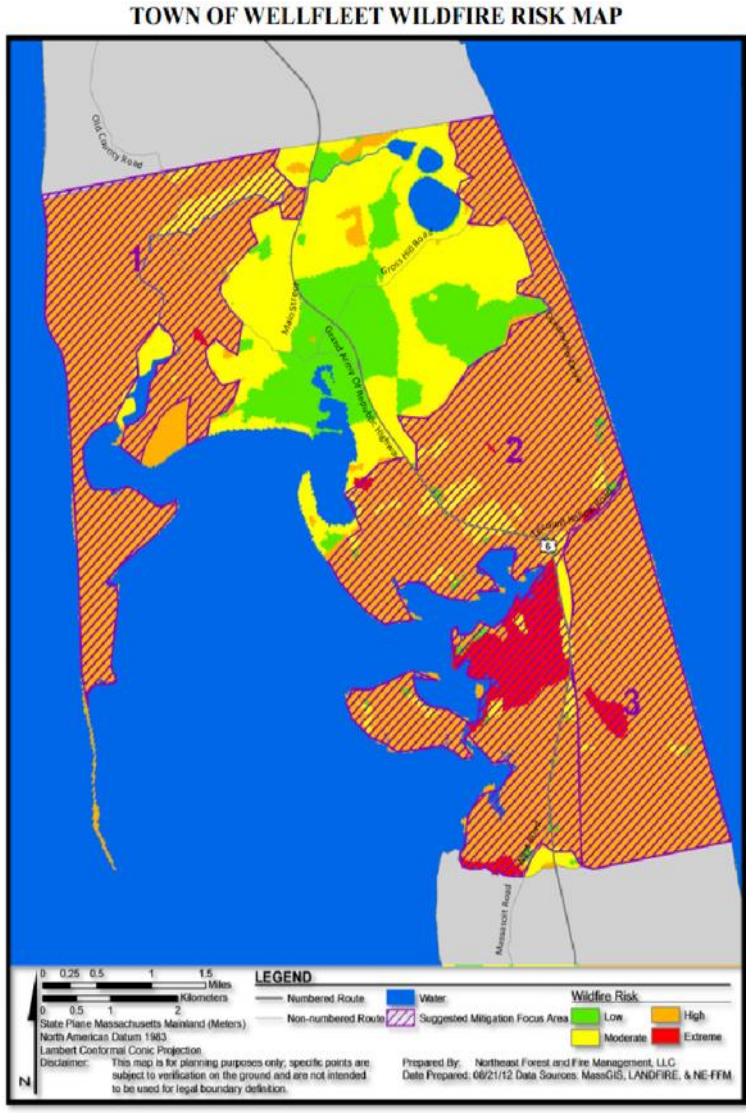


Figure 2.8 | Town of Wellfleet Wildfire Risk map from the Barnstable County Wildfire Preparedness Plan.

Fire: Urban and Wildland

Overview

This portion of the Wellfleet Hazard Mitigation Plan assesses two types of fire events: urban fires and wildfires.

Urban fires occur when buildings and structures catch fire, with potential to spread to adjoining structures. Urban fires are more common in areas where residences and businesses are clustered closely together, thereby increasing the possibility of rapid spread to nearby structures. Urban fires occur more frequently than wildfires and often result from everyday activities such as cooking, smoking, and appliance malfunction.

Wildfires are defined as any non-structural fire that occurs in a vegetative wildland including grass, shrub, leaf litter or forested area.[16] Wildfires often begin undetected and spread when brush, trees and homes are ignited. In Massachusetts, wildfires are typically caused by lightning, human activity (i.e. smoking, unattended campfires) or prescribed burns (intentional, controlled burns supervised by experienced fire personnel).[17]

In 2012, the Cape Cod Cooperative Extension and other regional partners developed the Barnstable County Wildfire Preparedness Plan. The plan notes that the region

[16] Massachusetts State Hazard and Climate Adaptation Plan 2018

[17] Ibid.

has a history of wildfires and as a result, most of Cape Cod has fire-adapted ecosystems that are prone to burning. Pitch pine barrens are the dominant vegetative community in the region, and these ecosystems contain highly flammable plant species that are adapted to survive or regenerate post fire.

Many Cape residents live in the Wildland Urban Interface (WUI), which is defined as the line or area where structures and other development meet with undeveloped wildland or vegetative fuel. Building in the WUI is dangerous because wildfires can move to surrounding developments and place homes and other buildings at risk for ignition.

B1c

Hazard Location

The Barnstable County Wildfire Preparedness Plan identifies three sites in Wellfleet that are at risk to wildland fires (See ***Figure*** 2.7)

One area (labelled "1" on the map) is on the bay side, encompassing primarily National Seashore land between the Truro town line and Great Island /Jeremy Point. Seashore woodlands on the ocean side from Newcomb Hollow to the Eastham town line are also at high risk, as is land on the bayside between Blackfish Creek and Lieutenant's Island (labelled #2 and # 3, respectively on the map).

B1c, B2a,c

Previous Occurrences and Extent

Notable wildland and urban/structural fires on the Outer Cape include the following:

- **1875:** 100 acre wildfire South Wellfleet
- **1907:** Large wildfire in Wellfleet
- **April 19, 20, 21, 1927:** 2,500 acres burned in Truro. (Barnstable Patriot, April 28, 1927)
- **June 1949**: 75 acres or more of brush and woodland burned after a fire started at the Truro Town Dump. Firefighters from Truro, Wellfleet, Brewster and Orleans helped bring it under control. (Provincetown Banner, June 16, 1949)
- Most wildland fires in Wellfleet under two acres and contained by the Wellfleet Fire Department.
- Recent notable urban fires in Wellfleet include the following:
- **July 2, 2004**, fireworks exploded prematurely, destroying a truck and starting a brush fire but no one was injured.
- **June 12, 2016**: fully involved structural fire on Lieutenant Island. Mutual aid was provided. Estimated damage over $350,000.
- **February 19, 2019**: structure fire in Wellfleet began around 11 PM at 2318 Route 6 EZ-Doze-It Excavating. Several explosions were reported. The fire quickly escalated to three alarms requiring mutual aid including tankers from across much of the Cape.

- **March 11, 2019** – Two-alarm fire on Lieutenant's Island destroyed a house and resulted in two fatalities.

B3a

Impact

Destruction caused by urban fires and wildfires depends on the following factors:

- size of the fire
- landscape
- amount of fuel (i.e. vegetation and structures) in the path of the fire
- direction and intensity of the wind
- response time of fire personnel
- number of firefighters able to respond to the fire
- access to the fire once it starts

Below is a list of possible damages from urban and wildland fires.

- **People**: death or injury to people and animals; smoke can cause health issues for people, even for those far away from the fire
- **Infrastructure**: gas, power and communications may be disrupted; flying embers can set fire to buildings more than one mile away from the initial fire
- **Buildings**: structures can be damaged or destroyed, multiple buildings can burn
- **Economy**: indirect economic losses in reduced tourism; as communication and infrastructure systems are damaged and disrupted, economic activities come to a standstill, often resulting in dislocation and dysfunction of normal business activities; when roadways are disrupted, it impacts the customer base for small businesses and leads to slow recovery times; the cost of relief and recovery may adversely affect investment in infrastructure or other development activities
- **Natural Systems**: extensive acreage can burn, damaging watersheds and critical natural areas; flash flooding and landslides can result from fire damage to the surrounding landscape. Wildfires strip slopes of vegetation exposing them to greater runoff and erosion; this weakens soils and causes failure on slopes. When fires burn hot and for long duration, the soil bakes and becomes impermeable, increasing runoff and the risk of flooding .
- **Transportation**: transportation may be temporarily disrupted.

Probability

B2b

The Planning Team determined that it is **LIKELY** that an urban fire will impact Wellfleet and ***LIKELY*** that a wildfire will impact the planning area. Probabilities were defined based on the frequency of occurrence:

- **Unlikely**: less than a 1% probability over the next 100 years
- **Possible**: 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely**: 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely**: near 100% probability in the next year

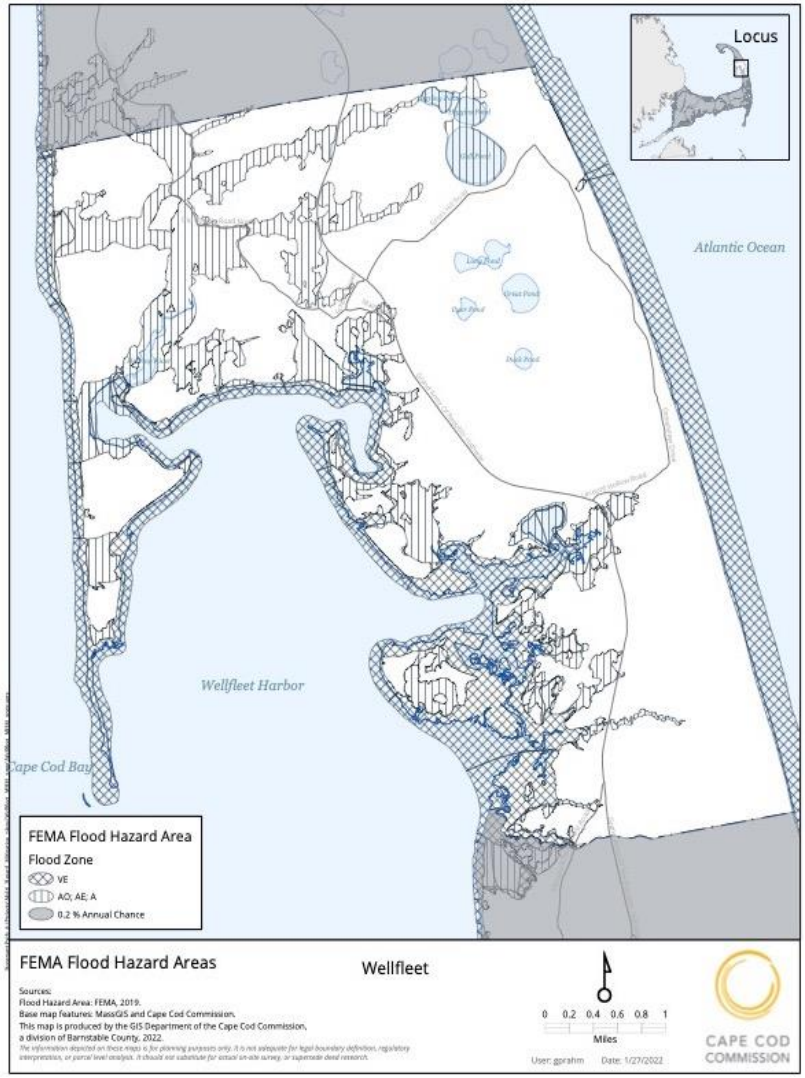


Figure 2.9 | FEMA Flood Hazard Map

The Planning Team used references from the 2016 hazard plan, the 2012 Barnstable County Wildfire Preparedness Plan and local knowledge of the town to make this probability determination.

Flood

Overview

Flooding can be caused by hurricanes, nor'easters, heavy rainstorms, and thunderstorms. Sea-level rise also exacerbates flooding in vulnerable areas. Wellfleet experiences both inland flooding and coastal flooding, as described below.

Inland flooding occurs when the volume of water on land due to heavy precipitation exceeds the capacity of natural and built drainage system. A severe storm that generates much rainfall in a short time causes flash flooding

Coastal flooding occurs when persistent high wind and changes in air pressure during a hurricane or nor'easter push water towards the shore. This action causes storm surge which raises the level of the water by several feet. Waves can be highly destructive as they move inland, battering structures in its path The magnitude of a flood varies with the tides; storm surge that occurs during high tide will flood larger areas than if the same surge occurred at low tide.[18]

[18] National Flood Insurance Program, Floodplain Requirements, FEMA 480.

Urban drainage flooding occurs in flat areas where runoff or rain collects and cannot drain out. Drainage systems are composed of ditches, storm sewers, retention ponds and other infrastructure that store runoff and carry it into a receiving stream, lake, or ocean. When most of these systems were built, they were designed to handle the amount of water expected during a 10-year storm event. Larger storms overload the system and result in back-ups, forming temporary ponds. This water will remain in an area until the blockage is cleared or the water is pumped out; or it infiltrates into the soil, or evaporates.[19]

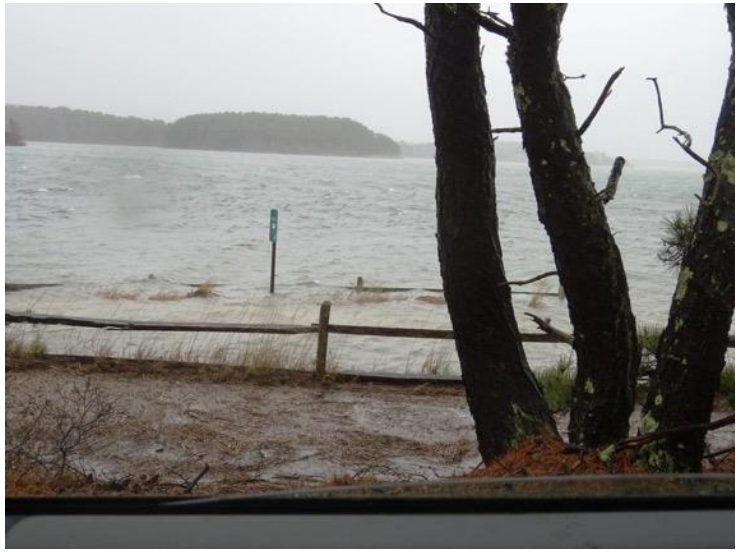


Figure 2.10 | Coastal Flooding during winter 2018 nor'easter

B1c

Hazard Location

Flooding in Wellfleet is also the result of coastal storms, nor'easters, heavy rains, tropical storms, and hurricanes. ***Figure 2.9*** shows the 2019 FEMA Flood Insurance Rate Map (FIRM) for Wellfleet. This map depicts areas of Wellfleet in V and A zones and the 2% annual flood areas.

Storm tide pathways refer to the paths of least resistance through which flood waters move through a community. Mapped by the Center for Coastal Studies in Provincetown, MA, the storm tide pathways viewer (https://stormtides.org/) can be used to identify increases in flood extents in 6" increments and the low-lying storm tide pathways that will flood at each 6" increase in storm surge. This information can be used by emergency managers, DPWs, planners, and others. The final report – *Mapping Storm Tide Pathways in Cape Cod Bay* – is available on the Town website: https://www.wellfleet-ma.gov/home/news/mapping-storm-tide-pathways-in-cape-cod-bay-massachusetts

Previous Occurrences and Extent

B1c, B2a,c

Below is a list of recent rain, flooding and coastal flooding events in Wellfleet. Data was collected from NOAA's National Climatic Data Center and local newspapers. It is not meant to be an exhaustive list of events but rather a representation of significant flooding occurrences.

[19] Ibid.

Table 2.3 | Recent Flooding Event History

Hazard Type	Date	Source	Comments on Impact
Storm	June 22, 2009		An unusually strong coastal storm moved southeast of Nantucket, resulting in coastal flooding and strong winds across portions of coastal Massachusetts. Minor coastal flooding occurred in Wellfleet, where a car got stuck in water moving over Lieutenant Island Road.
Coastal Flooding	March 7, 2013		Minor coastal flooding occurred in Eastham, Wellfleet, Brewster, and Chatham.
Coastal Flooding	January 3, 2014		Moderate coastal flooding impacted portions of Cape Cod. In Wellfleet, Summit Avenue and Old Wharf Road were impassable.
Storm	January 4, 2018	National Climatic Data Center	Caused significant coastal flooding at high tide. Storm surge and astronomical high tide.
Storm	March 2-3, 2018	National Climatic Data Center	Caused extensive coastal flooding in Wellfleet and the region. This storm resulted in a Federal Disaster Declaration.
Storm	March 7, 2018	National Climatic Data Center	High winds, power outages and coastal flooding.
Storm	March 13, 2018	National Climatic Data Center	High winds and heavy wet snow caused extensive power outages and coastal flooding. This storm resulted Federal Disaster Declaration for much of Massachusetts but not Barnstable County.

B3a

Impact

Below is a list of the possible impacts for a flooding event in Wellfleet:

People: people can be knocked down or washed off their feet by floodwaters; people can be injured or die from being trapped in their cars during a flood event; people can be displaced from their homes because of post-flood safety and health hazards; mold, mildew and bacteria can cause health issues; flooding can cause drinking water contamination.

Infrastructure: flooding can leave large amount of debris and sediment on and around town infrastructure; floods can damage gas lines, utility poles, water infrastructure, wastewater treatment plants; and cause sewage spills. Buildings: moving water can damage the walls of buildings; floodwater velocity can undermine foundations. Floodwaters pick up anything that floats, including logs, lumber, propane tanks and vehicles – which can damage buildings; buildings can float off foundations if not anchored properly.

Economy: as communication and infrastructure systems are damaged and disrupted, economic activities come to a standstill, often resulting in dislocation and dysfunction of normal business activities; roadways disruptions affect the customer base and slow recovery times for small businesses; the cost of relief and recovery may adversely affect investment in infrastructure or other development activities; losses may decrease land value in floodplains

B2b

Probability

The Planning Team determined that it is HIGHLY LIKELY flooding will impact the planning area. High probability was defined based on the frequency of occurrence:

- **Unlikely**: less than a 1% probability over the next 100 years
- **Possible**: 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely:** 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely**: near 100% probability in the next year

The Planning Team used the history of hurricanes, tropical storms, nor'easters, and flooding in Wellfleet to make this probability designation.

Hurricanes and Tropical Storms

Overview

A tropical cyclone is a rotating, organized system of clouds and thunderstorms that originates over tropical or subtropical waters.[20] Hurricane season in the Atlantic Basin runs from June 1 to November 30; peak activity is in early to mid-September.[21]

Four types of tropical cyclones can occur in the Atlantic Basin:

Tropical Depression: a tropical cyclone with maximum sustained winds of 38 mph or less

Tropical Storm: a tropical cyclone with maximum sustained winds of 39 to 73 mph

Hurricane: a tropical cyclone with maximum sustained winds of 74 mph or higher

Major Hurricane: a tropical cyclone with maximum sustained winds of 111 winds or higher, corresponding to a Category 3, 4, or 5 on the Saffir- Simpson Hurricane Wind Scale

Two data sets are used to classify tropical cyclones:

Saffir Simpson Hurricane Wind Scale is a 1 to 5 rating based on a hurricane's sustained wind speed.[22] This scale estimates potential property damage (***Table*** 2.4). Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous, however, and require preventative measures.

Amount and location of storm surge. Storm surge is water that is pushed toward the shore by the force of the winds swirling around the storm.[23] This advancing surge combines with the normal tides to create the hurricane storm tide, which can increase average water levels 15 feet (4.5 m) or more. In addition, wind-driven waves are superimposed on the storm tide. The rise in water level can cause severe flooding in coastal areas, particularly when the storm tide coincides with the normal high tides (***Figure*** 2.11).

[20] National Hurricane Center Outreach and Education, https://www.nhc.noaa.gov/climo/

[21] National Hurricane Center Outreach and Education http://www.srh.noaa.gov/jetstream/tropics/tc_basins.htm

[22] http://www.nhc.noaa.gov/aboutsshws.php

[23] National Weather Service Jetstream – Online School for Weather, Tropical Weather, Tropical Hazards www.srh.noaa.gov/jetstream/tropics/tc_hazards. htm

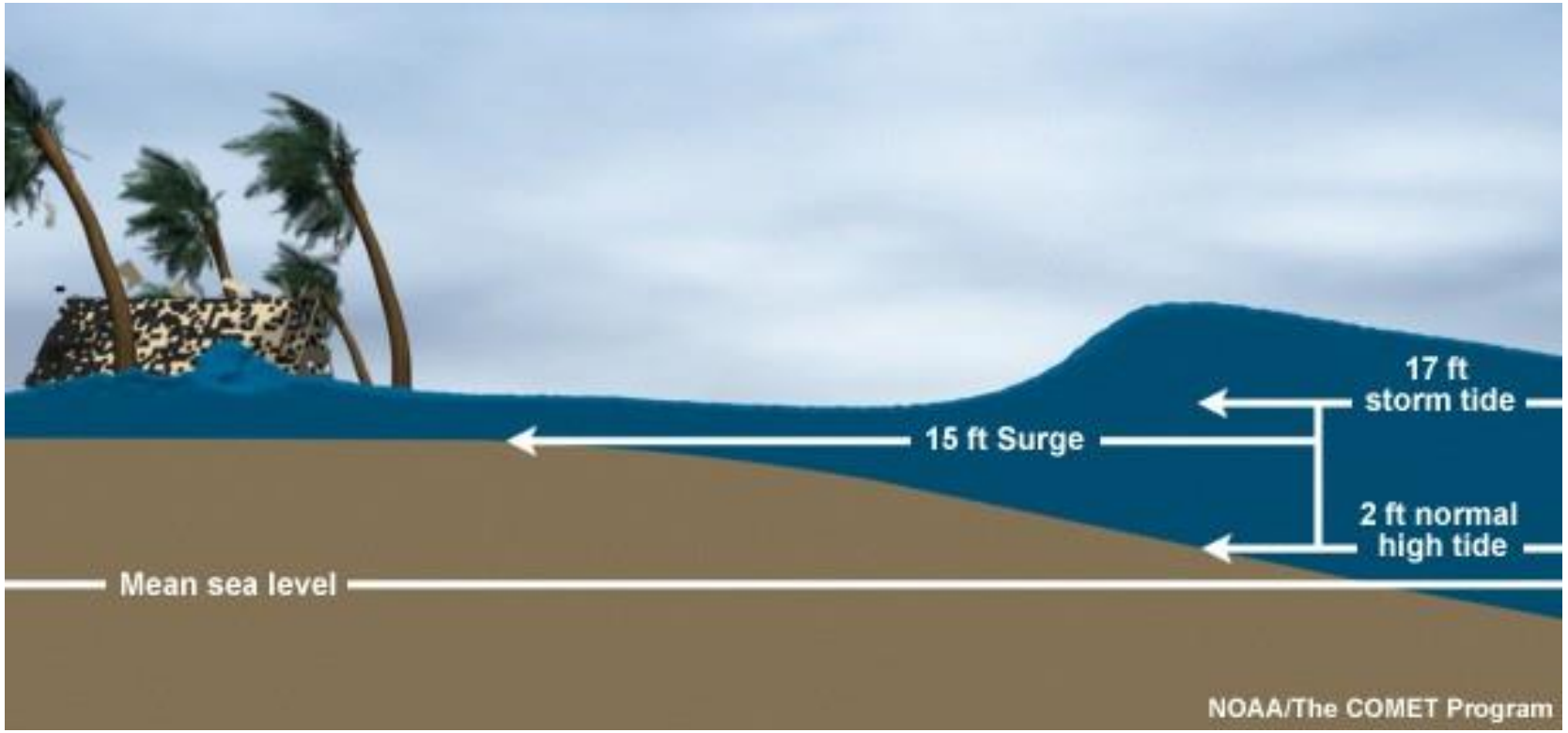


Figure 2.11 |Schematic of the generic differences between mean sea level, normal high tide, storm surge and storm tide. This graphic is for educational purposes only. The numbers shown (2, 15, 17 feet) are not specific to Wellfleet.

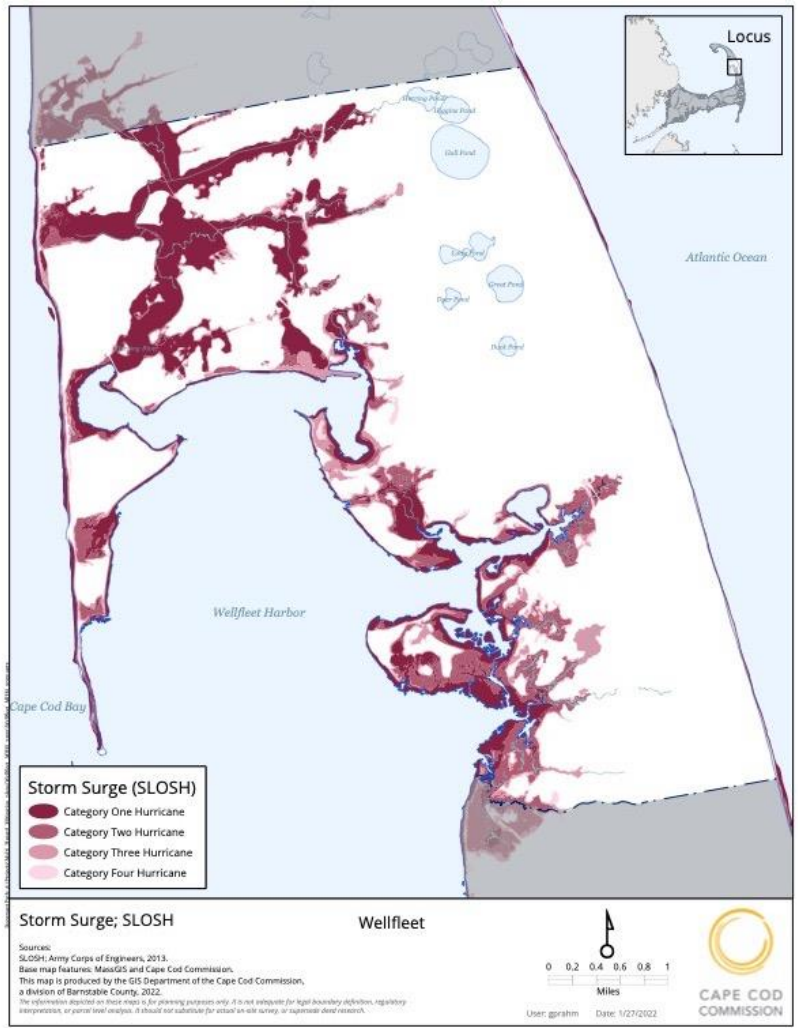


Figure 2.12 | Storm Surge (SLOSH) Map

The US Army Corps of Engineers New England Division, in cooperation with FEMA, prepared Sea, Lake and Overland Surge from Hurricanes (SLOSH) inundation maps. [24] SLOSH mapping represents potential flooding from worst-case combinations of hurricane direction, forward speed, landfall point, and high astronomical tide. It does not include riverine flooding caused by hurricane surge or inland freshwater flooding. The model, developed by the National Weather Service to forecast surges that occur from wind and pressure forces of hurricanes, considers only storm surge height and does not consider the effects of waves. The mapping was developed for New England coastal communities using the computer model, Long Island Sound bathymetry, and New England coastline topography. The resulting inundation areas are grouped into Category 1 and 2, Category 3, and Category 4. The hurricane category refers to the Saffir-Simpson Hurricane Intensity Scale. The Army Corps of Engineers considered the highest wind speed for each category, the highest surge level, combined with worst-case forward motion and developed a model to depict areas that would be inundated under those combined conditions.

Table 2.4 | Saffir-Simpson Hurricane Wind Scale (National Hurricane Center)

Category	Sustained Winds	Types of Damage Due to Hurricane Winds
1	74-95 mph 64-82 kt 119-153 km/h	Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph 83-95 kt 154-177 km/h	Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (major)	111-129 mph 96-112 kt 178-208 km/h	Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (major)	130-156 mph 113-136 kt 209-251 km/h	Catastrophic damage will occur: Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (major)	157 mph or higher 137 kt or higher 252 km/h or higher	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

B1c

Hazard Location

The entire planning area is vulnerable to tropical cyclones. Coastal areas are extremely susceptible to damage because of wind and storm surge. Inland areas can also be affected by flooding, strong wind and heavy rain associated with tropical cyclones. ***Figure 2.12*** shows the predicted storm surge in the planning area for the Category 1-4 storms

Previous Occurrences and Extent

B1c, B2a,c

The National Hurricane Center data show a strong history of hurricanes affecting the Atlantic Coast of the United States, including Barnstable County.

Table 2.5 identifies notable cyclones that affected Barnstable County. Data is from the FEMA disaster declaration website, the MA State Hazard Plan, and National Climate Data Center.

Cyclones and Tropical Storms for Barnstable County from 1954 - 2022

Table 2.5| Notable tropical storms and hurricanes for Barnstable County.

Number	Storm Name	Safir-Simpson Classification	Incident Period	Declaration Date	Reference
	Tropical Storm Henri		August 20, 2021		National Climatic Data Center
	Tropical Storm Isaiah		August 4, 2020		National Climatic Data Center
	Tropical Storm Elsa		July 9, 2021		National Climatic Data Center
	Tropical Storm Jose		September 20, 2017		National Climatic Data Center
	Tropical Storm Arthur	TS	July 4, 2014		Barnstable County Regional Emergency Planning Committee
EM-3350	Tropical Storm Sandy		October 27 to November 8, 2012		
DR-4097	Tropical Storm Sandy	TS	October 27 to November 8, 2012		

Number	Storm Name	Safir-Simpson Classification	Incident Period	Declaration Date	Reference
EM-3330	Tropical Storm Irene	Category 2	August 26 to September 5, 2011		
DR-4028	Tropical Storm Irene	Category 2	August 26 to September 5, 2011		
EM-3315	Hurricane Earl	Category 4	September 1 to September 4, 2010		
DR-914	Hurricane Bob	Category 3	August 19, 1991		
	Hurricane Gloria	Category 4	September 27, 1985		
	Hurricane Donna	Category 5	September 12 to September 13, 1960	Not declared	
	Hurricane Carol	Category 2-3	August 31, 1954	Not declared	
	Hurricane Edna	Category 3	September 11, 1954	Not declared	
	1944 Hurricane	Category 3	September 1938	Not declared	
	1938 Hurricane	Category 4	September 1944	Not declared	

B3a

Impact

CATEGORY 1:
74-95 mph 1-minute sustained winds

Impact to People/Pets/Livestock:

- Could result in injury or death from flying or falling debris.
- Impact to Frame Homes:
- Some poorly constructed frame homes can experience major damage, involving loss of the roof covering, damage to gable ends, removal of porch coverings and awnings.
- Unprotected windows may break if struck by flying debris.
- Masonry chimneys can be toppled.
- Well-constructed frame homes could have damage to roof shingles, vinyl siding, soffit panels and gutters.
- Failure of aluminum, screened-in, swimming pool enclosures can occur.

Impact to Apartments, Shopping Centers, and Industrial Buildings

- Some apartment building and shopping center roof coverings could be partially removed.
- Industrial buildings can lose roofing and siding especially from windward corners, rakes and eaves.
- Failures to overhead doors and unprotected windows will be common.

Impacts to Signage, Fences and Canopies:

- Occasional damage to commercial signage, fences and canopies will occur.

Impacts to Trees:

- Large branches will snap.
- Shallow-rooted trees will be toppled.

Impacts to Power and Water Infrastructure:

- Extensive damage to power lines and poles will likely result in power outages that could last a few to several days.

CATEGORY 2:
96-110 mph 1-minute sustained wind

Impact to People/Pets/Livestock:

- Substantial risk of injury or death due to flying or falling debris is likely.

Impact to Frame Homes:

- Poorly constructed frame homes are likely to lose their roof structures, especially if they are not anchored properly.
- Unprotected windows have a high probability of breaking from flying debris.
- Well-constructed frame homes could sustain major roof and siding damage.
- Failure of aluminum, screened-in, swimming pool enclosures will be common.
- Impact to Apartments, Shopping Centers, and Industrial Buildings

- A substantial percentage of apartment buildings and industrial buildings will have roof and siding damage.
- Unreinforced masonry walls can collapse.
- Impacts to Signage, Fences and Canopies:
- Commercial signage, fences, and canopies will be damaged and often destroyed.

Impacts to Trees:

- Many shallow-rooted trees will be snapped or uprooted.
- Roads will be blocked by toppled trees.

Impacts to Power and Water Infrastructure:

- Near total power loss is expected with outages that could last from several days to weeks.
- Potable water could become scarce as filtration systems begin to fail.

CATEGORY 3:
111-129 mph 1-minute sustained wind

Impact to People/Pets/Livestock:

- Flying and falling debris creates a high risk of injury or death.

Impact to Frame Homes:

- Poorly constructed frame homes can be destroyed by loss of the roof and exterior walls.
- Unprotected windows will be broken by flying debris.
- Well-built frame homes can experience major damage from the removal of roof decking and gable ends.
- A high percentage of apartment and industrial buildings will experience damage to roof coverings and siding.
- Isolated structural damage to wood or steel framing can occur.
- Complete failure of older metal buildings is possible.
- Older unreinforced masonry buildings can collapse.

Impacts to Signage, Fences and Canopies:

- Most commercial signage, fences, and canopies will be destroyed.

Impacts to Trees:

- Many trees will snap or become uprooted.
- Numerous roads will be blocked.

Impacts to Power and Water Infrastructure:

- Electricity and water will be unavailable for several days to a few weeks after the storm passes

CATEGORY 4:
130-156 mph 1-minute sustained wind

Impact to People/Pets/Livestock:

- Very high risk of injury or death due to flying and falling debris.

Impact to Frame Homes:

- Poorly constructed homes can sustain complete collapse of all walls as well as the loss of the roof structure.
- Well-built homes also can sustain severe damage with loss of most of the roof structure and/or some exterior walls.
- Extensive damage to roof coverings, windows, and doors will occur. Large amounts of wind-borne debris will be lofted into the air.
- Wind-borne debris will break most unprotected windows and penetrate some protected windows.

Impact to Apartments, Shopping Centers, and Industrial Buildings:

- A high percentage of apartment buildings will experience structural damage to the top floors.
- Steel frames in older industrial buildings can collapse.
- A high percentage of older unreinforced masonry buildings collapse would collapse.
- Impacts to Signage, Fences and Canopies:
- Nearly all commercial signage, fences, and canopies will be destroyed.

Impacts to Trees:

- Most trees will snap or become uprooted.
- Power poles will be downed.
- Numerous roads will be blocked.
- Fallen trees and power poles will isolate residential areas.

Impacts to Power and Water Infrastructure:

- Power outages will last for weeks to possibly months.
- Long term shortages will increase human suffering.
- Most of the area will be uninhabitable for weeks to months.

CATEGORY 5:
157 mph or higher 1-minute sustained wind

Impact to People/Pets/Livestock:

- Very high risk of injury or death due to flying and falling debris even if indoors in mobile or framed homes.
- Impact to Frame Homes:
- A high percentage of frame homes will be destroyed, with total roof failure and wall collapse.
- Extensive damage to roof covers, windows, and doors will occur.
- Large amounts of wind-borne debris will be lofted into the air.

- Wind-borne debris damage will occur to nearly all unprotected windows and many protected windows.

Impact to Apartments, Shopping Centers, and Industrial Buildings:

- Significant damage to wood roof commercial buildings will occur due to loss of roof sheathing.
- Complete collapse of many older metal buildings can occur.
- Most unreinforced masonry walls will fail, which can lead to building collapse.
- A high percentage of industrial buildings and low-rise apartment buildings will be destroyed.

Impacts to Signage, Fences and Canopies:

- Nearly all commercial signage, fences, and canopies will be destroyed.
- Impacts to Trees:
- All trees will snap or become uprooted.
- All power poles will be downed.
- Fallen trees and power poles will isolate residential areas.

Impacts to Power and Water Infrastructure:

- Power outages will last for weeks to possibly months.
- Long term shortages will increase human suffering.
- Most of the area will be uninhabitable for weeks to months.

B2b

Probability

The Planning Team determined that it is **HIGHLY LIKELY** that a hurricane or tropical storm will impact the planning area. High probability was defined based on the frequency of occurrence:

- **Unlikely**: less than a 1% probability over the next 100 years
- **Possible**: 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely**: 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely**: near 100% probability in the next year

The Planning Team used the history of tropical cyclones in Barnstable County and local knowledge to make this probability designation.

Landslides

Overview

A landslide is a general term used to describe the downslope movement of soil, rock and organic materials from of gravity.[25]

Most landslides in Massachusetts are caused by a combination of unfavorable geologic conditions (silty clay or clay layers contained in glaciomarine, glaciolacustrine, or thick till deposits), steep slopes, and/or excessive wetness leading to excess pore pressures in the subsurface.[26] Conditions associated with landslides include the following:

Water saturation on a slope occurs after intense rainfall, snow melt, changes in level of groundwater and water level changes along coasts and banks. Water from a rain event adds weight to the slope and reduces the strength of slope materials.

Undercutting of slopes by flooding and wave action occurs when streams and waves erode the base of slopes, causing them to over-steepen and eventually collapse. Areas where this type of failure occurs includes Cape Cod, Nantucket and Martha's Vineyard.

Construction related failures occur during construction activities such as cut and fill construction for highways and roads and when vegetation on a slope is removed during the construction of buildings. These activities can increase slope angle and decrease lateral support which can sometimes lead to landslide.[27]

Hazard Location

B1c

Landslides occur in every state in the U.S., but the majority of Massachusetts has a low incidence of landslides. In Wellfleet, the risk of flooding and loose soils could result in a landslide in the planning area.

Previous Occurrences and Extent

B1c, B2a,c

No federally declared landslide disasters occurred in Barnstable County between 1954 and 2021 and to date, no significant landslides have occurred in Wellfleet.

Based on reports from the USGS website, the extent of a landslide is quantified as the estimated amount of material in cubic yards that was deposited from a higher elevation. Since Wellfleet has no history of landslide occurrence, no data exists on landscape conditions and extent.

Impact

B3a

[25] The Landslide Handbook – A Guide to Understanding Landslides USGS Circular 1325, 2008]

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

[27] Landslide Loss Reduction: A Guide for State and Local Government Planning, FEMA-182, 1989

Below is a list of possible impacts that could result from a landslide.

- **People**: people, cars and homes can become buried; delays in emergency services; isolated residents
- Infrastructure: damaged power lines
- **Buildings**: destabilization of building foundations; building damage and destruction from sediment movement and flooding
- **Economy**: isolated businesses
- **Natural Systems**: downed trees; decreased water quality
- **Transportation**: road closures; damage to road segments and/or culverts, transportation delays

B2b

Probability

The Planning Team determined that it is POSSIBLE that a landslide will impact the planning area. Probability was defined based on the frequency of occurrence:

- **Unlikely**: less than a 1% probability over the next 100 years
- **Possible**: 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely**: 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely**: near 100% probability in the next year

The Planning Team used the history of flooding and the presence of loose soils to make this probability determination.

Figure 2.13 | Storm surge at Wellfleet Harbor, January 2018 Nor'easter

Nor'easters

Overview

A Nor'easter is a cyclonic storm that forms outside of the tropics and moves along the east coast of North America.[28] It is called a nor'easter because the winds over coastal areas blow from a northeasterly direction. These storms usually develop between Georgia and New Jersey within 100 miles of the coastline and move north or northeastward. Once these storms reach New England,

[28] NOAA: Know the dangers of nor'easters, http://www.noaa.gov/features/03_protecting/noreasters.html

they usually intensify. These storms can occur at any time of year but are most frequent between September and April. The years with the most nor'easters tend to coincide with El Niño events.[29]

The east coast of North America provides an ideal breeding ground for nor'easters. During the winter, the polar jet stream transports cold Arctic air southeast across Canada, the United States, and the Atlantic Ocean. Warm air from the Gulf of Mexico and the Atlantic moves northward, keeping the coastal waters relatively mild during the winter. This difference in temperature between the warm air over the water and cold Arctic air over the land is the area where nor'easters are born.

Nor'easters bring heavy rain and snow, gale force winds, rough seas, coastal flooding and can cause beach erosion. Sustained wind speeds of 20-40 mph are common during a nor'easter with short-term wind speeds gusting up to 50-60 mph.[30] Wind gusts associated with these storms can exceed hurricane force in intensity. Nor'easters are notorious for producing heavy snow, rain, and oversized waves that crash onto Atlantic beaches, often causing beach erosion and structural damage. Nor'easters may also sit stationary for several days, affecting multiple tide cycles and producing extended periods of heavy precipitation. The level of damage in a strong hurricane is often more severe than a nor'easter, but historically Massachusetts has suffered more damage from nor'easters because of the greater frequency of these coastal storms (one or two per year).

Traditionally, nor'easters were not given names like hurricanes and tropical storms, but his changed with the Weather Channel's adopting a naming protocol in 2012 that gained popularity in defining storm systems. Nor'easters do not have their own categorization scheme; but aspects of a nor'easter are categorized. For example, the Beaufort Scale is used to categorize the wind speed of a nor'easter (small craft advisory, gale warning, storm warning, hurricane force wind warning) and the Regional Snowfall Index is used to categorize snowfall during a nor'easter.

[29] Berman, G. and Nemunaitis-Monroe, K. 2012. Hurricane vs. Nor'easter, Marine Extension Bulletin, 1-4

[30] Massachusetts State Hazard Mitigation Plan, 2013

B1c

Hazard Location

Coastal areas of Wellfleet are the most susceptible to damages from wind, snow and storm surge during a nor'easter, but nor'easters can bring heavy snow, high winds, and flooding to the entire planning area.

B1c, B2a,c

Previous Occurrences and Extent

Since nor'easters are not categorized like hurricanes and tropical storms, it is difficult to track their history. Also, hurricanes and tropical storms can transform into nor'easters, making it especially difficult to track the history of nor'easters in a particular area.

The following is a list of *some* nor'easters that have affected Barnstable County, but it is not a complete list because of the reasons mentioned above:

February 1978: this blizzard/nor'easter produced 8-12 inches of snow as well as ice and flooding and 92 mph winds on the Lower Cape. It damaged buildings and infrastructure across Barnstable County including battering the bathhouse and parking lot at Coast Guard Beach in Eastham; waves flooded and flattened dunes on barrier beaches in Chatham, Eastham and Orleans; Monomoy Island off of Chatham split in several places; homes were destroyed; the Outer Cape was an island for a few hours when a 16-foot storm tide flooded Route 6 at Fort Hill with three feet of water; Bridge Road flooded in Eastham.[31] This event resulted in a federal disaster declaration (FEMA DR-546).

October-November 1991: This large nor'easter was an unusual event because it moved south and strengthened when it joined with Hurricane Grace – producing what some would call the "Perfect Storm." Winds measured over 80 mph with waves over 30 feet high in some parts of the coastline. This event resulted in a federal disaster declaration (FEMA DR-920).

December 1992: A strong nor'easter affected the Commonwealth from December 11 to 13, 1992. Impacts included deep and intense snowfall, freezing rain, heavy rainfall near the coast, coastal flooding and damaging winds. The weight of the snow taxed snow removal equipment in many communities and caused roof damage. Precipitation totals for this storm were extraordinary. Much of southern New England received up to 5 inches of liquid equivalent precipitation during a 2 to 3 - day period, with locally close to 8 inches recorded in parts of southeast Massachusetts. Along coastal sections of Massachusetts, much of the precipitation fell as rain or rain/snow mix. This caused considerable ponding and localized flooding in poorly drained areas. The greatest damage from this storm was due to coastal flooding. Most east-facing shoreline communities from Chatham to Wellfleet and Plymouth to the North Shore, as well as Nantucket Island, experienced some level of coastal flood damage. As much as 20 feet of dune was lost in Sandwich.

[31] NCDC

Many coastal roads were closed and docks and cottages were damaged.

March 1994: A strong nor'easter passed to the southeast of Cape Cod, resulting in heavy snow and drifting snow. Over southeast Massachusetts, between three and six inches of snow fell before it changed to rain. Wind gusts of up to 40 and 60 mph resulted from this event and created snow drifts of up to three feet. Buildings were damaged, businesses and schools were closed, and road travel was disrupted.

January 22-23, 2005: A major winter storm brought heavy snow, high winds, and coastal flooding to southern New England. In Massachusetts, blizzard conditions were reported on Nantucket. Near-blizzard conditions were reported in areas and brought between one and three feet of snow and produced wind gusts of up to 65 mph. The highest snowfall totals were reported in eastern Massachusetts (between two and three feet). Minor to moderate coastal flooding was observed around high tide in eastern Massachusetts coast. Roads were inundated and evacuations occurred.

April 2007: an intense coastal storm brought rain and coastal/inland flooding to eastern Massachusetts. The storm was primarily a rain event due to warmer temperatures. For this Patriot's Day Storm, the surge peaked on a high tide on April 16, 2007 and the time period of one-foot surge lasted more than four high tides (~47 hours). Major coastal flooding and storm damage resulted not only from the severity of the storm but also due to the timing of the Perigean spring tides. The 2007 nor'easter hit during highest predicted tide of the month which was also the top 0.2% of the year. This 2007 storm breached the barrier beaches at both Pleasant Bay on the Lower Cape and Katama Bay on Martha's Vineyard. While some breaches will close by themselves in a short amount of time, both of these 2007 breaches became new inlets for the bays. This event resulted in a federal disaster declaration (FEMA DR-1701). Counties included in this disaster received over $8 million in public assistance from FEMA.

January 2015: Winter storm Juno was a powerful nor'easter that impacted the northeast and New England.[32] Governor Baker declared a state of Emergency and issued travel bans in preparation for this storm; all shelters in Barnstable County were opened; transit and ferry services were cancelled; winds gusted to 75 mph; rain/snow mix transitioning to 15-18 inches of snow; thundersnow occurred in various regions across Cape Cod; storm surge and coastal flooding caused erosion in many areas on Cape Cod; Pilgrim Nuclear Power Station shutdown in response to degrading offsite electrical grid conditions; dune break at Ballston Beach in Truro; significant damage to coastal areas in Cape Cod National Seashore. This event resulted in a Federal Disaster Declaration (FEMA DR-4214).

January 4, 2018: Nor'easter caused significant coastal flooding at high tide. Low lying roads around downtown

[32] http://capeandislands.org/post/blizzard-2015-delivers-high-wind-more-snow-forecast

Wellfleet flooded from storm surge and astronomical high tide.

March 2-3, 2018: Nor'easter caused extensive coastal flooding in Wellfleet and the region. The coastal flooding concern was centered around three high tides: midday Friday, midnight and midday Saturday, with astronomical high tide , high winds and storm surge. Wind gusts over 80 mph were recorded on Cape Cod. This storm resulted in a Federal Disaster Declaration.

March 7, 2018: Another Nor'easter struck the region, again bringing high winds, power outages and coastal flooding.

March 13, 2018: High winds and heavy wet snow caused extensive power outages and coastal flooding the in third Nor'easter to strike the region in less than two weeks. Widespread power outages. 70 mph winds recorded.

October 26-27, 2021: A low pressure nor'easter underwent bombogenesis as it developed east of Nantucket on the 26th. Winds gusted to 60-80+ mph on the outer portions of Cape Cod. Peak wind gusts included: 82 mph in Wellfleet. The winds caused widespread damage to trees and power lines. According to the Massachusetts Emergency Management Agency, reported damage in Barnstable County amounted to $1,247,874. Approximately $800,000 of that damage total was for debris removal and emergency protective measures.[33]

January 28-29, 2022: An "explosive" cyclogenesis of low pressure off the mid-Atlantic brought a nor'easter with blizzard conditions to much of New England, including Cape Cod and Wellfleet. Hurricane force winds over 80 mph were recorded on the Outer Cape, including Wellfleet. Widespread power outages (for multiple days i some locations) and downed power lines occurred in Wellfleet and all of Cape Cod.

[33] NCDC

B2b

Impact

Below is a list of possible impacts that could occur in Wellfleet during a nor'easter:

People: Longer response time for emergency personnel; see also impact on people in the Flood hazard profile.

Infrastructure: damages to water infrastructure; utility outages

Buildings: wind damage to buildings, see also damages to buildings in the Flood hazard profile

Economy: loss of business function; damage to inventory; relocation costs; wage loss

Natural Systems: snow and ice accumulation can negatively impact vegetation and natural habitat, downed trees and fallen branches; coastal landscape can be reshaped by storm surge

Transportation: roadways can become impassable from storm surge and debris; culverts damaged from storm surge

B3a

Probability

The Planning Team determined that it is HIGHLY LIKELY that a nor'easter will impact the planning area. High probability was defined based on the frequency of occurrence:

- **Unlikely**: less than a 1% probability over the next 100 years
- **Possible**: 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely**: 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely**: near 100% probability in the next year

The Planning Team used the history of nor'easters impacting Wellfleet to make this probability designation.

High Winds

Overview

Wind is air in motion relative to the ground surface.[34] High winds can occur as an isolated event or accompany other weather events such as:

- before and after frontal systems
- hurricanes and tropical storms
- severe thunder and lightning storms
- tornadoes
- nor'easters

The National Weather Service issues warnings and advisories for high wind events as follows:

Wind Advisory: for non-tropical events over land, sustained winds of 31-39 mph for at least one hour or any gusts up to 46-57 mph

High Wind Warning: for non-tropical events over land, sustained winds of 40-73 mph or any gusts 58+ mph

Small Craft Advisory: for non-tropical events over water, sustained winds of 29-38 mph.

Gale Warning: for non-tropical events over water, sustained winds of 39-54 mph

Storm Warning: for non-tropical events over water, sustained winds of 55-73 mph

Hurricane Force Wind Warning: for non-tropical events over water, sustained winds of 74+ mph

Tropical Storm Warning: for tropical systems, any inland or coastal area with expected sustained winds from 39-73 mph

Hurricane Warning: for tropical systems, any inland or coastal area with expected sustained winds of 74+ mph.

Hazard Location

B1c

FEMA compiled 40 years of tornado history and 100 years of hurricane history to generate a map of the frequency and strength of windstorms in the United States (***Figure*** 2.14*)*

The map shows that Wellfleet is in Wind Zone II with maximum wind speeds of 160 mph. The map pertains only to hurricane and tornado winds and does not capture wind advisories, high wind warnings, small craft advisories, and gale warnings. As a coastal location, Wellfleet experiences numerous high wind events other than hurricanes and tornados on a regular basis.

[34] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, 2018

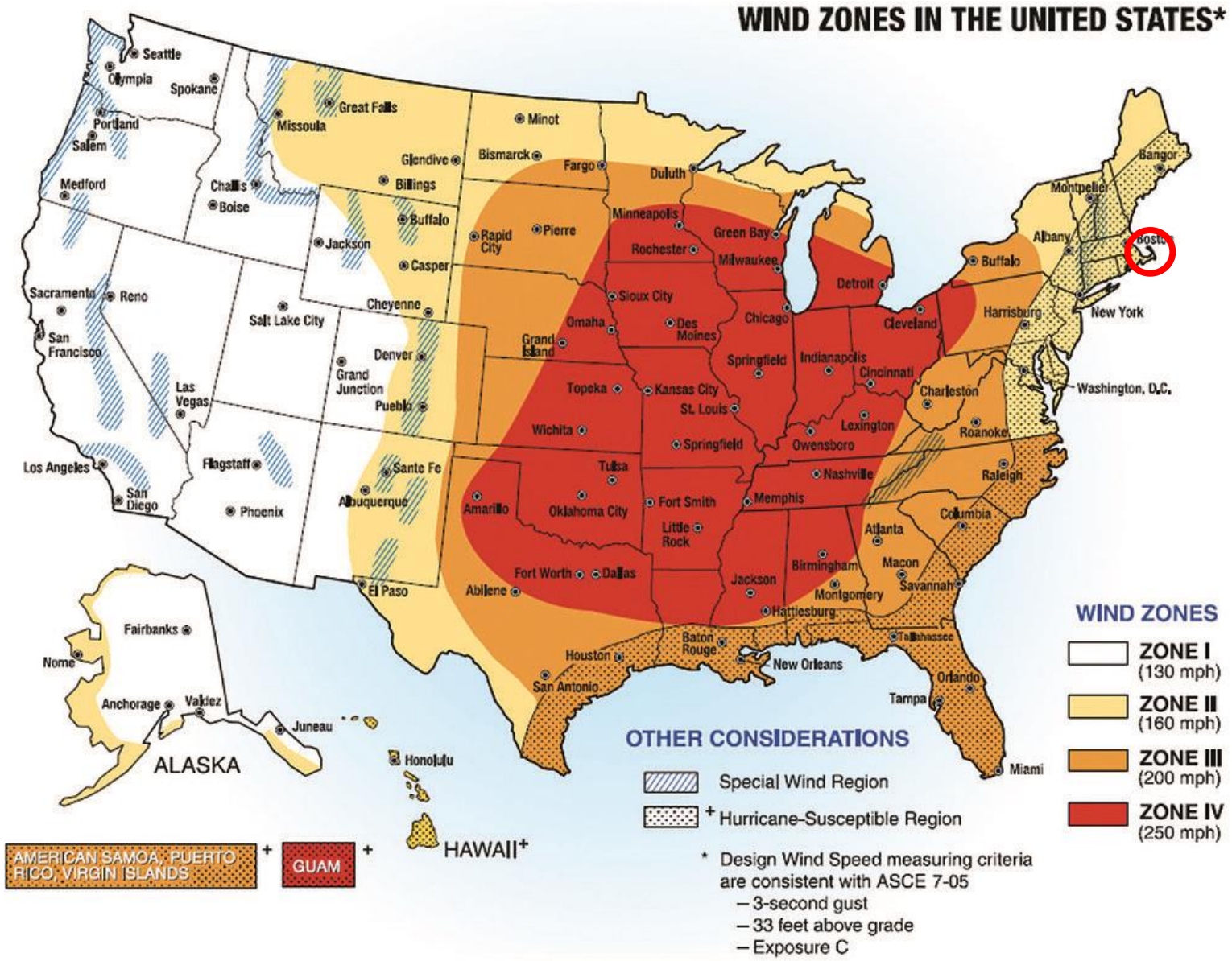


Figure 2.14| Map of frequency and strength of windstorms in the United States. Planning area is highlighted with a red circle. Map is from the 2013 Massachusetts State Hazard Plan.

B1c, B2a,c

Previous Occurrences and Extent

Over the last decade (between October 1, 2010, and November 1, 2021), a total of 140 high wind events were recorded in Barnstable County on 78 days. High winds are defined by NWS 10-1605 as sustained non-convective winds of 35 knots (40 mph) or greater lasting for 1 hour or longer, or gusts of 50 knots (58 mph) or greater for any duration.[35] The probability of future high wind events is expected to increase based on climate projections for the state that suggest a greater occurrence of severe weather events in the future. Specific information on the extent of these NCDC wind events in Wellfleet is unavailable, although the database does provide descriptions of some thunder wind events recorded in Wellfleet.[36]

B3a

Impact

People: power outages can affect vulnerable populations, especially if outages occur during the winter months

Infrastructure: downed power lines, power outages (wind gusts of only 40 to 45 mph have caused scattered power outages from downed trees and wires); high wind events can generate rough seas which can cause damage to coastal infrastructure

Buildings: damage to roofs, windows

Economy: loss of power can cause businesses to close temporarily until power is restored

Natural Systems: downed trees and branches

B2b

Probability

The Planning Team determined that it is **HIGHLY LIKELY** that a high wind event will impact the planning area. High probability was defined based on the frequency of occurrence:

- **Unlikely**: less than a 1% probability over the next 100 years
- **Possible**: 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely**: 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely**: near 100% probability in the next year

The Planning Team used Wellfleet's history of high wind, hurricanes/tropical storms, and nor'easters as well as the town's proximity to the ocean to make this probability determination.

[35] National Climate Data Center

[36] ibid

Thunderstorms

Overview

A thunderstorm is a storm that produces lightning and thunder and is usually accompanied by gusty winds, heavy rain and sometimes hail.[37] The National Weather Service considers a thunderstorm to be severe if it produces any of the following: hail at least one inch in diameter, winds of 58+ mph or a tornado.

Three basic "ingredients" are required for the formation of a thunderstorm: moisture that forms clouds and rain, unstable air that rises rapidly and lift caused by cold or warm fronts, sea breezes, or heat from the sun. The following is a description of the formation of thunderstorms:

The rising air in a thunderstorm cloud causes various types of frozen precipitation to form within the cloud (i.e. small ice crystals, snow and ice pellets, and water pellets). The smaller ice crystals are carried upward toward the top of the clouds by the rising air while the denser ice pellets are either suspended by the rising air or start falling towards the ground. Collisions occur between the ice crystals and the pellets and these collisions serve as the charging mechanism for the thunderstorm. The small ice crystals become positively charged while the pellets become negatively charged. As a result, the top of the cloud becomes positively charged and the middle to lower part of the cloud becomes negatively charged. When the charge difference between the ground and the cloud becomes large, a charge starts moving toward the ground and a powerful discharge occurs between the cloud and the ground (***Figure*** 2.15).[38]

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

[38] Thunderstorms, Tornadoes, Lightning: Nature's Most Violent Storms, A Preparedness Guide, US Department of Commerce, NOAA, and the National Weather Service.

Figure 2.15| Schematic of how lightning develops, from Thunderstorms, Tornadoes and Lightning: Nature's Most Violent Storms

B1c

Hazard Location

According to a map presented in the Massachusetts State Hazard Plan, Barnstable County experiences about approximately 20 thunderstorm days per year (see ***Figure*** 2.16*).*

B1c, B2a,c

Previous Occurrences and Extent

Figure 2.12 indicates that Massachusetts experiences between 20 and 30 thunderstorm days. Using local knowledge, the Planning Team concluded that at least a few thunderstorms occur every year in Wellfleet, but data on these storm events is not consistently recorded at the local level. (The thunderstorm profile relies on data from the NOAA National Climatic Data Center (NCDC) but this website does not have searchable data at the town level.)

The following is a list of some historical thunderstorms that occurred on Cape Cod between August 2015 and December 2021, although it is not a complete list:

- **August 4, 2015**: A line of thunderstorms developed across Long Island, NY and moved quickly towards RI and southeastern MA. These storms caused significant wind damage knocking down a significant number of trees.
- **July 15, 2016**: A weak frontal boundary stalled across the I-95 corridor and was the focus for showers and thunderstorms to develop during the afternoon. A few of these storms produced damaging winds. The Automated Weather Observation System at Provincetown Municipal Airport recorded a wind gust of 63 mph associated with the thunderstorm.
- **July 22, 2016**: A cold front moved through southern New England and when coupled with the existing heat and humidity, resulted in showers and thunderstorms developing over much of the area late in the day and continuing into the evening and overnight hours.

- **August 9, 2018**: A cold front moved across Massachusetts, bringing thunderstorms and downpours to Southeast Massachusetts and especially over Cape Cod. Up to 4.5 inches of rain fell on Cape Cod during the morning and early afternoon. Lightning struck a house on Mill Road in Eastham.
- **July 22, 2019**: A line of severe thunderstorms rolled across Cape Cod, leading the National Weather Service to issue a tornado warning. Lightning strikes together with high winds caused numerous power outages, fallen limbs, and downed trees that blocked roads. Flash flooding occurred in several locations.
- **July 23, 2019**: Thunderstorms brought heavy downpours and high winds to the region, again causing flash flooding, downed trees, and blocked roads. The storms brought one or more tornados to the Cape, that caused extensive power outages, downed trees, building damage, including roof removal, and road blockages, with heavy damages in parts of Yarmouth, Dennis, Harwich, and Chatham.
- **November 23, 2020**: Ahead of an advancing cold front, an isolated rotating thunderstorm prompted a Tornado Warning for eastern Martha's Vineyard and a portion of Cape Cod. Although no tornado occurred, there were severe wind gusts on Cape Cod.
- **November 13, 2021**: A fast-moving cold front combined with a potent short-wave trough lifting northeastward across western and northern New England to produce severe thunderstorms across southern New England.

B3a

Impact

Below is a list of impacts that could occur during a thunderstorm:

People: power outages can affect vulnerable populations, especially if outages occur during the winter months; injury or death can occur when people are caught outdoors during a thunderstorm; people can become stuck if area flooding occurs

Infrastructure: downed power lines and power outages, heavy rain associated with a thunderstorm can overwhelm drainage systems, causing area flooding and property destruction

Buildings: damage to roofs and windows; heavy rain associated with a thunderstorm can overwhelm drainage systems, causing area flooding and property destruction; lightning strikes can cause buildings to catch on fire

Economy: loss of power can cause businesses to close until power is restored; lightning strikes can cause economic loss to businesses

Natural Systems: downed trees and branches

Probability

B2b

The Planning Team determined that it is **HIGHLY LIKELY** that thunderstorms will impact the planning area. High

probability was defined based on the frequency of occurrence:

- **Unlikely**: less than a 1% probability over the next 100 years
- **Possible**: 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely**: 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely**: near 100% probability in the next year
- The Planning Team used Wellfleet's history of thunderstorms to make this probability determination.

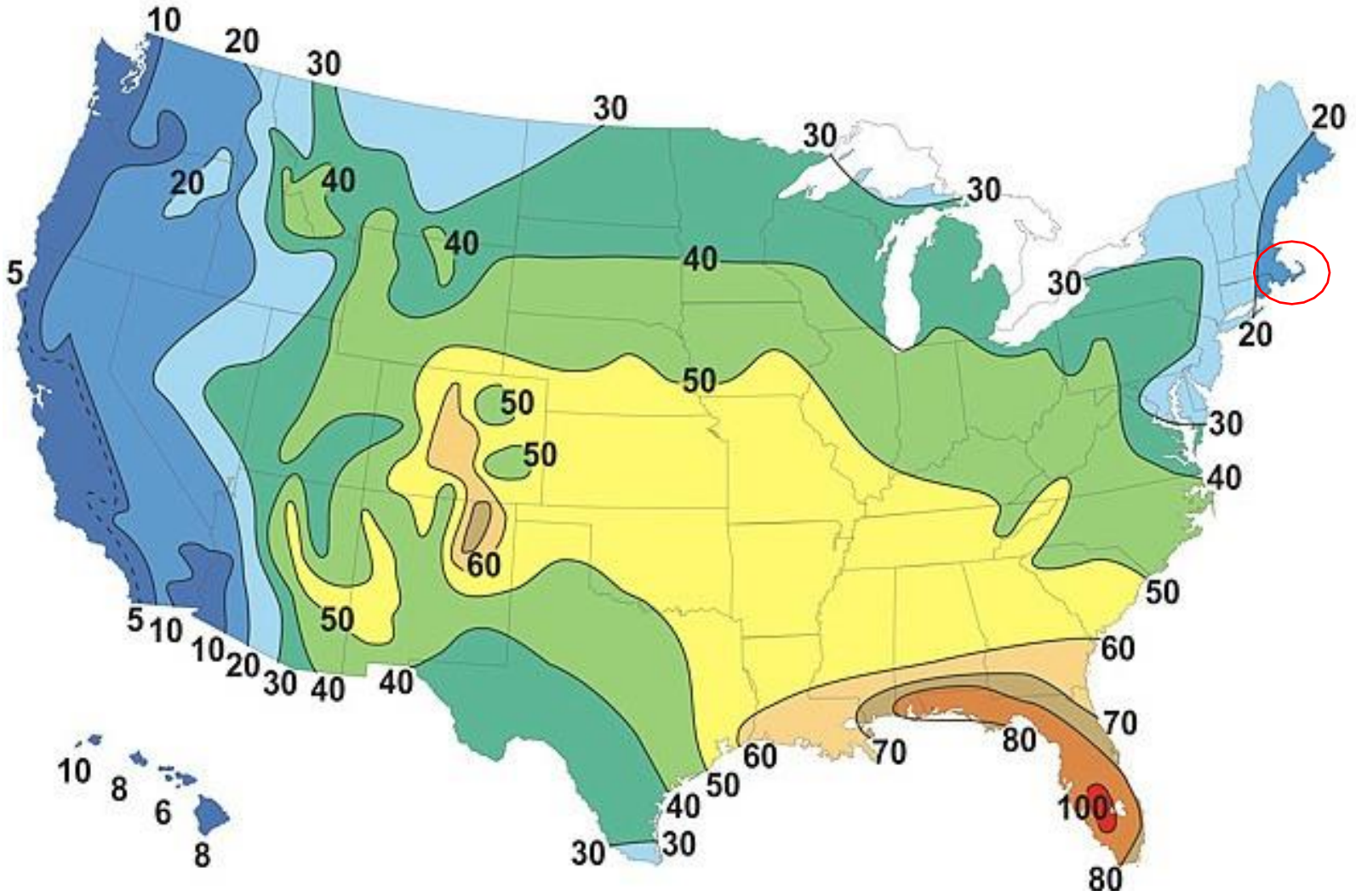


Figure 2.16| Map of the average number of thunderstorms per year in the United States. Planning area is highlighted with a red circle. Map is from the 2013 Massachusetts State Hazard Plan

Extreme Temperatures

Overview

Extreme temperatures are defined as temperatures far outside the normal ranges for the season in a specific area. Extreme cold events occur when temperatures drop well below normal and are generally characterized in temperate zones by the ambient air temperature dropping to approximately 0°F or below. Excessive summer temperatures are often identified as days when temperatures rise well above normal; e.g. temperatures of 90°F or higher.

B1c

Hazard Location

The entire planning area is vulnerable to extreme temperatures.

B1c, B2a,c

Previous Occurrences and Extent

According to NOAA's National Climatic Data Center (NCDC), the following extreme heat and extreme cold events were reported for Barnstable County between December 1, 2009 and 2021:

- **July 22, 2011**: Extreme heat event. A strong upper-level ridge brought very hot temperatures to Southern New England and increased humidity levels such that heat index values rose above 105 degrees for a period of a few hours. The Automated Weather Observation System at Coast Guard Air Station Cape Cod (KFMH) near Falmouth, recorded heat indexes of 105 over a three-hour period. The Automated Weather Observation System at Provincetown Municipal Airport (KPVC) also recorded heat indexes of 105 during this time frame.
- **February 14, 2016**: Arctic high pressure brought strong northwest winds and extremely cold wind chills to southern New England. Many locations reported wind chills between 25 and 35 degrees below zero. Wind chills as low as 32 below zero were reported in Falmouth and Hyannis.

Impact

B3a

Below is a list of possible impacts that could occur during extreme temperature events[39]:

People: children and elderly are particularly at risk to health problems associated with extreme temperature; heat-induced illness such as sunburn, heat cramps, heat exhaustion and heat stroke; cold-induced illness such as frost bite and hypothermia; air quality can be affected during extreme heat events which can cause health hazards; residents can be displaced if warming/cooling centers are opened during extreme temperature events

Infrastructure: power failure; salt water freezes in bays/harbors and can damage coastal infrastructure; extreme temperatures can cause school closings

[39] Massachusetts State Hazard Mitigation and Climate Adaption Plan, 2018.

Buildings: in extreme cold temperature, urban fire risk increases as people use space heaters, generators, and fires to stay warm

Economy: extreme cold temperatures can inhibit fishing and other outdoor operations/work and the transport of goods and services

Natural Systems: saltwater freezing can occur in coastal bays and harbors

Transportation: icy roads make travel difficult

B2b

Probability

The Planning Team determined that it is **LIKELY** that extreme temperatures will impact the planning area. Probability was defined based on the frequency of occurrence.:

- **Unlikely**: less than a 1% probability over the next 100 years
- **Possible**: 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely**: 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely**: near 100% probability in the next year.

Tornadoes

Overview

A tornado is a violently rotating column of air extending from a thunderstorm cloud to the ground.[40] Tornadoes are not always visible as funnel clouds because they are nearly translucent until they pick up dust and debris. The average tornado moves from southwest to northeast, but they can travel in any direction and suddenly change direction. The average speed of a tornado is 30 mph, but they can be stationary or move as fast as 70 mph. The strongest tornadoes have rotating winds of more than 200 mph.

Tornadoes can form from a variety of sources including:

- tropical storms and hurricanes as they move onto land
- individual cells within severe thunderstorms squall lines
- an isolated super-cell thunderstorm
- tropical cyclones or their remnants
- air convergence with upward spins

B1c

Hazard Location

The entire planning area is vulnerable to tornadoes, especially the coastline. Compared to the rest of Massachusetts, Barnstable County has a very low tornado density, defined as the number of tornadoes per 20 square miles.[41]

B1c, B2a,c

Previous Occurrences and Extent

According to the NOAA National Climatic Data Center, Barnstable County experienced the following tornado and waterspouts events between January 1, 1950 and January 1, 2020. No tornadoes have been reported in Wellfleet.

- **August 9, 1968**: F1 tornado was reported for Barnstable County. Many trees felled, destructive wind and hail, fruit and vegetable crops damaged, utility lines damaged, power outages, roof was lifted from a fruit stand (account taken from NCDC Storm data for August 1968)
- **August 22, 1977**: F1 tornado was reported for Barnstable County, a small tornado touched down in Yarmouth and destroyed an art gallery and street signs. It also picked up two buildings and spawned large thunderstorms across Cape Cod.
- **August 20, 1997**: Showers developed during the afternoon in southeastern Massachusetts and produced three waterspouts, at least one confirmed weak tornado (F0) and numerous funnel clouds. The first waterspout occurred just east of the Sagamore Bridge, over Cape Cod Bay, at 1:30 p.m. Another waterspout was reported just west of Bourne, over Buzzards Bay, at 3:20 p.m. Throughout the afternoon, there were numerous

[40] NOAA's National Weather Service, Storm Prediction Center: http://www.spc.noaa.gov/faq/tornado/f-scale.html

[41] Massachusetts State Hazard Mitigation and Climate Adaption Plan, 2018

reports of funnel clouds, some of which appeared in newspaper photos and documented via amateur radio operators' videos. Many of the funnels came as far as half-way down before retreating up into the cloud. There were no reports of damage or injury.

- **September 9, 1998**: Funnel Cloud at Hyannis/Barnstable Airport
- **September 30, 2017:** Funnel Cloud - Falmouth Heights
- **October 23, 2018**: 2 Water Spouts NNE Sagamore Bridge
- **October 29, 2018**: A waterspout in Vineyard Sound came ashore in Woods Hole, MA then quickly dissipated. Eyewitness reports at the Woods Hole Golf Club described a swirling mass that lofted four wooden Adirondack chairs into the air and deposited them 500 feet away onto a tennis court. There was no other damage. At the same time, two nearby weather stations reported wind gusts of 56 (Woods Hole Yacht Club) and 65 mph (Mesonet site at Woods Hole Passage Light). (Description/narrative from NCDC.)
- **July 23, 2019**: A waterspout moved onshore just west of Kalmus Beach in Barnstable, MA at 1157 AM EDT (1057 AM EST). Winds gusted to 91 mph at a Mesonet observation site at Kalmus. They had shifted from southeast to west-northwest with the passage of the tornado. The tornado continued moving northeastward at about 35 mph. The damage was discontinuous but where the tornado touched down, the damage was quite significant, with winds estimated as high as 110 mph. The roof of a motel on the south side of Main Street in West Yarmouth was completely peeled off. Additional significant tornado damage occurred just southwest of the Dennis-Yarmouth Regional High School. Dozens of large trees were uprooted and a few were snapped off. Another house had a hole in the roof from a fallen tree. The tornado then lifted. but severe straight-line wind damage was observed from West Dennis eastward to West Harwich. Numerous large trees were uprooted, consistent with 90 mph gusts or greater. The same supercell storm that produced the Barnstable-Yarmouth tornado went on to touch down again near the center of Harwich at 1210 PM EDT. It moved northeast through Harwich Center. At least 150 hardwood trees were either uprooted or snapped. A few homes also had shingles that were ripped off. Wind gusts were estimated as high as 110 mph. The tornado then lifted, but severe straight-line wind damage was observed in Chatham. (Description/narrative from NCDC)
- **Sept 09, 2021:** Waterspout in Wellfleet at Duck Harbor.

B3a

Impact

Below is the Fujita Tornado Damage Scale developed in 1971 by T. Theodore Fujita:[42]

- **Scale F0, <73 mph winds, light damage**: some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
- **Scale F1, 73- 112 mph winds, moderate damage**: Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
- **Scale F2, 113- 157 mph winds, considerable damage**: Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
- **Scale F3, 158- 206 mph winds, severe damage**: Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
- **Scale F4, 207-260 mph winds, devastating damage**: Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.
- **Scale F5, 261-318 mph winds, incredible damage**: Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters; trees debarked; incredible phenomena will occur.

Probability

B2b

The Planning Team determined that it is POSSIBLE that a tornado will impact the planning area. Probability was defined based on the frequency of occurrence:

- **Unlikely**: less than a 1% probability over the next 100 years
- **Possible**: 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely**: 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely: near** 100% probability in the next year

The Planning Team used Wellfleet's and the region's history of tornados to make this probability determination.

[42] NOAA's National Weather Service, Storm Prediction Center: http://www.spc.noaa.gov/faq/tornado/f-scale.html

Drought

Overview

Drought can be defined and characterized in numerous ways (e.g. meteorological, hydrological, agricultural, etc.), but the root cause is an extended period of deficient precipitation[43] Drought conditions occur in virtually all climatic zones yet its characteristics vary significantly from one region to another, since it is relative to the normal precipitation in that region.

B1c

Hazard Location

The entire planning area could be affected by drought.

B1c, B2a,c

Previous Occurrences and Extent

According to the Massachusetts Drought Management Plan, a determination of drought level is based on seven indices:

Standardized Precipitation Index (SPI) reflects soil moisture and precipitation conditions; calculated monthly using Massachusetts Rainfall Database at DCR, Office of Water Resources. SPI values are calculated for "look-back" periods of 1 month, 3 months, 6 months, and 12 months.

Crop Moisture Index (CMI) reflects short-term soil moisture conditions as used for agriculture; available from the National Climate Data Center.

Keetch-Byram Drought Index (KBDI) is designed specifically for fire potential assessment. The KBDI attempts to measure the amount of precipitation

necessary to return the soil to full field capacity.

Precipitation Index is a comparison of measured precipitation amounts (in inches) to historic normal precipitation. Cumulative amounts for 3-, 6-, and 12-month periods are factored into the drought determination.

Groundwater Level Index is based on the number of consecutive months groundwater levels are below normal (lowest 25% of period of record for the respective months). The U.S. Geological Survey (USGS) monitors groundwater levels in a network of monitoring wells throughout Massachusetts.

Streamflow Index is based on the number of consecutive months that streamflow levels are below normal (lowest 25% of period of record for the respective months). The USGS monitors streamflow in a network of gauges throughout Massachusetts.

Reservoir Index is based on the water levels of small, medium and large index reservoirs across the state. The reservoir level relative to normal conditions for each month of the year will be considered. As part of its monthly conditions report, DCR, Office of Water Resources maintains a list of index water supply reservoirs and the percentage at which they are at capacity as well as non-water supply index reservoir levels, as available.

The 2019 Massachusetts Drought Management Plan uses five drought levels to provide information on the current

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

status of water resources in distinct regions of Massachusetts (Western, Central, Connecticut River Valley, Northeast, Southeast and Cape and Islands). The levels provide a basic framework from which to take actions to assess, communicate, and respond to drought conditions. For the purposes of the drought management plan, conditions are classified into five levels - a normal condition and four drought severity levels. These levels are based on the six drought indices, observed impacts to various resources and forecasts as described in detail in the plan. They provide distinction between different levels of drought severity and are used to provide adequate warning of worsening drought conditions.[44]

The condition levels are:

- **Level 0**-Normal i.e. No Drought,
- **Level 1**-Mild Drought' (formerly "Advisory"), '
- **Level 2**-Significant Drought (formerly "Watch"),
- **Level 3**-Critical Drought (formerly "Warning"), and
- **Level 4**-Emergency Drought (formerly "Emergency").

The U.S. Drought Monitor45 started in 2000. Since 2000, the longest duration of drought (D1-D4) in Massachusetts lasted 48 weeks beginning on June 07, 2016 and ending on May 2, 2017. The most intense period of drought occurred the week of October 4, 2016 where D4 affected 52.13% of Massachusetts land. The following list of dates and drought levels/ descriptions for Barnstable County was compiled from data in the Massachusetts State Hazard Mitigation Plan, US Drought Monitor website, National Climate Data Center, and the Department of Conservation and Recreation Drought Management website:

- **1991**: Drought conditions in Barnstable County but no data is available on the drought Level as described above. The observation well located in the vicinity of the Barnstable Airport set a record monthly low for two months. Local and state officials were concerned with water table levels primarily because of the impacts of low pond levels (i.e., Mary Dunn Pond) on wildlife and vegetation.
- **2001**: Drought Advisory in December
- **2002**: Drought Advisories and Watches from February to December. Rainfall was below normal for all of Massachusetts during November, with amounts in Southeast Massachusetts ranging from near 2 to 3 inches below normal.
- **2004**: Drought Advisory October and November.
- **2014**: Drought Advisory in October
- **2016**: Drought watch August; drought advisory in November
- **2017**: Drought advisory continued through March
- **2020**: Level D2 Severe drought declared in Southeastern Massachusetts, including Barnstable County.

[44] The drought levels, terminology, and indices were revised for the updated plan. Details about the changes are available in the 2019 plan: https://www.mass.gov/files/documents/2019/10/03/drought-plan.pdf.

[45] https://www.drought.gov/drought/data-gallery/us-drought-monitor

- **2021**: March – August: Mild drought status declared in Barnstable County.[46]

B3a

Impact

The following is a list of impacts that are possible with drought:

People: increased conflicts between water users, reduction in drinking water, food shortages, migration from a community

Infrastructure: reduced water levels, soil erosion

Buildings: soil erosion could cause damage to foundations and buildings

Economy: reduced crop yield, increased prices for food

Natural Systems: increased fire hazard, damage to water quality, damage to wildlife and fish habitat, degradation of landscape quality, loss of biodiversity, soil erosion, loss of wetlands

B2b

Probability

The Planning Team determined that it is **LIKELY** that a drought will impact the planning area. Probability was defined based on the frequency of occurrence:

- **Unlikely**: less than a 1% probability over the next 100 years
- **Possible**: 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely**: 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely**: near 100% probability in the next year

The Planning Team used Barnstable County's history of drought to make this probability determination.

[46] https://www.mass.gov/info-details/drought-status

Severe Winter Weather: Snow, Blizzards and Ice Storms

Overview

A winter storm occurs when significant precipitation falls during periods of low temperatures.[47] Winter storms typically occur from early autumn to late spring and can include any of the following events:[48]

Blizzards: defined as winter storms with sustained or frequent wind gusts to 35 miles per hour or more, accompanied by falling or blowing snow that reduces visibility to or below one-quarter mile. Severe blizzards are defined as winter storms with temperatures near or below 10°F, winds exceeding 45 miles per hour and visibility near zero miles.

Blowing snow: wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground that is picked up by the wind.

Snow squalls: brief, intense snow showers accompanied by strong gusty winds. Snow accumulation may be significant.

Snow showers: snow falling at varying intensities for brief periods of time, some accumulation is possible.

Snow flurries: light snow falling for short durations with little to no accumulation.

Ice pellets and sleet: composed of frozen or mostly frozen raindrops or refrozen partially melted snowflakes. These pellets of ice usually bounce after hitting the ground or other hard surfaces.

Winter Storm Warning is issued for sleet or a combination of sleet and snow based on total accumulation which is locally defined by area.

Icing: occurs when liquid rain falls and freezes on contact with structures and objects on the ground, causing a coating of ice on a solid object or surface.

Coastal flooding: winds generated from intense winter storms can cause widespread tidal flooding and severe beach erosion along coastal areas.

Ice jams and floes: long cold spells can cause rivers and lakes to freeze. A rise in the water level or a thaw breaks the ice into large chunks which become jammed at man-made and natural obstructions. Ice jams act as a dam, resulting as severe flooding.

Snow melt: sudden thaw of a heavy snow pack, often leads to flooding.

Hazard Location

B1c

The entire planning area is at risk for snow, blizzards and ice storms.

[47] How to Prepare for a Winter Storm, www.ready.gov/prepare

[48] Winter Storms, The Deceptive Killers, A Preparedness Guide, U.S. Department of Commerce, NOAA, National Weather Service, American Red Cross, June 2008

B1c, B2a,c

Previous Occurrences and Extent

Snow and other forms of winter precipitation occur frequently in Wellfleet. According to the National Weather Service, average annual snowfall for the Outer Cape Cod area is between 25-50 inches per year based on data from 1991-2020.[49]

Below is a list of federally-declared disasters from winter storm events in Barnstable County.

It is important to note that Wellfleet has experienced severe winter storms in addition to those listed below, which includes only storms declared federal disasters

[49] NOAA link.

Table of Federally Declared Disasters from Winter Storms

Table 2.6 | Major Disaster Declarations for Barnstable County for Winter Storms. Data is from the FEMA Disaster Declaration website

Number	Disaster Type	Incident period	Declaration Date
DR-546	coastal storms, flood, ice, snow	February 6 - 8, 1978	February 10, 1978
DR-975	winter coastal storm	December 11 - 13, 1992	December 21, 1992
EM-3103	blizzards, high winds and record snowfall	March 13-17, 1993	March 16, 1993
DR-1090	blizzard	January 7-13, 1996	January 24, 1996
EM-3175	snowstorm	February 17 - 18, 2003	February 11, 2003
EM-3191	snow	December 6 - 7, 2003	January 15, 2004
EM-3201	snow	January 22-23, 2005	February 17, 2005
DR-1701	severe storms, inland and coastal flooding	April 15 - 25, 2007	May 16, 2007
DR-4110	severe winter storm, snowstorm, flooding	February 8-10, 2013	April 19, 2013
DR-4214	severe winter storm, snowstorm, flooding	January 26 - 29, 2015	April 13, 2015
DR-4372	severe winter storm, flooding	March 2-3, 2018	June 25, 2018

B3a

Impact

Below is a list of impacts likely to occur during a winter storm event:[50,51]

People: walking and driving can become hazardous due to icy conditions, snow accumulation, low visibility and extreme cold may cause people to shelter in place without utilities or other services until driving is safe or utilities are restored; injury from slipping and falling, overexertion during shoveling, frostbite; death from hypothermia, carbon monoxide poisoning (when gas powered furnaces and alternative heating sources are used inappropriately indoors during power outages); people may become isolated in their homes

Infrastructure: ice and heavy snowfall can knock out heating, power, and communication services for several hours or days; pipes and water mains may break due to extremely cold temperatures; large sections of ice can cause damage to floating docks

Buildings and Property: structural failure of buildings due to heavy snow loads; roof failure; structural damage to buildings because of high wind; damage to fishing vessels and recreational boats because of ice floes and coastal flooding

Economy: as people are immobilized by the storm, they are unable to go to work, leading to economic losses; excessive costs to the town and residents because of increased plowing, snow removal, salting and sanding

Transportation: roadways can become hazardous due to icy conditions, snow accumulation, low visibility and extreme cold; transit and airport facilities may close temporarily because of severe winter weather; snow storms halt the transport of supplies, goods and services because of unsafe roadways.

Probability

B2b

The Planning Team determined that it is **HIGHLY LIKELY** that a winter storm (snow and blizzard) will impact the planning area. High probability was defined based on the frequency of occurrence:

- **Unlikely**: less than a 1% probability over the next 100 years
- **Possible**: 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely**: 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely**: near 100% probability in the next year

The Planning Team used Wellfleet's history of snow storms and blizzards to make this probability designation.

[50] Ibid.

[51] Winter Storms, The Deceptive Killers, A Preparedness Guide, U.S. Department of Commerce, NOAA, National Weather Service, American Red Cross, June 2008

Tsunami

Overview

A tsunami is a series of traveling ocean waves of extremely long wavelength usually caused by displacement of the ocean floor, seismic or volcanic activity or underwater landslides. Tsunamis generate a devastating onshore surge of water.[52] The waves associated with a tsunami move hundreds of miles per hour in the open ocean and can come ashore with wave heights of 100 feet or more.

B1c

Hazard Location

All coastal communities of Massachusetts are exposed to the threat of tsunamis, but it is unknown what the probability is of a damaging tsunami along the Massachusetts coast.[53]

According to the NOAA National Climatic Data Center, Barnstable County did not experience any tsunamis between January 1, 1950 and February 2021.

Six tsunamis have been reported for the US Atlantic coast and Gulf coast in the last 200 years.[54]

Three tsunamis were generated in the Caribbean Sea, where a convergent plate exists. Tsunamis are more likely to occur at convergent margins, so this area has a higher probability of generating earthquakes that could produce a tsunami.

Two tsunamis were related to a magnitude 7+ earthquake along the Atlantic coast. One tsunami was reported off the mid- Atlantic states and may be associated with an underwater landslide.

Previous Occurrences and Extent

B1c, B2a,c

There is no data on the extent of these tsunamis for Barnstable County or Wellfleet.

Impact

B3a

Below is a list of potential impacts of a tsunami:

People: hydraulic forces of the tsunami can injure or kill people; floating debris can endanger human lives; people and businesses may be left without fuel, food or employment

Infrastructure: floating debris can batter infrastructure; breakwaters and piers may collapse, and scouring actions sweep away infrastructure; oil fires often result because the waves carry away oil tanks which can ignite

Buildings: hydraulic forces of the tsunami will destroy buildings; floating debris can batter inland structures, which may be swept away

Economy: public utilities may be damaged and harm the local economy, especially for the fishing industry; disruption of coastal systems could have far-reaching economic effects

[52] Massachusetts State Hazard Mitigation Plan, 2013

[53] Ibid.

[54] Ibid.

Natural Systems: trees and plants are uprooted; animal habitats such as nesting sites for birds are destroyed. Land animals are killed by drowning and sea animals are killed by pollution if dangerous chemicals are washed away into the sea, thus poisoning marine life.

Transportation: roads, bridges and culverts buckle or are swept away

B2b

Probability

The Planning Team determined that it is **unknown** and **UNLIKELY** that a tsunami will impact the planning area. Probability was defined based on the frequency of occurrence:

- **Unlikely**: less than a 1% probability over the next 100 years
- **Possible**: 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely**: 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely**: near 100% probability in the next year

The Planning Team used the low frequency of tsunamis in Barnstable County to make this probability designation.

Sea Level Rise

Overview

Sea level rise refers to the increase in mean sea level over time.[55]

Relative sea level rise is a combination of eustatic and isostatic contributions:

Eustatic contributions to sea level rise are global-scale changes and include thermal expansion of seawater as it warms and the addition of water volume from melting land-based glacial ice sheets.

Isostatic contributions to sea level rise are more localized changes in land surface elevations, such as subsidence or sinking.

Sea level has been rising around the globe for thousands of years since the end of the last Ice Age. Tidal gauges and satellites have been measuring changes in sea level for over a century. Tide gauge stations measure the height of water referenced to a horizontal control point, or benchmark, and gauges are used to track and predict tide levels and longer-term sea level. Long-term data sets from tide stations have been used to understand local and global sea level trends. NOAA's Center for Operational Oceanographic Products and Services maintains several

[55] Sea Level Rise: Understanding and Applying Trends and Future Scenarios for Analysis and Planning, Massachusetts Office of Coastal Zone Management, December 2013

tide gauge stations across coastal Massachusetts, including long-term stations at Boston, Woods Hole and Nantucket. The sea level data recorded by NOAA and other tide gauges produce trends in relation to fixed reference levels on land, includes variation in local land elevations.

The warming atmosphere associated with global climate change is expected to accelerate both the thermal expansion of seawater and the melting of glaciers and ice sheets and will lead to increasing rates of sea level rise.[56]

B1c

Hazard Location

The entire coast of Wellfleet is vulnerable to sea level rise.

In 2014, the Cape Cod Commission developed a "bathtub" model to visualize Cape Cod's vulnerability to sea level rise (see Sea Level Rise Viewer at https://slrv.apps.capecodcommission.org/). The Sea Level Rise data was derived from classified Digital Elevation Model (DEM) data collected through Light Detection and Ranging (LiDAR) in 2011 by the USGS. The elevation data is accurate to 18 cm at a 95% confidence level with a 1 meter resolution. This elevation data was adjusted to Mean Higher High Water (MHHW) using the NOAA Datum Software. Sea Level Rise is shown as a simple representation of a change in elevation, commonly referred to as a "bathtub" model. No account has been made for the effects of velocity and resulting erosion caused by wave action.

B1c, B2a,c

Previous Occurrences and Extent

Mean sea level trends from the Boston, Woods Hole and Nantucket long-term stations are listed below[57]:

- **Boston, MA tide gauge station**: 0.11 ± 07 inches per year, measured over the period of 1921-2012
- Century rate at the Boston tide gauge: 0.92 feet per 100 years
- **Woods Hole, MA tide gauge station**: 0.11 ± 07 inches per year, measured over the period of 1932-2012
- Century rate at the Woods Hole tide gauge: 0.92 feet 100 years
- **Nantucket, MA tide gauge station**: 0.14 ± 0.017 inches per year, measured over the period of 1965-2012
- Century rate at the Nantucket tide gauge: 1.15 feet per 100 years

[56] Ibid.

[57] Ibid.

B3a

Impact

As relative sea level rises, high water elevations will move landward, areas of coastal shorelines will retreat, and low-lying areas will be increasingly exposed to erosion, tidal inundation, and coastal storm flooding. Developed parts of the coast are especially vulnerable because of the presence of infrastructure and buildings that can be damaged or destroyed by coastal storms. Development often impedes the ability of natural coastal systems to buffer inland areas from storm damage, further exacerbating the problem. Coastal habitats including salt marshes, beaches and dune systems, and floodplains, are also vulnerable to rising sea levels. These areas provide significant environmental benefits, including habitat value, filtering of pollutants for improved water quality, protection of inland areas from flooding and storm surge, and extensive recreational opportunities.[58]

B2b

Probability

The Planning Team determined that it is **HIGHLY LIKELY** that sea level rise will impact the planning area. Probability was defined based on the frequency of occurrence:

- **Unlikely**: less than a 1% probability over the next 100 years
- **Possible**: 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely**: 10-100% probability in the next year or at least one chance in the next 10 years

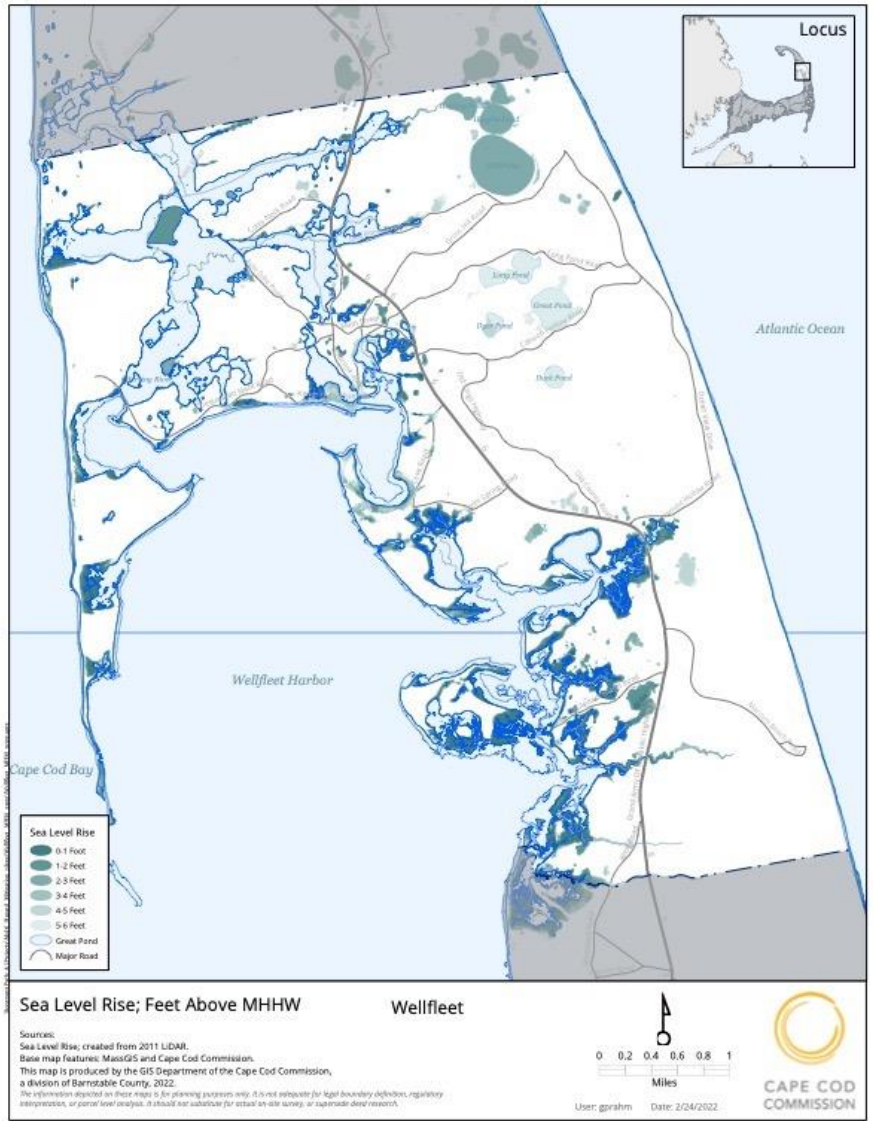


Figure 2.17 | Sea level rise map for Wellfleet.

https://www.wellfleet-ma.gov/

[58] Ibid.

- **Highly Likely**: near 100% probability in the next year

The Planning Team used the history of sea level rise in Massachusetts to make this probability designation.

Climate Change

Climate is defined as average temperature and precipitation and includes the type, frequency, and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of extremes such as storms, high winds, and tornado events. While predicting changes in storm events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society, and the environment.[59]

The following changes in hazard frequency and intensity are expected to occur with changes in climate:[60]

Coastal Erosion: Climatic trends can change a beach from naturally accreting to eroding due to increased episodic erosion events caused by waves from an above-average number of storms and high tides, or from the long-term effects of fluctuations in sea or lake level. The coastal zone is being severely impacted by erosion and flooding due in part to climate change and sea-level rise. It is likely that the impact will increase in the future as sea levels continue to rise at the current rate or rises at an accelerated rate.

Earthquakes: The impacts of global climate change on earthquake probability are unknown. Some scientists feel that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity according to research into prehistoric earthquakes and volcanic activity. NASA and USGS scientists found that retreating glaciers in southern Alaska might be opening the way for future earthquakes.

Fire: Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management and vegetation fuels. Hot dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation. When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.

Flooding: While it is not known if the number of storms will increase in the future as the result of climate changes, it is anticipated that the intensity of tropical and extra-tropical storms may increase as the storm intensity is a function of sea surface temperature, which continues to rise. Thus, we may experience more intense storms with greater rainfall in the future.

[59] United States Environmental Protection Agency, 2006

[60] Massachusetts State Hazard Mitigation Plan

Tropical Cyclones: Although there is still some level of uncertainty, research indicates the warming climate may double the frequency of Category 4 and 5 hurricanes by the end of the century and decrease the frequency of less severe hurricane events.

Nor'easters and Winter Storms: Weather extremes are likely to become more frequent and cause more damage under a changing climate. Although no specific storm is directly linked to climate change, an increasing number of events could become more common. New England is expected to experience changes in the amount, frequency, and timing of precipitation. Along with rising temperatures, it is expected that annual precipitation will increase by 14%, with a slight decrease in summer totals and a 30% increase in winter totals. Winter precipitation is predicted to be in the form of rain rather than snow. This change in precipitation will have significant effects on the amount of snow cover, winter recreation, spring snowmelt and peak stream flows, water supply, aquifer recharge, and water quality. Snow is also predicted to fall later in the winter and cease falling earlier in the spring.

Severe Weather (wind, extreme temperature, thunderstorms, tornadoes, drought): Climate change presents a significant challenge for risk management associated with severe weather. The frequency of severe weather events has increased steadily over the last century. The number of weather-related disasters during the 1990s was four times that of the 1950s, and cost 14 times as much in economic losses. Historical data show that the probability for severe weather events increases in a warmer climate. With a warmer climate, droughts could become more frequent, more severe, and longer-lasting. Higher temperatures also bring an increase in invasive ocean species. Wellfleet's Shellfish Department has noted that with consecutive mild, ice-free winters, disease organisms could impact more shellfish. Shellfish predators including green crabs, blue crabs, and cow-nosed rays also pose threats to Wellfleet shellfish as water temperatures rise.[61]

[61] Nancy Civetta, Wellfleet Shellfish Constable, email dated February 11, 2022. For further information see "Potential Impacts of Climate Change and Variability on Shellfish Resources, July 2015." https://www.wellfleet-ma.gov/sites/g/files/vyhlif5166/f/file/file/climate_change_-_potential_impacts_on_shellfish.pdf

Hazards Selected for Risk Assessment

After reviewing the hazards in the Massachusetts Hazard Mitigation and Climate Adaptation Plan and 2016 Wellfleet Hazard Mitigation Plan and assigning a probability to each hazard, the Planning Team determined which were significant for Wellfleet. They also reviewed the public and stakeholder input provided in the hazard survey to support/confirm the determination ***Table*** 2.7 documents the evaluation process used for determining which of the state listed hazards are considered significant enough to warrant further evaluation in the risk assessment. A hazard was further evaluated for a risk assessment if the following criteria were met:

- the Planning Team determined that the probability of the hazard was highly likely
- the hazard was identified as a top concern during the MVP process

Using the process described above, the following hazards were selected for risk assessment in Chapter 4:

- Coastal Erosion/Shoreline Change
- Flood
- Hurricanes and Tropical Storms
- Sea Level Rise
- Nor'easters
- High Winds
- Severe Winter Weather

Table 2.7 | Relevant Hazards for Wellfleet

Type of Natural Hazard	What is the future probability of the hazard as determined by the Planning Team?	Was the hazard identified as a top concern during the MVP process?	Was the hazard further evaluated in the risk assessment in Chapter 4?
Coastal Erosion and Shoreline Change	HIGHLY LIKELY	Yes	Yes
Dam (Culvert) Failure	POSSIBLE	No	No
Earthquake	POSSIBLE	No	No
Urban Fire	LIKELY	No	No

Hazards Selected for

Type of Natural Hazard	What is the future probability of the hazard as determined by the Planning Team?	Was the hazard identified as a top concern during the MVP process?	Was the hazard further evaluated in the risk assessment in Chapter 4?
Wildland Fire	LIKELY	No	No
Flood	HIGHLY LIKELY	Yes	Yes
Hurricane and Tropical Storms	HIGHLY LIKELY	Yes	Yes
Landslide	POSSIBLE	No	No
Nor'easters	HIGHLY LIKELY	Yes	Yes
High Winds	HIGHLY LIKELY	Yes	Yes
Thunderstorms	HIGHLY LIKELY	Yes	YES
Extreme Temperatures	POSSIBLE	Yes	No
Tornadoes	POSSIBLE	No	No
Drought	LIKELY	No	No
Severe Winter Weather	HIGHLY LIKELY	Yes	Yes
Tsunami	UNLIKELY	No	No
Sea Level Rise	HIGHLY LIKELY	Yes	Yes

Table 2.7 | Relevant Hazards for Wellfleet

Hazards Selected for

Asset Inventory

Chapter Three

Chapter 2 profiles natural hazards that have affected Wellfleet in the past or could affect the town in the future. The next step in the hazard planning process is to identify the types of assets located in Wellfleet and its population. Once this asset inventory in complete, the Planning Team can determine which assets and populations are vulnerable to the impacts of natural hazards. **Chapter 3 is an inventory of the people and natural and built environments in Wellfleet.**

Population: Year-round and Seasonal

Approximately 3,617 year-round residents live in Wellfleet (according to 2019 American Community Survey estimates).[62] The median household income for this population is $74,639.

Like other Cape Cod towns, Wellfleet's population grows significantly from winter to summer. The total seasonal population amount includes year-round household occupants, second home-owners or residents, and transient renters of hotels/motel rooms/rental houses/ bed and breakfast accommodations. There is no singular numeric estimate of Wellfleet's seasonal population because this statistic is difficult to determine. For the purposes of this plan, seasonal population estimate seeks to address and reflect how many individuals may need to be accounted for within the town, regardless of resident, visitor or transient status.

The 2016 Hazard Mitigation Plan provided an estimate of about 13,900 additional people with overnight accommodations in Wellfleet on a summer day/peak season.[63] The estimate includes seasonal home occupants as well as hotel/motel, bed & breakfast, etc. occupants.

Estimates and projections for total summer population range from to 17,000 to 21,000.[64] Regardless of the variation in estimates, the substantial seasonal population boom puts a strain on Town services and affects long-range planning.

Wellfleet and all of Barnstable County experienced a significant population boom in 2020-2022 during the COVID-19 pandemic. With a significant number of seasonal or part time residents choosing to spend more time in Wellfleet during the pandemic and a significant number of people relocating to Wellfleet, its seasonal and year-round population has grown.[65]

[62] For additional data on Wellfleet population, housing, economic, and other characteristics, see Data Cape Cod at https://datacapecod.org/

[63] 2016 Wellfleet Hazard Mitigation Plan, p, 100.

[64] Ibid.

[65] For more information on address changes in Barnstable County during the pandemic, see https://datacapecod.org/pf/address-changes/

Base Map of Wellfleet

Figure 3.1 is a base map for the Town of Wellfleet; it shows the geographic area of Wellfleet and includes features such as roads, rivers, coastlines. The base map provides a frame of reference for the reader of the Wellfleet Hazard Mitigation Plan.

Natural Environment

Wellfleet's natural environment is a character defining element and economic engine for the town. Bordered on the east by the Atlantic Ocean and on the west by Cape Cod Bay, Wellfleet's beaches, dunes, ponds, wetlands, undeveloped open spaces, and harbor are key features that define both the physical and cultural character of the town. Wellfleet's natural resources contribute considerably to town character and help drive the local economy. Shellfishing is a multi-million dollar industry in Wellfleet and major economic force in town, which is known for its world-famous Wellfleet oyster. Wellfleet's shellfishing industry's value is currently estimated to be about $7.7 million.[66] The town also has a significant density of rare species, as determined by the Nature Conservancy and the Massachusetts Natural Heritage and Endangered Species Program (NHESP).

Wellfleet's coastlines and natural resources both limit and shape future growth. Developable land is limited. 61

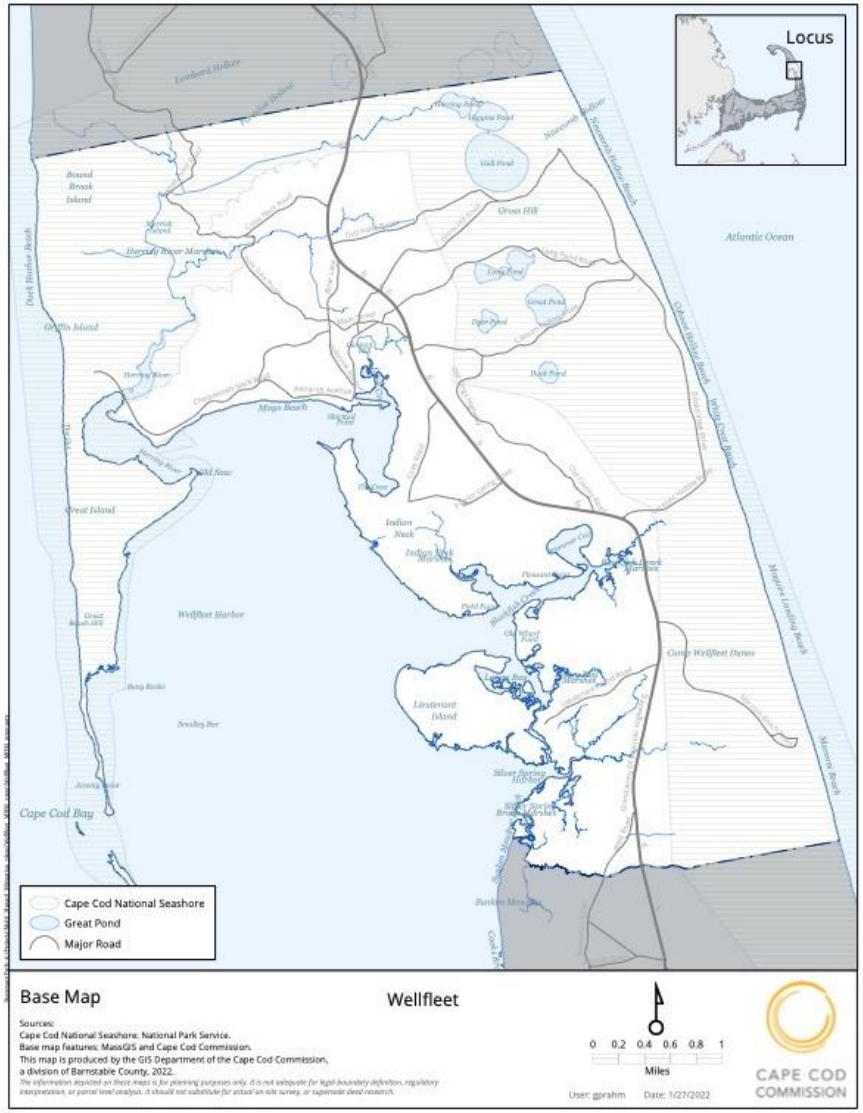


Figure 3.1 | Wellfleet Base Map

[66] Figure from Wellfleet Town Assessor, May 26, 2022.

percent of Wellfleet is located within Cape Cod National Seashore and is controlled by the National Park Service. Most future growth in Wellfleet will be infill or redevelopment.

Homes

Wellfleet's residential development is located throughout the town, including the downtown village center area and outside the downtown within residential zoning districts and inside the National Seashore. Many buildings in the downtown area are historically significant and are part of Wellfleet's Historic District. Over 92% of Wellfleet's housing stock is single family homes.

Wellfleet has 4,701 total housing units. The 2019 American Community Service estimates for total housing units is shown in ***Table 3.1*** | The 2019 American Community Service estimates for total housing units.[67]

Table 3.1 | The 2019 American Community Service estimates for total housing units.

Total Housing Units:	**4,701**
Occupied units	1,598 (34%)
Owner	1,358 (85%)
Renter	240 (15%)
Vacant Units	3,103 (66%)

According to the ACS data hazard plan, almost 70 percent of the town's housing units were built after 1960. Almost 42% of Wellfleet's homes have 3 bedrooms, and about 28% have two bedrooms.[68]

Substandard housing conditions are not uncommon in Wellfleet, as many residential buildings were not built for year-round occupancy and have inadequate insulation and inefficient heating systems.

[67] 2019 American Community Service, US Census, estimate

[68] For more on Wellfleet housing characteristics, see Data Cape Cod https://datacapecod.org/pf/housing-characteristics/

UNITS IN STRUCTURE	Estimate
1-unit, detached	**4,333**
1-unit, attached	**72**
2 units	**52**
3 or 4 units	**64**
5 to 9 units	**14**
10 or more	**13**
Mobile home	**153**
Boat, RV, etc	**0**

Table 3.2 | Number and type of housing units in Wellfleet, U.S. Census American Community Survey (estimate), 2019. *Note: The ACS housing units data estimates contain a high margin of error and may not reflect actual number of existing units.

Businesses and Employment

Wellfleet's business landscape is dominated by tourism-supported service industries, primarily Retail and Accommodations/Food Service (*Table 3.3*).[69]

Industry	Number	Values
Wholesale trade	**2**	**D**
Retail trade	**35**	**27,798**
Information	**3**	**N**
Finance and insurance	**3**	**N**
Real estate and rental and leasing	**8**	**D**
Professional, scientific, and technical services	**4**	**D**
Administrative and support and waste management and remediation services	**13**	**D**
Educational services	**5**	**D**
Health care and social assistance	**8**	**D**
Arts, entertainment, and recreation	**5**	**2,256**
Accommodation and food services	**37**	**31,799**
Other services (except public administration)	**8**	**4,082**

Table 3.3 | Estimated Number and Value of Wellfleet Businesses, U.S. Census American Community Survey, D=Withheld to avoid disclosing data for individual companies N=Data not available or not comparable

[69] As noted elsewhere in this plan, Wellfleet's shellfishing industry is a vital economic engine for the community. According to the Town Assessor its value is approximately $7.7 million.

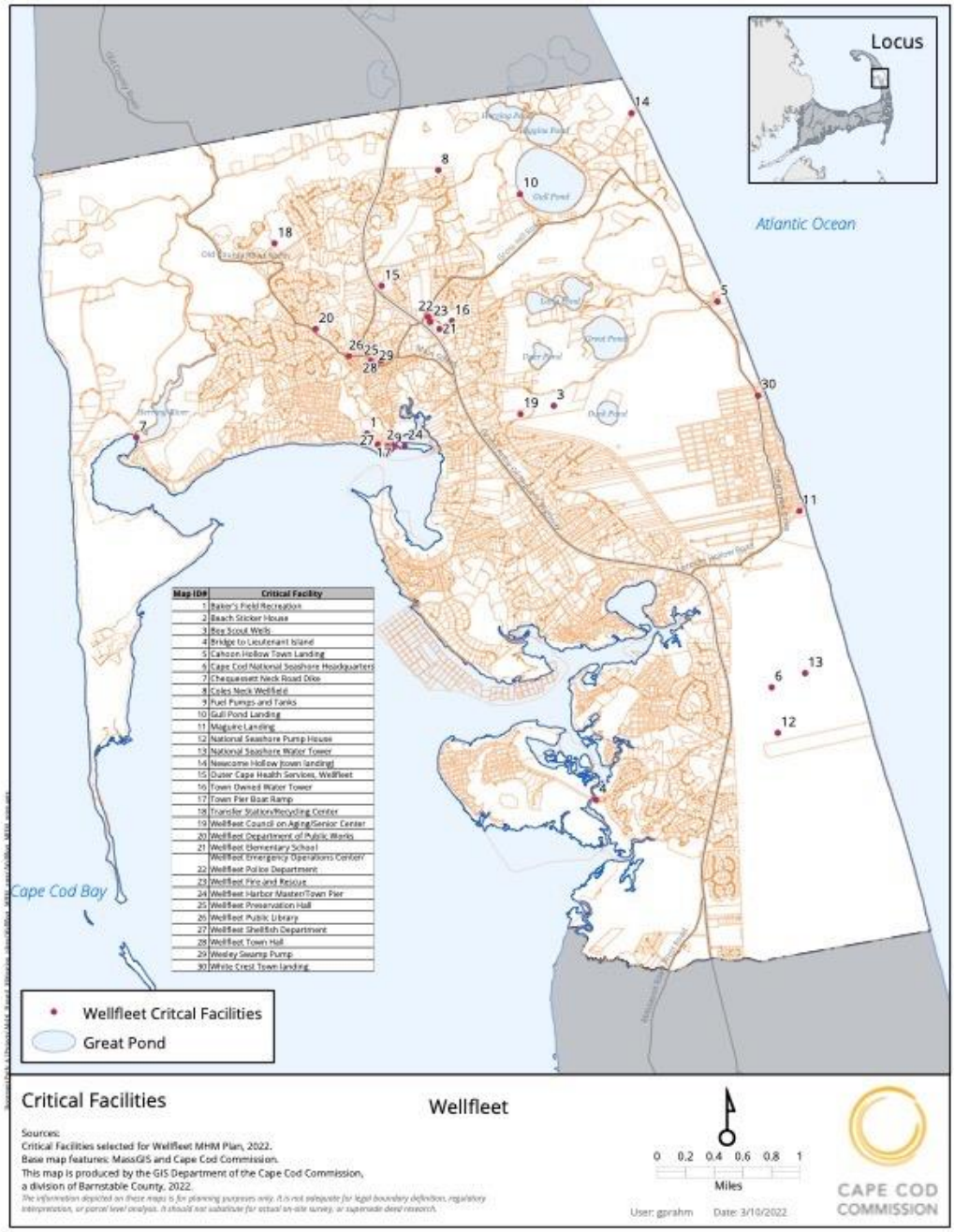
Table 3.4 | Wellfleet Employment and Wages Report, 2020 Annual. [70]

Description	Number	Total Wages	Average Monthly Employment	Average Weekly Wages
Agriculture, Forestry, Fishing and Hunting	8	$697,203	14	$958
Construction	23	$5,831,253	105	$1,068
Wholesale Trade	3	$1,625,192	28	$1,116
Information	4	$1,172,563	32	$705
Finance and Insurance	4	$1,522,650	20	$1,464
Real Estate and Rental and Leasing	7	$1,487,798	26	$1,100
Professional and Technical Services	6	$378,340	7	$1,039
Administrative and Waste Services	19	$3,298,689	82	$774
Health Care and Social Assistance	14	$2,361,296	53	$857
Arts, Entertainment, and Recreation	9	$5,437,694	100	$1,046
Accommodation and Food Services	32	$11,537,560	273	$813
Other Services, Except Public Administration	9	$1,882,994	48	$754
Total, All Industries	**188**	**$52,905,889**	**1,062**	**$958**

[70] See https://lmi.dua.eol.mass.gov/lmi/EmploymentAndWages#, for further details.

Critical Facilities

Table 3.5 is a list of the Critical Facilities in Wellfleet. Figure 3.2 shows their locations.



Map ID#	Critical Facility
1	Baker's Field Recreation
2	Beach Sticker House
3	Boy Scout Wells
4	Bridge to Lieutenant Island
5	Cahoon Hollow Town Landing
6	Cape Cod National Seashore Headquarters
7	Chequessett Neck Road Dike
8	Coles Neck Wellfield
9	Fuel Pumps and Tanks
10	Gull Pond Landing
11	Maguire Landing
12	National Seashore Pump House
13	National Seashore Water Tower
14	Newcome Hollow (town landing)
15	Outer Cape Health Services, Wellfleet
16	Town Owned Water Tower
17	Town Pier Boat Ramp
18	Transfer Station/Recycling Center
19	Wellfleet Council on Aging/Senior Center
20	Wellfleet Department of Public Works
21	Wellfleet Elementary School
22	Wellfleet Emergency Operations Center/ Wellfleet Police Department
23	Wellfleet Fire and Rescue
24	Wellfleet Harbor Master/Town Pier
25	Wellfleet Preservation Hall
26	Wellfleet Public Library
27	Wellfleet Shellfish Department
28	Wellfleet Town Hall
29	Wesley Swamp Pump
30	White Crest Town Landing

Figure 3.2 I Map of Critical Facilities in Wellfleet

Table 3.5 | List of Critical Facilities in Wellfleet

Type of Critical Facility		Name of Critical Facility	
Essential Facilities	Assets that are essential to the health and welfare of the whole population and are especially important following hazard events. The potential consequence of losing these assets is so great that they were carefully inventoried. The building, contents and function/services provided to the community are significant. Source: FEMA How-to Guide 2/ FEMA 386-2	Wellfleet Town Hall	Town Pier
		Wellfleet Police Station	Transfer Station
		Wellfleet Fire Station	Adult Community Center/Senior Center
		Outer Cape Health Services	Shellfish Department
		Wellfleet Elementary School	Beach Sticker Office
		Department of Public Works	Bakers Field Recreation
		Wellfleet Library	National Seashore Headquarters
		Preservation Hall	
		Harbormaster's Office	
Transportation Systems	Critical assets in all 5 modes of transportation (air, road, transit, rail, sea). Source: FEMA How-to Guide 2/ FEMA 386-2	Route 6	Gull Pond Landing
		Commercial Street	White Crest Town Landing
		Chequessett Neck Road Dike (Herring River)	Maguire Landing
		Cahoon Hollow Town Landing	Bridge to Lieutenant Island
		Newcomb Hollow Town	

https://www.wellfleet-ma.gov/

Type of Critical Facility		Name of Critical Facility	
		Landing	
Lifeline Utilities	Includes wastewater, water, oil, natural gas, electric power, and communication systems	Town owned fuel pumps and tanks	Pumping Station #2 (Cole's Neck)
		Town owned water tower	National Seashore Pump House
		National Seashore water tower	Wesley Swamp Pump
		Pumping Station #1 (Old Boy Scout Camp)	

B4a

Repetitive Loss Properties

Repetitive Loss Properties are those for which two or more losses of at least $1,000 each have been paid under the National Flood Insurance Program (NFIP) within any 10-year period since 1978.

The Town of Wellfleet had no Repetitive Loss Properties in 2016, when the last Hazard Mitigation Plan was completed. Shannon Hulst, Deputy Director Cape Cod Cooperative Extension/Woods Hole Sea Grant and Floodplain/Community Rating System Specialist requested updated Repetitive Loss Properties data from FEMA in June 2021 for Wellfleet's Community Ratings System program and Hazard Mitigation Plan purposes but has been unable to get this information in time for the 2022 plan update.

New Developments in Wellfleet

D1a

Table 3.6 | New Development in Wellfleet

Permit Issued Date	EC Date	Address	Bldg Type (Res, Non-Res, Addition, Accessory, etc.)	New Bldg or SI/SD	FIRM Zone	Comments
4/30/20	5/3/21	210 Kendrick Ave (unit 2)	Residential	New Construction	AE	Elevate above Flood - Flood Vents
2/1/18	6/19/17	210 Kendrick Ave (unit 1)	Residential	New Construction	AE	Elevate above Flood - Flood Vents
2/6/18	3/25/19	210 Kendrick Ave (Unit 3)	Residential	New Construction	AE	Elevate above Flood - Flood Vents
2/20/19		90 Aunt Sarah's Way	Residential	Substantial Improvement	AE	Flood Vents
5/21/19		5 Holbrook Ave	Residential	Substantial Improvement	AE	Elevate above Flood - Flood Vents
11/28/16	11/13/17	1225 STATE HWY ROUTE 6	Residential	New Construction	AE	Elevate above Flood - Flood Vents

Most of the new development in Wellfleet since completion of the 2016 hazard mitigation plan is infill development and has not increased the community's hazard vulnerability. The New Development table shows new buildings in Wellfleet since completion of the 2016 hazard plan that are located in flood hazard areas and the accompanying mitigation.

Vulnerability Assessment

Chapter Four

Chapter 2 of the Wellfleet Hazard Plan profiles natural hazards that could impact the town in the future or have impacted Wellfleet in the past. Chapter 3 inventories the assets that could be damaged during a hazard event, such as buildings, infrastructure and critical facilities. Chapter 4 ties together the hazard profiles and asset inventories to estimate the potential losses that Wellfleet could experience during a natural hazard event. **Chapter 4 answers the question: How will assets in Wellfleet be affected by hazard events?**

This chapter provides the following two assessments:

- **Vulnerability Assessment of Parcels and Buildings**: this assessment was completed by the Cape Cod Commission using data from the Town Assessor's office and reviewed by the Planning Team.
- **Exposure Assessment of Critical Facilities**: the Planning Team used Geographic Information System (GIS) analysis to identify whether critical facilities could be exposed to flooding, surge, sea level rise and coastal erosion.

The methods for the 2022 Vulnerability Assessments are provided below.

Methods of the Vulnerability Assessment of Parcels and Buildings:

To estimate the total number of parcels and value of buildings located in Wellfleet, the Planning Team used 2021 Town Assessing data. This data set contains information about parcels such as use codes, building characteristics and assessed values. The 2021 parcel data is also linked to geometry data for specific parcels on the ground. The 2021 data is the most current data set that contains both the parcel and the geometry data. This large data set was grouped into categories using Massachusetts Property Type Classification Codes. Parcel numbers and building values were totaled for each category.[71] It is important to note that the category titles are based on the State's Classification Code designations and not selected by members of the Planning Team. Below is a list of examples of asset types in each category.

Agriculture: agricultural land/farms, greenhouses, farm buildings

Banks: bank buildings

Entertainment and Recreation: includes eating and drinking establishments, indoor recreation, recreational land

General Services: includes warehouses and distributional facilities, post office, housing authority, municipal property

Medical Office/Clinics: includes medical office buildings

Multi-Family Dwelling: includes condos, 2-3 family homes, multiple houses on a single property, 4-8 unit homes and 8+ units

Non-Profit/Municipal: government or town owned properties, public parking lots, libraries, museums, fraternal offices

Parking: commercial parking lots

[71] Property Type Classification Codes, Non-arm's Length Codes and Sales Report Spreadsheet Specifications, prepared by the Bureau of Local Assessment, revised June 2016.

Personal/Repair Services: includes buses and funeral homes

Retail Trade: includes hardware stores, shopping malls, supermarkets, small retail

Single Family Dwelling: single family homes

Temporary Lodging: includes motels, inns, resorts

Theaters: includes theaters and stadiums

Vacant: includes developable land, undevelopable land, residential open land, underwater land or marshes not under public ownership

Wholesale Trade: includes tanks holding fuel and oil products for retail distribution, bottled gas and propane tanks, lumber yards

Next, Commission staff used GIS to overlay maps of hazard areas onto parcel and value data. Only a subset of natural hazards was identified for further vulnerability assessment (see ***Table*** 2.7 for rationale). Below is a list of hazards selected for the vulnerability assessment and a description of the available data used for the assessment.

Flooding: FEMA flood hazard maps, adopted by Wellfleet in 2014.

Hurricanes and Tropical Storms: The storm surge that occurs during tropical cyclones is assessed using the SLOSH (Sea, Lake, and Overland Surges from Hurricanes) model. Currently, there is no model available for the impact of wind from tropical cyclones. ***Figure 2.12*** in Chapter 2 shows a SLOSH map for the Town of Wellfleet.

Sea Level Rise: Bathtub model developed by the Cape Cod Commission was used to model the impacts of sea level rise on Wellfleet. ***Figure 2.17*** in Chapter 2 shows a Sea Level Rise map for the Town of Wellfleet.

Coastal Erosion/Shoreline Change: GIS was used to identify which properties had a physical connection to saltwater. A property that shares a boundary with saltwater was identified as "coastal property." Parcel and building values were identified. The Planning Team recognizes that this method is coarse but is useful for identifying some vulnerable properties.

Nor'easters: Mapping/location data is not available specific to Nor'easter impacts. A detailed vulnerability assessment could not be completed, although the assessments for flooding and coastal erosion overlap and are related to some nor'easter impacts.

High Winds: Data is not available specific to wind impacts/locations. A detailed vulnerability assessment could not be completed, other than noting as a coastal community the entire town is vulnerable to impacts from high winds.

Severe Winter Weather: Data is not available. A detailed vulnerability assessment could not be completed specific to severe winter weather.

Urban Fire: data is not available. A detailed vulnerability assessment could not be completed specific to urban fire vulnerability.

Wildfire: a wildfire vulnerability assessment was completed for Wellfleet in 2012 by wildfire professionals and referenced in Chapter 2.

It is important to note that SLOSH and Sea Level Rise models are coarse models to illustrate vulnerability to storm surge and sea level rise using the best available data. These models have the following strengths and their weaknesses:

Methods of the Vulnerability Assessment of Parcels and Buildings:

Sea, Lake and Overland Surges from Hurricanes (SLOSH) model: SLOSH is a computerized numerical model developed by the National Weather Service (NWS) to estimate storm surge heights resulting from historical, hypothetical, or predicted hurricanes in consideration of atmospheric pressure, size, forward speed, and track data2. These parameters are used to create a model of the wind field which drives the storm surge. The SLOSH model consists of a set of physics equations which are applied to a specific locale's shoreline, incorporating the unique bay and river configurations, water depths, bridges, roads, levees and other physical features. However, the SLOSH model does not explicitly model the impacts of waves on top of the surge nor does it account for normal river flow or rain flooding. Future advancements in the SLOSH model will allow for the resolution of some of these limitations.[72]

Cape Cod Commission's Sea Level Rise model: Sea Level Rise data was derived from classified Digital Elevation Model (DEM) data collected through Light Detection and Ranging (LiDAR) in 2011 by the United States Geological Society (USGS). The elevation data is accurate to 18 cm at a 95% confidence level with a 1-meter resolution. This elevation data was adjusted to Mean Higher High Water (MHHW) using the NOAA VDatum Software. Sea Level Rise is shown as a simple representation of a change in elevation, commonly referred to as a "bathtub" model. No account has been made for the effects of velocity and resulting erosion caused by wave action.

The SLOSH and Sea Level Rise models used for the vulnerability assessment are adequate for the purposes of this hazard mitigation plan. For more specific analyses to address flooding risks, the Town of Wellfleet has been working with consultants using more refined modelling methodology. The Cape Cod Commission's "Low Lying Roads Project," for example, will identify flooding risk in low lying areas and produce feasibility analyses for mitigation options in selected locations.[73] The Woods Hole Group (project consultant) will employ the state-of-the-art Massachusetts Coast Flood Risk Model (MC FRM) to identify vulnerable road segments under different sea level rise scenarios and time scales. One output from this work is a projection of the probability and extent of flooding at the present, 2030, 2050, and 2070.

[72] http://www.nhc.noaa.gov/surge/slosh.php

[73] See the Low Lying Roads Project website: https://www.capecodcommission.org/our-work/low-lying-roads-wellfleet/

Parcels and Buildings in Hazard Areas

**Parcels intersecting A or V zones counted within flood zone.*
*** Values based on 2021 Wellfleet Assessors data*
FEMA Flood Insurance Rate Maps (FIRM), version 2019 used

	Parcels			Buildings		
Type/Use	**# in Town**	**# in Hazard Area***	**% in Hazard Area***	**Total Building Value****	**Building Value in Hazard Area****	**% in Hazard Area**
Banks	2	1	50%	$1,155,800	$880,500	76%
Church/Non-Profit Offices	186	123	66%	$10,349,700	$2,023,000	20%
Emergency Response	3	-	0%	$4,828,600	$0	0%
Entertainment and Recreation	18	10	56%	$395,700	$228,600	58%
General Services	64	26	41%	$19,335,900	$4,999,500	26%
Heavy Industrial	4	1	25%	$0	$0	0%
Medical Office/Clinic	4	2	50%	$6,135,000	$5,059,100	82%
Multi-family Dwelling	305	94	31%	$178,481,200	$70,947,300	40%
Personal/Repair Services	2	-	0%	$298,600	$0	0%
Retail Trade	29	10	34%	$6,333,200	$2,361,400	37%
Single Family Dwelling	3,125	845	27%	$867,628,400	$255,296,900	29%
Temporary Lodging	20	7	35%	$10,291,700	$3,453,200	34%
Theaters	1	1	100%	$335,200	$335,200	100%
Vacant	1,224	417	34%	$5,934,100	$1,535,000	26%
Wholesale Trade	8	4	50%	$1,533,600	$346,200	23%
Water or ROWs	42	20	48%	$0	$0	
TOTALS:	5,037	1,561	31%	$1,113,036,700	$347,465,900	31%

Table 4.1 | The number of parcels and value of buildings values located in A or V zone. Table generated using 2021 Wellfleet Assessing Data.

Methods of the Vulnerability Assessment of Parcels and Buildings:

Parcels and Buildings Vulnerable to Sea Level Rise

Table 4.2 | The number of parcels and value of buildings exposed to sea level rise. Table generated using 2021 Wellfleet Assessing Data

	Sea Level Rise 1- Foot		Sea Level Rise 2-Feet		Sea Level Rise 3-Feet	
Type of Use	**Parcel Count**	**Value of Buildings**	**Parcel Count**	**Value of Buildings**	**Parcel Count**	**Value of Buildings**
Banks	0	$0	0	$0	1	$880,500
Church/Non-Profit Offices	104	$2,023,000	111	$2,309,800	119	$2,309,800
Emergency Response	0	$0	0	$0	0	$0
Entertainment and Recreation	10	$228,600	10	$228,600	10	$228,600
General Services	20	$4,317,800	22	$4,693,200	23	$4,933,400
Heavy Industrial	0	$0	0	$0	0	$0
Medical Office/Clinic	0	$0	0	$0	0	$0
Multi-family Dwelling	69	$53,876,500	77	$56,024,000	90	$60,167,900
Personal/Repair Services	0	$0	0	$0	1	$145,600
Retail Trade	9	$1,750,500	10	$2,160,900	10	$2,160,900
Single Family Dwelling	510	$160,927,300	617	$193,740,200	717	$220,610,500
Temporary Lodging	4	$2,246,000	6	$3,060,000	6	$3,060,000
Theaters	0	$0	0	$0	1	$335,200
Vacant	373	$1,317,000	414	$1,455,400	461	$1,455,400
Water or Rights of Way (ROW)	18		18		21	
Wholesale Trade	2	$136,000	2	$136,000	2	$136,000
TOTALS:	1,119	$226,822,700	1,287	$263,808,100	1,462	$296,423,800

Table 4.2 (continued) | The number of parcels and value of buildings exposed to sea level rise. Table generated using 2021 Wellfleet Assessing Data

	Sea Level Rise 4-Feet		Sea Level Rise 5-Feet		Sea Level Rise 6-Feet	
Type of Use	**Parcel Count**	**Value of Buildings**	**Parcel Count**	**Value of Buildings**	**Parcel Count**	**Value of Buildings**
Banks	1	$880,500	1	$880,500	1	$880,500
Church/Non-Profit Offices	123	$2,309,800	125	$2,309,800	128	$2,309,800
Emergency Response	0	$0	0	$0	0	$0
Entertainment and Recreation	10	$228,600	10	$228,600	10	$228,600
General Services	27	$5,347,200	27	$5,347,200	29	$5,516,500
Heavy Industrial	1	$0	1	$0	1	$0
Medical Office/Clinic	0	$0	0	$0	0	$0
Multi-family Dwelling	98	$62,940,600	104	$72,310,200	114	$79,871,300
Personal/Repair Services	1	$145,600	1	$145,600	1	$145,600
Retail Trade	11	$2,255,600	12	$3,038,200	12	$3,038,200
Single Family Dwelling	796	$242,639,900	871	$262,298,600	954	$282,456,000
Temporary Lodging	6	$3,060,000	6	$3,060,000	7	$3,963,600
Theaters	1	$335,200	1	$335,200	1	$335,200
Vacant	0	$0	509	$1,535,000	541	$2,396,400
Water or Rights of Way (ROW)	484	$1,535,000	24		28	$0
Wholesale Trade	23		4	$346,200	4	$346,200
TOTALS:	1,582	$321,678,000	1,696	$351,835,100	1,831	$381,487,900

Methods of the Vulnerability Assessment of Parcels and Buildings:

Parcels and Buildings Vulnerable to Hurricanes

Table 4.3 | The number of parcels and value of buildings vulnerable to hurricanes. Table generated using 2021 Wellfleet Assessing Data.

	Category 1 Storm		Category 2 Storm		Category 3 Storm		Category 4 Storm	
Type of Use	**Parcel Count**	**Value of Buildings**	**Parcel Count**	**Value of Buildings**	**Parcel Count**	**Value of Buildings**	**Parcel Count**	**Value of Buildings**
Banks	0	$0	1	$880,500	1	$880,500	1	$880,500
Church/Non-Profit Offices	79	$1,432,000	108	$1,463,600	120	$1,463,600	128	$2,532,500
Entertainment and Recreation	9	$228,600	10	$228,600	10	$228,600	10	$228,600
General Services	15	$2,823,500	21	$4,139,300	24	$4,507,900	25	$4,507,900
Heavy Industrial	0	$0	1	$0	2	$0	2	$0
Medical Office/Clinic	0	$0		$0	1	$755,000	2	$5,059,100
Multi-family Dwelling	50	$45,781,800	71	$53,486,400	90	$65,674,700	106	$76,618,600
Personal/Repair Services	0	$0	0	$0	0	$0	1	$153,000
Retail Trade	8	$1,484,100	8	$1,484,100	12	$2,863,500	14	$3,131,000
Single Family Dwelling	348	$113,507,000	576	$184,878,000	792	$241,716,900	934	$279,928,400
Temporary Lodging	4	$2,246,000	6	$3,060,000	7	$3,453,200	9	$3,985,600
Theaters	0	$0	0	$0	1	$335,200	1	$335,200
Vacant	219	$1,091,200	308	$1,317,000	367	$1,535,000	405	$1,535,000
Wholesale Trade	1	$136,000	2	$136,000	4	$346,200	4	$346,200
Total	733	$168,730,200	1,112	$251,073,500	1,431	$323,760,300	1,642	$379,241,600

Parcels and Buildings Vulnerable to Shoreline Change

Table 4.4 | The number of parcels and value of buildings on parcels that share a physical boundary with sea water. If a parcel shares a boundary with sea water, it is assumed to be vulnerable to coastal hazards such as shoreline change and erosion.

Location	# of Parcels	Building Value
Not Coastal	4,001	$884,243,400
Coastal	1,036	$228,793,300

Parcel Geometry and Assessed Building Values From Wellfleet Fiscal Year 2021 Assessor

Exposure Assessment of Critical Facilities by the Planning Team

Table 4.5 | Exposure Assessment for Critical Facilities.

Facility	Hurricane Category for Flooding (SLOSH)	Sea Level Rise (feet) for flooding	Flood zone?	Coastal Parcel?
Bakers Field Recreation	3	5	AE	N
Beach Sticker House	3	4	AE	Y
Boy Scout Wells	None	None	No	N
Breakwater	1	1	VE	Y
Bridge to Lieutenant Island	2	1	VE	Y
Cahoon Hollow Town Landing	None	None	No	Y
Cole's Neck Wellfield	None	None	No	N
Adult Community Center (senior center)	None	None	No	N
Department of Public Works	None	None	No	N
Fuel pumps and tanks (town owned)	3	5	VE	Y
Gull Pond bathroom	None	None	No	N
Gull Pond Landing	None	4	No	N
Harbormaster and Town Pier	3	6	AE	Y

Methods of the Vulnerability Assessment of Parcels and Buildings:

Facility	Hurricane Category for Flooding (SLOSH)	Sea Level Rise (feet) for flooding	Flood zone?	Coastal Parcel?
Harbormaster office	3	6	AE	Y
Chequessett Neck Road Dike (Herring River)	4	None	AE	Y
Maguire Landing	None	None	No	N
National Seashore Headquarters	None	None	No	Y
National Seashore Pump House	None	None	No	Y
National Seashore Water Tower	None	None	No	Y
Newcomb Hollow (town landing)	None	None	No	Y
Outer Cape Health	None	None	No	N
Police Station	None	None	No	N
Preservation Hall	None	None	No	N
Shellfish Department	3	5	VE	Y
Town Hall	None	None	No	N
Town owned water tower	None	None	No	N
Transfer Station	None	None	No	N
Wellfleet Apartments (Wellfleet Housing Authority)	None	None	No	N
Wellfleet Elementary School	None	None	No	N
Wellfleet Fire Department	None	None	No	N
Wellfleet Library	None	None	No	N
Wesley Swamp Pump	None	None	No	N
White Crest Town landing	None	None	No	Y

Table 4.5 (Continued) | Exposure Assessment for Critical Facilities.

B3b

Vulnerable Populations

Below is a description of segments of the population who are vulnerable to the impacts of natural hazard events:[74]

Coastal Erosion: Coastal erosion is not generally considered an imminent threat to public safety because shoreline changes are gradual over several years. However, drastic changes to the shoreline may occur in a single storm event which can cause immediate threat to homes and public safety.

Culvert Failure: All populations in a culvert failure inundation zone would be exposed to the risk of culvert failure. The potential for loss of life is affected by the capacity and number of evacuation routes available to populations living in areas of potential inundation.

Earthquake: All of Wellfleet is potentially exposed to direct and indirect impacts from earthquakes. The degree of exposure is dependent on many factors, including the age and construction type of dwelling structures, soil types in which homes are constructed, proximity to fault locations, etc. Time of day also exposes different sectors of the community to the hazard.

Wildland and Urban Fire: As demonstrated by historical urban and wildfire events, potential losses include human health and life of residents and responders. The most vulnerable populations include the elderly, children, and mobility challenged as well as emergency responders and those within a short distance of the interface between the built environment and the wildland environment.

Flooding: The impact of flooding on life, health, and safety is dependent upon several factors including the severity of the event and whether adequate warning time is provided to residents. Exposure includes the population living in or near floodplain areas that could be impacted. Exposure includes not only those who reside in a defined hazard zone, but also others who may be affected by a hazard event (e.g., risk while traveling in flooded areas, or compromised access to emergency services during an event). The degree of such impacts will vary and is not strictly measurable. Of the population exposed, the most vulnerable include the economically disadvantaged and population over the age of 65. Those over the age of 65 are vulnerable because they are more likely to seek or need medical attention, which may not be available due to isolation during a flood event. They also may have more difficulty evacuating.

Hurricanes and Tropical Storms: The impact of a hurricane or tropical storm on life, health and safety is dependent upon several factors including the severity of the event and whether residents receive adequate warning time. It is assumed that the entire population of Barnstable County is exposed to this hazard. Residents may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings, and debris carried by high winds can lead to injury or loss

[74]Massachusetts State Hazard Mitigation Plan, 2013.

of life. Socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Of the population exposed, the most vulnerable include the economically disadvantaged and population over the age of 65. Those over the age of 65 are vulnerable because they are more likely to seek or need medical attention, which may not be available due to isolation during a flood event. They also may have more difficulty evacuating.

Landslides: It is difficult to determine demographics of populations vulnerable to landslides.

Nor'easters: The impact of a nor'easter on life, health and safety is dependent upon several factors including the severity of the event and whether residents received adequate warning time. All of Wellfleet's population is exposed to this hazard (wind and rain/snow). The most vulnerable include the economically disadvantaged and population over the age of 65. Those over the age of 65 are vulnerable because they are more likely to seek or need medical attention, which may not be available due to isolation during a flood event. They also may have more difficulty evacuating.

Severe Weather (wind, thunderstorms, tornadoes, extreme temperatures, drought): For the purposes of this plan, the entire population of Wellfleet is exposed to severe weather events. Residents may be displaced or require temporary to long-term sheltering from these weather events. In addition, downed trees, damaged buildings and debris carried by high winds can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Vulnerable populations include the elderly, low income or linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life threatening to those dependent on electricity for life support. Isolation of these populations is a significant concern. These populations face isolation and exposure during severe weather events and could suffer more secondary effects of the hazard.

Severe Winter Weather (snow, blizzards and ice): According to NOAA's National Severe Storms Laboratory, winter weather indirectly and deceptively kills hundreds of people in the U.S. every year, primarily from automobile accidents, overexertion and exposure. Winter storms are often accompanied by strong winds, creating blizzard conditions with blinding wind-driven snow, drifting snow and extreme cold temperatures with dangerous wind chills. These storms are considered deceptive killers because most deaths and other impacts or losses are indirectly related to the storm. Injuries and fatalities may occur due to traffic accidents on icy roads, heart attacks while shoveling snow or hypothermia from prolonged exposure to cold.

Heavy snow can immobilize a region and paralyze a town, shutting down its transportation network, stopping the flow of supplies, and disrupting medical and emergency services. The elderly are considered most susceptible due

to their increased risk of injury and death from falls and overexertion and/or hypothermia from attempts to clear snow and ice, or related to power failures. In addition, severe winter weather events can reduce the ability of these populations to access emergency services. Residents with low incomes may lack access to housing or their housing may be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply).

Tsunami: It is difficult to determine demographics of populations vulnerable to tsunamis.

B3b

Summary of Vulnerable Infrastructure

Below is a description of Wellfleet infrastructure that is vulnerable to the impacts of natural hazard events:

- **Commercial Street** in downtown area is low lying and vulnerable to flooding.
- **Bridge to Lieutenant Island** is vulnerable to flooding; it is inundated at high tide.
- **Mayo Creek culvert** near the town pier is vulnerable to flooding.
- **Blackfish Creek** culvert on Route 6 is vulnerable to flooding.
- **Box culvert** on West Road is compromised.
- **Fresh Brook Creek culvert** on Route 6 is vulnerable to flooding.
- **Town landings** at Burton Baker Beach and Paine Hollow are vulnerable to flooding.
- **Old Wharf Road** is critical for shellfishing and vulnerable to flooding.
- **Beach access points and parking lots** at Cahoon Hollow, Maguire's Landing, Newcomb Hollow and White Crest Beach are vulnerable to coastal erosion.
- **Chequessett Neck Road dike** (**Herring River)** tide gates are in poor condition and not properly functioning. The potential for uncontrolled gate failure poses flooding risks to upstream property and the environment. The dike and tide gates will be replaced with a new bridge with sluice gates that is resilient to coastal storms and sea level rise while allowing full restoration of Herring River.

Recent studies to address vulnerable infrastructure:

The Town of Wellfleet has undertaken several studies and projects since the 2016 Hazard Mitigation Plan to address flooding impacts in the community. These include the 2019 MVP Workshop, a Coastal Resiliency grant to address intermunicipal shoreline management, and a 2021-2023 MVP Low Lying Roads Project (currently underway),[75] among others. The Town is also working with MassDOT to see how Route 6 flooding issues might be addressed in the state's 2023 Route 6 resurfacing project.

[75] https://www.capecodcommission.org/our-work/low-lying-roads-project/

Mitigation Strategy

Chapter Five

Chapter 2 profiles specific hazards that could affect Wellfleet and Chapter 4 assesses the losses that could result from hazard events. The next step in the hazard planning process is to identify actions to reduce risk and loss of life and to develop ways to implement these actions. This so-called “Mitigation Strategy” determines broad goals and outlines specific actions for the next five years. **Chapter 5 outlines a hazard mitigation strategy for the Town of Wellfleet for the next five years.**

C3a,b

Mitigation Goals

Mitigation goals are broad guidelines that articulate Wellfleet's desire to protect people and structures, reduce the cost of disaster response and recovery, and minimize disruption to the community following a disaster.[76]

Mitigation Goals for the 2022 Wellfleet Hazard Mitigation Plan are:

- Reduce the potential for loss of life, property, infrastructure, and environmental, cultural and economic resources in Wellfleet from natural disasters.
- Mitigate financial losses incurred by municipal, residential, industrial, agricultural and commercial establishments due to natural hazards.
- Reduce the damage to public infrastructure resulting from natural hazards to critical facilities including roadways and culverts, the town pier, shellfishing facilities, and drinking water facilities.
- Competitively position the Town to seek and apply for funding opportunities to implement the actions identified in the Wellfleet Hazard Plan.
- Ensure that mitigation measures are sensitive to the natural features, historic resources, and community character of Wellfleet.
- Communicate local hazard mitigation planning activities with Barnstable County, Outer Cape Towns, Cape Cod National Seashore, and the Massachusetts Emergency Management Agency.
- Increase public awareness of existing hazards and encourage hazard mitigation planning as part of the overall municipal planning process.
- Restore salt marshes to increase flood storage, and functionality of degraded wetlands.

Mitigation Actions

Mitigation actions are any action, process or project designed to reduce or eliminate long term risk from natural hazards. These mitigation actions are developed by the Planning Team and must be consistent with the vulnerability and risk assessment performed in Chapter 4 and with the priorities of the Town of Wellfleet.

Below is a description of how the Planning Team developed the Mitigation Actions section of the 2022 Wellfleet Hazard Mitigation Plan:

- **Progress Determination on Mitigation Actions in 2016**: The Planning Team assigned a status to each mitigation action in the 2016 Hazard Mitigation Plan and explained whether the action was completed, an existing capability, in progress, deferred, or deleted (See ***Table*** 5.1).
- **Future Mitigation Actions for the 2022 Hazard Mitigation Plan**: The list contains new mitigation actions based on the Vulnerability and Risk Assessment in Chapter 4, MVP actions, and other considerations; "In Progress" and continued actions

[76] FEMA How-to Guide 3: Developing the Mitigation Plan: Identifying mitigation actions and implementation strategies, FEMA 386-3, April 2003

identified in *Table 5.1* were carried forward into the 2022 Mitigation Actions list

- **Capability Assessment**: The Team reviewed and revised the Capability Assessment from the 2016 Hazard Mitigation Plan. Also, any action designated as an "existing capability" in *Table 5.1* was carried over to the Capability Assessment. (*Table 5.2*)

D2a

Progress Determination on Mitigation Actions since 2016

Before identifying new Mitigation Actions for the 2022 Hazard Plan, the Planning Team discussed the status of the mitigation actions in the 2016 Wellfleet Hazard Mitigation Plan and assigned one of the following status determinations to each mitigation action:

- **Complete**: The project was implemented and completed in 2016 – 2021.
- **Existing Capability**: The project was implemented and completed in 2016 – 2021 and it will continue to be implemented on an annual basis in the future. These action items are also included in the capability assessment (***Table*** 5.1).
- **In Progress**: The project was started in the 2016 – 2021 timeframe and it is still in progress.
- **Deferred**: The project is important, but it was deferred because there was no funding available or it is not feasible to complete the project.
- **Deleted**: The project is no longer relevant to the community.

Progress Determination on Mitigation Actions since 2016

Table 5.1| Progress Determination on 2016 Mitigation Actions

Hazard Type	Responsible Department	Action Item Number	Action Item	Status	Explanation
All Hazards	Harbormaster, DPW, Police, Fire	1	Continue to gather accurate data on the location, history, extent and impact of natural hazards in Wellfleet	Ongoing/ Existing Capability	Wellfleet participated in Center for Coastal Studies Stormtides Pathways study that identifies coastal inundation areas. Ongoing work with CZM and other regional partners will continue.
All Hazards	All	2	Conduct an assessment of local infrastructure that is subject to damage from flooding or storm surge or that is likely to cause damage to surrounding areas should it fail or flood. Develop, prioritize and seek funding for a list of needed infrastructure improvement projects.	In Progress	Roadways are currently being assessed in two grants, one MVP and the CZM Coastal Resiliency Grant. The town is working with CZM and CCC on a Low lying roads grant for FY 2021, in conjunction with the Health and Conservation Agent. The Herring River Restoration Project Phase 1 includes elevation of two miles of low-lying roadway segments, making them more resilient. The Town will consider adding beach parking lots for future assessment plus vulnerable locations around Mayo Creek, Hawes Pond, and Chequessett Neck Rd dike.

Progress Determination on Mitigation Actions since 2016

Hazard Type	Responsible Department	Action Item Number	Action Item	Status	Explanation
All Hazards	Police and Fire, DPW	3	Seek an alternate or emergency traffic route for travel over Blackfish Creek in the event that Route 6 is compromised	In Progress	Wellfleet DPW has notified MassDOT about this to see if they can incorporate flood mitigation into design for the Pavement Preservation Project for Federal fiscal year 2023. The state will also look at other areas along Route 6 that are identified as within the 100-year flood event. The town still needs to look for an alternate route to West Road. The town worked with together with CCNS and legislative delegation to look for emergency route alternative should Route 6 be closed. Since NPS land is not an option based on the working group discussions , the town might want to create a new action item to pursue other alternatives.
All Hazards	Police and Fire, DPW	4	Investigate utilizing the Senior Center as a shelter; this will require rewiring for a generator and wind shudders on the windows.	Completed	The town applied for a BRIC (Building Resilient Infrastructure Communities) grant through MEMA/FEMA but was unsuccessful. The regional shelter program negated consideration of local shelters. For 2022 the town will add new action to investigate using ACC as a warming/cooling center during extreme temperature events (rather than a local shelter).

Progress Determination on Mitigation Actions since 2016

Hazard Type	Responsible Department	Action Item Number	Action Item	Status	Explanation
All Hazards	Health, Police and Fire	5	Continue to coordinate with the Local Emergency Planning Committee, Barnstable County Regional Emergency Planning Committee, Cape Cod National Seashore, Massachusetts Department of Transportation (i.e. salt, sand, sheltering equipment, manpower, message boards)	Ongoing/ Existing Capability	This is ongoing. The regional committee and local emergency planners meet regularly to discuss emergency preparedness planning. The town conducts drills, exercises, and real life events according to our emergency management plans.
All Hazards	All	6	Distribute educational brochures, put up signs, post on social media about emergency services and natural hazards likely to affect the town i.e. storm surge, urban flooding, coastal erosion, nor'easters and winter storms. This outreach is specifically for the general public, visitors and tourists. When visitors and tourists need emergency services, they often do not know how to successfully access those services.	Ongoing /Existing Capability	This has been done and is ongoing through town website. DPW also posts on the website and is looking into creating a Facebook page. The Police Department. uses message boards, social media, and Civic Ready. Wellfleet Health and Conservation Department shares a Facebook page with the Truro Health and Conservation Department and disseminates relevant information.
All Hazards	Police and Fire	7	Purchase variable message boards for the town	Completed	Done/accomplished.

Progress Determination on Mitigation Actions since 2016

Hazard Type	Responsible Department	Action Item Number	Action Item	Status	Explanation
All Hazards	Police	8	Obtain a town specific emergency notification system and conduct public outreach to increase the number of subscribers. This action will enhance communication to residents and vulnerable populations before, during and after hazard events	Completed	Completed. Increasing the number of subscribers or system enhancement could be new action.
All Hazards	All	9	Seek funding opportunities to reduce Wellfleet's vulnerability to natural hazards	Ongoing/ Existing Capability	The Herring River Restoration Project Phase 1 is underway. Permitting, final design and bid specifications are nearly complete and construction is scheduled to commence. Wellfleet was awarded Low Lying Roads project grants in 2021. DPW is working with the Cape Cod Conservation District to compile stormwater, fish passage and saltmarsh work which should be done by the end of the year. The CZM Coastal Resiliency Grant is addressing some of the environmental and infrastructure issues. Action grants will be needed to carry out identified solutions. Also, the Wellfleet Conservation Commission has draft regulations for coastal development and used District Local Technical Assistance funding award to develop a draft floodplain bylaw.

Progress Determination on Mitigation Actions since 2016

Hazard Type	Responsible Department	Action Item Number	Action Item	Status	Explanation
All Hazards	All	10	Update the Continuity of Operations Plan for the Town of Wellfleet to ensure that groups and departments in town are aware of the Chain of Command and know who to call and where to go in the case of a hazard event.	Completed	Former assistant town administrator compiled the entire towns COOP plan. The DPW updated theirs for COVID but should continue working on other types of hazards.
All Hazards	Police and Fire	11	Continue planning efforts and playing a role in sheltering on Cape Cod, inter-municipal and intra-municipal communications and shared services	Ongoing/ Existing Capability	PD and ACC continue to do this. Considering ACC as warming/cooling station.
All Hazards	All	12	Monitor critical facilities to ensure that they are protected from the effects of natural hazards to the maximum extent possible.	Ongoing/ Existing Capability	The DPW is looking into facility management software that could be a good tool for this.
All Hazards	DPW	13	Reduce the number of power outages in town during a hazard event by educating the public about tree trimming, maintaining a tree trimming program/ vegetation management plan. Also communicate with Eversource about utility pole infrastructure, maintenance, and vegetation management.	Ongoing/ Existing Capability	DPW is in constant communication with Eversource on their management plan. The town should consider using social media for communications/education.

Progress Determination on Mitigation Actions since 2016

Hazard Type	Responsible Department	Action Item Number	Action Item	Status	Explanation
All Hazards	Police and Fire, DPW	14	Evaluate the generators at the Police and Fire Stations to ensure that the current generator at the Fire Department can handle the load of the Police Department building. Purchase a new generator for the Police Department if appropriate and then move the existing generator to the Adult Community Center	Completed	Police Department has a new building with a generator. The Fire Department's generator is oversized for the facility; and the ACC doesn't need one because it's not going to be a shelter.
All Hazards	All	15	Obtain better communication equipment (i.e. portable radios, mobile terminals) for emergency personnel to use during a hazard event	Completed	Police and Fire Departments received a grant to upgrade radios. The Beach Department got repeaters for beach emergencies. The Beach Department and Harbormaster need to upgrade radios to digital. DPW's existing radio system is fully functional and adequate for current services. Consider new action to upgrade Beach and Harbormaster equipment.
All Hazards	Fire, DPW	16	Obtain more resources and personnel for the Department of Public Works and the Fire Department	Ongoing/ Existing Capability	Add the Police Department, Marina, and Conservation/Health to the list for 2022 action item.
Flooding, Hurricanes, Tropical Storms, Severe Winter Weather, Nor'easters	All	17	Educate the public about MEMA's "Know Your Zone" Campaign and sheltering in place	Completed	Wellfleet continues to educate the public on MEMA programs, but this program isn't active.

Progress Determination on Mitigation Actions since 2016

Hazard Type	Responsible Department	Action Item Number	Action Item	Status	Explanation
Flooding, Shoreline Change, Hurricanes, Tropical Storms, Nor'easters	All	18	Conduct public outreach within the community about relocating or building a new shellfish building outside the floodplain.	In progress	This item is an ongoing discussion with the Shellfish department and was added to their capital plan for FY 2023.
Flooding, Shoreline Change, Hurricanes, Tropical Storms, Nor'easters	All	19	Evaluate the impact of natural hazard events on Title 5 infrastructure and consider alternatives (i.e. sewering)	Ongoing/ Existing Capability	This is an ongoing action in the development of the town's watershed permit
Flooding, Shoreline Change, Hurricanes, Tropical Storms, Severe Winter Weather, Nor'easters	Police and Fire, DPW	20	Develop a debris management plan for the town of Wellfleet or coordinate with the Barnstable County Regional Emergency Planning Committee about a regional debris management plan. A debris management plan would include information on the amount, type and disposal of demolition debris, storm debris, and hazardous waste. Also the plan would identify sites for sorting, chipping and transporting the debris after the hazard event.	Deferred	This is a good idea but was not a high priority. DPW might reconsider it for a future action item.

Progress Determination on Mitigation Actions since 2016

Hazard Type	Responsible Department	Action Item Number	Action Item	Status	Explanation
Flooding, Shoreline Change, Hurricanes, Tropical Storms, Nor'easters	All	21	Improve Wellfleet's Class in the Community Ranking System to at least a Class 8.	Ongoing/ Existing Capability	Town completed this - achieved Class 7 and will seek to continue that - carry over to 2022 Actions. The Conservation Commission completed draft floodplain zoning revisions/regs updates, and the Conservation Agent is working with Barnstable County Cooperative Extension/Woods Hole Sea Grant on the CRS program.
Flooding, Shoreline Change, Hurricanes, Tropical Storms, Nor'easters	Administration, Harbormaster and Marina	22	Update the harbor management plan	Completed	Done as of January 2021. Also completed the ponds management plan.
Flooding, Shoreline Change, Hurricanes, Tropical Storms, Severe Winter Weather, Nor'easters	Harbormaster and Marina	23	Replace the current docks at the marina with wooden docks. The current dock system is degrading during the winter months and the docks are challenging to remove and maintain in the event of an emergency	In Progress	This is 75% complete.
Flooding, Shoreline Change, Hurricanes, Tropical Storms, Severe Winter Weather, Nor'easters	DPW	24	Continue to monitor assets that are vulnerable to the effects of climate change	Ongoing/ Existing Capability	This action is a good candidate for Facility Management software tracking (Similar to Action #2).

Table 5.1 | Progress Determination on 2016 Mitigation Actions

C5a

Mitigation Actions for the 2022 Hazard Plan

This section of the plan is the most dynamic because grant funding and staff capabilities and capacity influence viability of proposed actions. This section may be updated to ensure that it remains consistent with current Town priorities. The mitigation concerns listed below are in no particular order.

The Planning Team created a "High, Medium, Low" prioritization ranking for the Mitigation Actions. Several variables factor into development of actions and priority designation:

Life Safety/Social:

- How effective is the action at protecting lives and preventing injuries?
- If the action is to improve structures/infrastructure, will it also protect lives and prevent injury?
- Will the action affect one segment of the population more than another?
- Will the action disrupt the community in any way? (i.e. impact emergency service routes, break up neighborhoods).

Property Protection:

- Will the action eliminate or reduce damage to structures and infrastructure? If so, how?
- What are the secondary impacts of the mitigation action?
- Does it solve a problem or a symptom of the problem?

Technical/Legal/Environmental/ Administrative:

- Is the mitigation action technically feasible based on Wellfleet's current capabilities?
- Is the action a long or short-term solution?
- What are the benefits of the project? What are the costs?
- Does the action support Wellfleet's Mitigation Goals?
- Does Wellfleet have the authority to implement the action? If not, who does?
- Is the action consistent with town values and other planning projects?
- What are the environmental impacts of the action?
- Does it comply with environmental regulations?

Political/Local Champion:

- Is there political support to implement and maintain the action?
- Does the public support the mitigation action?
- Is there a strong advocate for the action?

The Priority designations for 2022 Mitigation Actions (high, medium, low) are based on the following factors:

- **High Priority**: town will begin or complete these projects within three years.
- **Medium Priority**: town will begin or complete these projects within four years.

- **Low Priority**: town will begin or complete these projects within five years.

C5a

2022 Mitigation Actions

The following is a list of projects/actions recommended by the Planning Team. For each action identified below, a brief description is provided, as well as the responsible department(s), potential funding sources, priority, and anticipated timeline[77]. The list also identifies relevant town plans and Hazard Mitigation Plan goals addressed for each action.

Table 5.2 | Hazard Mitigation Actions

Flooding

Mitigation Action #1

Conduct an assessment of local infrastructure that is subject to damage from flooding or storm surge or that is likely to cause damage to surrounding areas should it fail or flood. Develop, prioritize and seek funding for a list of needed infrastructure improvement projects.

Project Type:
Planning

Responsible Dept:
DPW

Funding Source(s):
MVP grants (25% local match), CZM grants
< $100,000

Timeframe:
2022-2025

Consistency With Mitigation Goals:
Reduce the potential for loss of life, property, infrastructure, and environmental, cultural and economic resources in Wellfleet from natural disasters; Competitively position the Town to seek and apply for funding opportunities to implement the Wellfleet Hazard Plan.

Consistency With Other Town Plans:
CEMP

Carried forward | **Priority: H**

[77] Ongoing actions that have been carried forward and are conducted as part of the town's existing capabilities are given a timeframe as 2022-2027, ongoing annually.

2022 Mitigation Actions

All Hazards

Mitigation Action #2

Distribute educational brochures, put up signs, post on social media about emergency services and natural hazards likely to affect the town i.e. storm surge, urban flooding, coastal erosion, nor'easters and winter storms.This outreach is specifically for the general public, visitors and tourists. When visitors and tourists need emergency services, they often do not know how to successfully access those services.

Project Type:
Outreach

Responsible Dept:
Emergency Management Director

Funding Source(s):
Town Staff Budget
< $50,000

Timeframe:
2022-2027/ongoing annually

Consistency With Mitigation Goals:
Increase public awareness of existing hazards and encourage hazard mitigation planning as part of the overall municipal planning process.

Consistency With Other Town Plans:
CEMP

Carried forward | **Priority: H**

All Hazards

Mitigation Action #3

Seek funding opportunties to reduce Wellfleet's vulnerability to natural hazards.

Project Type:
Planning

Responsible Dept:
Administration

Funding Source(s):
MVP grants (25% local match), CZM grants
> $100,000

Timeframe:
2022-2027/ongoing annually

Consistency With Mitigation Goals:
Reduce the potential for loss of life, property, infrastructure, and environmental, cultural and economic resources in Wellfleet from natural disasters.

Consistency With Other Town Plans:
LCP, MVP

Carried forward | **Priority: H**

All Hazards

Mitigation Action #4

Monitor critical facilities to ensure that they are protected from the effects of natural hazards to the maximum extent possible.

Project Type:
Planning

Responsible Dept:
DPW

Funding Source(s):
Town Staff Budget
< $50,000

Timeframe:
2022-2027/ongoing annually

Consistency With Mitigation Goals:
Increase public awareness of existing hazards and encourage hazard mitigation planning as part of the overall municipal planning process; Reduce the potential for loss of life, property, infrastructure, and environmental, cultural and economic resources in Wellfleet from natural disasters.

Consistency With Other Town Plans:
LCP, CEMP

Carried forward | **Priority: H**

All Hazards

Mitigation Action #5

Develop an Outer Cape grassroots education and outreach strategy to address climate resilience.

Project Type:
Planning and Outreach

Responsible Dept:
Conservation

Funding Source(s):
Town Staff Budget
< $50,000

Timeframe:
2023-2025

Consistency With Mitigation Goals:
Increase public awareness of existing hazards and encourage hazard mitigation planning as part of the overall municipal planning process.

Consistency With Other Town Plans:
MVP

New | **Priority: H**

2022 Mitigation Actions

Invasive Species, Flooding

Mitigation Action #6

Develop and implement a plan for nutrient reduction.

Project Type:
Planning

Responsible Dept:
Health

Funding Source(s):
State Revolving Fund +/-8 Million Request
> $100,000

Timeframe:
2023-2027

Consistency With Mitigation Goals:
Reduce the potential for loss of life, property, infrastructure, and environmental, cultural and economic resources in Wellfleet from natural disasters.

Consistency With Other Town Plans:
MVP, LCP

New

Priority: H

Coastal Erosion, Flooding

Mitigation Action #7

Conduct an inventory of privately owned structures within 100' of coastal banks, review continually, and prioritize outreach efforts.

Project Type:
Data Collection, Outreach

Responsible Dept:
Building

Funding Source(s):
Town Staff Budget
< $50,000

Timeframe:
2025-2027

Consistency With Mitigation Goals:
Reduce the potential for loss of life, property, infrastructure, and environmental, cultural and economic resources in Wellfleet from natural disasters.

Consistency With Other Town Plans:
MVP, LCP

New

Priority: H

Flooding

Mitigation Action #8

Conduct an inventory of and develop a contingency plan for Town owned buildings and infrastructure in the flood zone.

Project Type:
Data collection, Planning

Responsible Dept:
Building

Funding Source(s):
Town Staff Budget
< $50,000

Timeframe:
2025-2027

Consistency With Mitigation Goals:
Reduce the potential for loss of life, property, infrastructure, and environmental, cultural and economic resources in Wellfleet from natural disasters.

Consistency With Other Town Plans:
LCP

New | **Priority: H**

Coastal Erosion, Flooding

Mitigation Action #9

Identify low-lying roads and beach parking lots susceptible to erosion and develop and implement a plan to address road flooding problems and beach access issues.

Project Type:
Planning

Responsible Dept:
Conservation

Funding Source(s):
Town staff budget, MVP Grant and CZM Resiliency Grant
< $50,000

Timeframe:
2022-2025

Consistency With Mitigation Goals:
Reduce the potential for loss of life, property, infrastructure, and environmental, cultural and economic resources in Wellfleet from natural disasters.

Consistency With Other Town Plans:
MVP, LCP

New | **Priority: H**

2022 Mitigation Actions

Flooding, Shoreline Change, Hurricanes, Tropical Storms, Severe Winter Weather, Nor'easters

Mitigation Action #10

Continue to monitor assets that are vulnerable to the effects of climate change.

Project Type:
Outreach

Responsible Dept:
DPW

Funding Source(s):
Town Staff Budget
< $50,000

Timeframe:
2022-2027

Consistency With Mitigation Goals:
Reduce the potential for loss of life, property, infrastructure, and environmental, cultural and economic resources in Wellfleet from natural disasters.

Consistency With Other Town Plans:
LCP

Carried forward | **Priority: H**

Flooding, Invasive Species

Mitigation Action #11

Pursue funding for culvert replacement and salt marsh restoration.

Project Type:
Mitigation

Responsible Dept:
DPW

Funding Source(s):
NCRS Grant
> $100,000

Timeframe:
2022-2025

Consistency With Mitigation Goals:
Reduce the potential for loss of life, property, infrastructure, and environmental, cultural and economic resources in Wellfleet from natural disasters. Restore salt marshes to increase flood storage, and functionality of degraded wetlands.

Consistency With Other Town Plans:
MVP, LCP

New | **Priority: H**

Flooding, Shoreline Change, Hurricanes, Tropical Storms, Severe Winter Weather, Nor'easters

Mitigation Action #12

Replace the current docks at the marina with wooden docks. The current dock system is degrading during the winter months and the docks are challenging to remove and maintain in the even of an emergency.

Project Type:
Mitigation

Responsible Dept:
Harbormaster

Funding Source(s):
Town Staff Budget
> $100,000

Timeframe:
2024-2027

Consistency With Mitigation Goals:
Reduce the potential for loss of life, property, infrastructure, and environmental, cultural and economic resources in Wellfleet from natural disasters.

Consistency With Other Town Plans:
Harbor Management Plan

Carried forward (75% complete)

Priority: H

All Hazards

Mitigation Action #13

Continue to gather data on the location, history, extent and impact of natural hazards in Wellfleet.

Project Type:
Data Collection

Responsible Dept:
Administration

Funding Source(s):
Town Staff Budget
< $50,000

Timeframe:
2022-2027

Consistency With Mitigation Goals:
Competitively position the Town to seek and apply for funding opportunities to implement the Wellfleet Hazard Plan.

Consistency With Other Town Plans:
LCP

Carried forward

Priority: H

2022 Mitigation Actions

All Hazards

Mitigation Action #14

Continue to coordinate with the Local Emergency Planning Committee, Barnstable County Regional Emergency Planning Committee, Cape Cod National Seashore, Massachusetts Department of Transportation (i.e. for salt, sand, sheltering, equipment, manpower, message boards needs).

Project Type:
Outreach/Planning

Responsible Dept:
Police

Funding Source(s):
Town Staff Budget, Public Health Excellence Grant
< $50,000

Timeframe:
2022-2027/ongoing annually

Consistency With Mitigation Goals:
Communicate local hazard mitigation planning activities with Barnstable County, Outer Cape Towns, Cape Cod National Seashore, and the Massachusetts Emergency Management Agency.

Consistency With Other Town Plans:
CEMP

Carried forward | **Priority: H**

All Hazards

Mitigation Action #15

Continue planning efforts and playing a role in sheltering on Cape Cod, inter-municipal and intra-municipal communications and shared services.

Project Type:
Planning

Responsible Dept:
Police and Fire

Funding Source(s):
Town Staff Budget, Public Health Excellence Grant
< $50,000

Timeframe:
2022-2027/ongoing annually

Consistency With Mitigation Goals:
Increase public awareness of existing hazards and encourage hazard mitigation planning as part of the overall municipal planning process.

Consistency With Other Town Plans:
CEMP

Carried forward | **Priority: H**

All Hazards

Mitigation Action #16

Acquire a generator and rewire the Adult Community Center (or other public building) for use as cooling/heating station during hazard events, power outages, etc.

Project Type:
Mitigation

Responsible Dept:
DPW

Funding Source(s):
BRIC Grant, Green Communities Grant, Town Staff Budget

< $50,000

Timeframe:
2023-2025

Consistency With Mitigation Goals:
Reduce the potential for loss of life, property, infrastructure, and environmental, cultural and economic resources in Wellfleet from natural disasters.

Consistency With Other Town Plans:
CEMP

New | **Priority: H**

All Hazards

Mitigation Action #17

Pursue bylaw and regulatory changes to address resilience

Project Type:
Planning/Regulaiton

Responsible Dept:
Planning

Funding Source(s):
Town Staff Budget

< $50,000

Timeframe:
2023-2027

Consistency With Mitigation Goals:
Reduce the potential for loss of life, property, infrastructure, and environmental, cultural and economic resources in Wellfleet from natural disasters.

Consistency With Other Town Plans:
MVP, LCP

New | **Priority: M-H**

2022 Mitigation Actions

Flooding, Shoreline Change, Hurricanes, Tropical Storms, Nor'easters

Mitigation Action #18

Evaluate the impact of natural hazard events on Title 5 infrastructure and consider alternatives (i.e. sewering).

Project Type:
Planning

Responsible Dept:
Conservation

Funding Source(s):
Town Staff Budget, Town Meeting Allocation
> $100,000

Timeframe:
2022-2027

Consistency With Mitigation Goals:
Reduce the potential for loss of life, property, infrastructure, and environmental, cultural and economic resources in Wellfleet from natural disasters.

Consistency With Other Town Plans:
LCP

Carried forward | **Priority: M**

All Hazards

Mitigation Action #19

Work with MassDOT on the future Route 6 resurfacing project to provide safe travel over Blackfish Creek in the event that the road is compromised.

Project Type:
Mitigation

Responsible Dept:
DPW

Funding Source(s):
Federal Highway Administration grants
$50,000-100,000

Timeframe:
2023-2027

Consistency With Mitigation Goals:
Reduce the potential for loss of life, property, infrastructure, and environmental, cultural and economic resources in Wellfleet from natural disasters; Competitively position the Town to seek and apply for funding opportunities to implement the Wellfleet Hazard Plan.

Consistency With Other Town Plans:
CEMP

In Progress / Carried forward (as modified) | **Priority: M**

All Hazards

Mitigation Action #20

Reduce the number of power outages in town during a hazard event by educating the public about tree trimming, maintaining a tree trimming program/ vegetation management plan. Also communicate with Eversource about utility pole infrastructure, maintenance, and vegetation management.

Project Type:
Preparedness,
Planning and Outreach

Responsible Dept:
DPW

Funding Source(s):
Town Staff Budget
< $50,000

Timeframe:
2022-2027/ongoing annually

Consistency With Mitigation Goals:
Increase public awareness of existing hazards and encourage hazard mitigation planning as part of the overall municipal planning process.

Consistency With Other Town Plans:
LCP

Carried forward | **Priority: M**

All Hazards

Mitigation Action #21

Obtain more resources and personnel for the Department of Public Works, Police, Marina, Health/Conservation and the Fire Department.

Project Type:
Preparedness

Responsible Dept:
Administration

Funding Source(s):
Town Staff Budget
>$100,000

Timeframe:
2022-2027/ongoing annually

Consistency With Mitigation Goals:
Increase public awareness of existing hazards and encourage hazard mitigation planning as part of the overall municipal planning process.

Consistency With Other Town Plans:
CEMP

Carried forward | **Priority: M**

2022 Mitigation Actions

All Hazards

Mitigation Action #22

Work with the state and regional partners to expand and improve Broadband and electrical infrastructure network through improved access.

Project Type:
Preparedness,
Planning and Outreach

Responsible Dept:
DPW

Funding Source(s):
Last Mile Infrastructure Grant
> $100,000

Timeframe:
2023-2027

Consistency With Mitigation Goals:
Reduce the potential for loss of life, property, infrastructure, and environmental, cultural and economic resources in Wellfleet from natural disasters.

Consistency With Other Town Plans:
MVP, LCP

New | **Priority: M**

All Hazards

Mitigation Action #23

Obtain digital communications equipment for Harbormaster, DPW, and Beach Program.

Project Type:
Preparedness

Responsible Dept:
Harbormaster, DPW

Funding Source(s):
Town Staff Budget or
COMIRS State Grant
< $50,000

Timeframe:
2023-2027

Consistency With Mitigation Goals:
Reduce the potential for loss of life, property, infrastructure, and environmental, cultural and economic resources in Wellfleet from natural disasters.

Consistency With Other Town Plans:
CEMP, Harbor Management Plan

New | **Priority: M**

Flooding, Shoreline Change, Hurricanes, Tropical Storms, Nor'easters

Mitigation Action #24

Improve Wellfleet's Class in the Community Ranking System to at least a Class 8.

Project Type:
Planning

Responsible Dept:
Building

Funding Source(s):
Town Staff Budget
< $50,000

Timeframe:
2023-2027

Consistency With Mitigation Goals:
Reduce the potential for loss of life, property, infrastructure, and environmental, cultural and economic resources in Wellfleet from natural disasters.

Consistency With Other Town Plans:
LCP

Carried forward / in progress

Priority: L

Flooding, Shoreline Change, Hurricanes, Tropical Storms, Severe Winter Weather, Nor'easters

Mitigation Action #25

Develop a debris management plan for the town of Wellfleet or coordinate with the Barnstable County Regional Emergency Planning Committee about a regional debris management plan. A debris management plan would include information on the amount, type and disposal of demolition debris, storm debris, and hazardous waste. Also the plan would identify sites for sorting, chipping and transporting the debris after the hazard event.

Project Type:
Planning

Responsible Dept:
DPW

Funding Source(s):
MVP grants (25% local match), Town Staff Budget
< $50,000

Timeframe:
2022-2027

Consistency With Mitigation Goals:
Increase public awareness of existing hazards and encourage hazard mitigation planning as part of the overall municipal planning process.

Consistency With Other Town Plans:
CEMP

Carried forward (deferred)

Priority: L

C2a

A6c

Participation in National Flood Insurance Program

Continued compliance with NFIP

To be approved by the FEMA, the Wellfleet Hazard Mitigation Plan update must describe the Town's participation in the National Flood Insurance Program (NFIP). The NFIP is based on a mutual agreement between the Federal government and the Town of Wellfleet.[78] Federally backed flood insurance is available in Wellfleet provided the Town agrees to regulate development in the mapped floodplain.[79] To remain compliant with the NFIP, Wellfleet is committed to the following activities:

- Issue or deny floodplain development/ building permits.
- Inspect all developments to ensure compliance with local bylaws.
- Maintain records of floodplain development.
- Assist with floodplain identification and mapping as well as any revision of floodplain maps, including local requests for map updates.
- Help residents obtain information on flood hazards, floodplain map data, flood insurance and proper construction practices.
- Maintain standards required for Community Rating System compliance.

In addition, Wellfleet will be updating its floodplain zoning and adopting new coastal resiliency bylaw (through the Conservation Commission) before the next hazard plan update.

[78] National Flood Insurance Program (NFIP) Floodplain Management Requirements: A study guide and desk reference for local officials, FEMA 480, February 2005

[79] Ibid.

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Existing Capabilities Assessment

Wellfleet has a unique set of existing capabilities, including Town and regional plans, policies, staff, funding, and other resources available to accomplish mitigation and reduce short and long-term vulnerability.

Summaries of the capabilities is provided in ***Tables 5.3 through 5.6***. The 2022 capabilities assessment expands upon a similar analysis provided in the 2016 Wellfleet Hazard Mitigation Plan. Ongoing mitigation actions from the previous plan have been incorporated into the existing capabilities. The 2022 assessment also includes a description of opportunities where local plans, regulations, and policies could be expanded or improved.

Town Plans and Policies

Wellfleet has several planning documents that address natural hazards and include measures associated with hazard mitigation. Through implementation of these plans, Wellfleet can guide and manage growth and development, with the goal of reducing hazard vulnerability. Both local and regional plans contribute to Wellfleet's hazard mitigation capabilities and are listed below. Several Town plans are old and should be updated. Grant funding such as District Local Technical Assistance (DLTA) and technical assistance from the Cape Cod Commission may be options available for these efforts. (Wellfleet also has Zoning, Subdivision, and Floodplain bylaws and regulations that contribute to its hazard mitigation capabilities, as described in the Existing Mitigation Measures section below.)

Table 5.3 | Existing Capabilities – Town Plans and Policies

Existing Capability	Explanation of Capability	Responsible Department	Natural Hazard(s)
Local Comprehensive Plan 2008 (LCP)	The Wellfleet LCP articulates the Town's future vision and provides goals and actions to achieve the vision. The LCP is the community's primary planning document and addresses issues related to land use and growth management, open space protection, natural resources, capital facilities, economic development, housing, and transportation. The LCP should be updated. An update process began but was interrupted by COVID. A new LCP would provide an opportunity to incorporate updated climate action goals into the plan, which should reference and include the 2022 Hazard Mitigation Plan actions and the Cape Cod Climate Action Plan.	Town Administration	All Hazards

Existing Capabilities Assessment

Existing Capability	Explanation of Capability	Responsible Department	Natural Hazard(s)
Open Space Plan 2005	Wellfleet's open space plan addresses open space protection needs and acquisition strategies, including parcels in coastal hazard areas for conservation and recreation. The OSRP should be updated This would provide an opportunity to provide updated resource mapping, including identification of vulnerable parcels in the flood zone for conservation and areas of increased coastal erosion.	Conservation	All Hazards
Harbor Management Plan	The Harbor Management Plan addresses harbor management issues including climate change impacts on harbor infrastructure and shellfish resources. Having a harbor management plan also helps the town secure funding for mitigation projects.	Harbormaster	Flooding, sea level rise, severe winter storms, nor'easters, hurricane/tropical storms
Municipal Vulnerability Preparedness (MVP) Plan	Town of Wellfleet received Municipal Vulnerability Preparedness (MVP) designation in 2019. The Town is now certified as an "MVP community" and eligible for MVP action grant funding only available to MVP-certified communities, which the Town will use to seek funding and implement its resiliency plans.	Conservation, DPW	All Hazards
Intermunicipal Shoreline Protection Framework	The towns of Wellfleet, Provincetown, Truro and Eastham partnered with the Center for Coastal Studies to conduct a study on bayside sediment transport in 2018. The grant funded first year study has led to a successful submission for an additional two-year CZM grant to further the work, which was completed in May 2022 (Low Lying Road Assessment report) .	Conservation	Flooding, sea level rise, severe winter storms, nor'easters, hurricane/tropical storms
Regional Transportation Plan	The Regional Transportation Plan identifies priority transportation projects across Cape Cod, which may include projects related to road flooding and culvert repair. The Town works together with the Cape Cod Metropolitan Planning Organization (MPO) to get future roadway projects on the Transportation Improvement Program (TIP).	DPW	Flooding

Staffing and Boards

The Town of Wellfleet has a very capable staff that work together to help the Town plan for and implement specific mitigation actions. This includes a Building Commissioner, Public Works Director, Conservation Agent, Police Chief, Fire Chief, Harbormaster, Beach Administrator, and Shellfish Constable. The town has a Local Planning Board, Conservation Commission, Shellfish Advisory Board, and Energy and Climate Action Committee which also help develop and guide mitigation actions. Town staff also partner with the Cape Cod Commission and Barnstable County for technical assistance, including the services of a Certified Floodplain Manager. The Town of Wellfleet has experienced staff shortages and turnover in recent years, and like neighboring Outer Cape communities faces significant staffing challenges given the lack of affordable and attainable housing opportunities in the region. Wellfleet would benefit from having a full time Town Planner who could oversee the Planning Board, guide zoning bylaw changes, and coordinate planning projects, including hazard mitigation efforts. To help strengthen Wellfleet's abilities to accomplish mitigation goals and reduce the town's short-term and long-term vulnerabilities, the town has pursued partnerships with neighboring communities, and regional, state, and federal agencies. Until the Town can increase staffing, regional partnerships will play a major role in addressing hazard mitigation.

Table 5.4 | Existing Capabilities – Staffing and Boards

Existing Capability	Explanation of Capability	Responsible Department	Natural Hazard(s)
Emergency Management	Police and Fire Departments oversee emergency management coordination	Police and Fire	All
Conservation Agent and Conservation Commission	The Conservation Commission reviews the local regulations on an annual basis and regulates development within and adjacent to wetland resource areas.	Conservation	All

Existing Capability	Explanation of Capability	Responsible Department	Natural Hazard(s)
Department of Public Works	The department responsible for all town infrastructure is critical to any preparation, mitigation, response and recovery from natural hazards in the emergency management cycle.	DPW	All
Harbormaster	The Harbormaster works directly with boat owners and to educate them on appropriate actions to take during a storm event.		
Wellfleet Adult Community Center	ACC is a resource for Wellfleet residents and provides educational programs for the community, including hazard planning and emergency preparedness. The building has potential to be used as a warming station, and the Town is exploring its feasibility (see 2022 Mitigation Actions).	ACC	All

Financial

Financial capabilities are the resources that a town has for funding mitigation actions. The costs to implement mitigation activities vary from relatively low cost to high cost activities. Low cost actions include public education and outreach efforts, which require minimal costs other than staff time and existing operating budgets. Higher cost actions, such as major infrastructure redesigns, could require a substantial monetary commitment from local, state, and federal funding sources. The town's annual revenue from taxes could fund some mitigation actions, but larger actions often need additional outside funding, such as from state and federal grant programs. Wellfleet has been successful in partnering with neighboring communities for grant funding related to hazard mitigation, including the 2019 MVP planning grant, the phased Intermunicipal Shoreline Management, and the 2021 Low Lying Roads project grant. This regional approach to obtain grant funding has been effective and the town will continue to seek joint grant funding opportunities with other Outer Cape communities to address hazard mitigation.

Table 5.5 | Existing Capabilities – Financial

Existing Capability	Explanation of Capability	Responsible Department	Natural Hazard(s)
Grant Funding	The Health & Conservation Agent and DPW director pursue grants to address flooding and related hazard impacts. This includes both planning studies and infrastructure projects. Fire and Police pursue grants related to public safety and emergency management.	Town Administrator	All Hazards

Existing Mitigation Measures

The following are existing and ongoing mitigation measures performed by the Town of Wellfleet:

Table 5.6 | Existing Capabilities – Existing Mitigation Measures

Existing Capability	Explanation of Capability	Responsible Department	Natural Hazard(s)
Comprehensive Emergency Management Plan (CEMP)	The CEMP addresses mitigation, preparedness, response and recovery from a variety of natural and other emergencies It also provides an overall framework for integration and coordination of emergency management and response activities and facilitates coordinated response to any emergency. The Police Chief attends the monthly Barnstable County Regional Emergency Planning Committee meetings.	Police and Fire	All Hazards

Existing Capability	Explanation of Capability	Responsible Department	Natural Hazard(s)
County Wildfire Protection Plan 2012	This is a county plan. If the county undertakes a plan update, the Town could include refined strategies where applicable for wildfire prevention, especially given recent drought cycles.	Fire	Fire
Emergency Power Generators	Town staff reviews and monitors an inventory of town-owned generators. More generators are needed. The DPW has applied for FEMA funding for these.	Police, Fire, DPW	All
State Building Code	The Massachusetts State Building Code contains many detailed regulations regarding wind loads, earthquake resistant design, flood-proofing, and snow loads	Building	All Hazards
Fire Code	Fire Code: Wellfleet observes state, federal, and local fire codes. New sprinkler system laws are continually enforced. The Building Commissioner seeks input from the Fire Department on where to place sprinklers in local businesses.	Fire, Building	Fire
Education and Public Outreach	Educational Materials: The town distributes educational materials from local, county and State level organizations such as the Barnstable County Regional Emergency Planning Committee (BCREPC) and the Cape Cod Cooperative Extension (CCCE). Materials include but are not limited to: CCCE's "Questions and Answers on Purchasing Coastal Real Estate in MA" and "Homeowner's Handbook to Prepare for Coastal Hazards."	Police and Fire, Building	All
Public Works Operations/ Maintenance Activities	The Public Works Department actively maintains the Town's storm drain system. Specific activities include street sweeping, catch basin cleaning and roadway treatments	DPW	Flooding

Existing Capability	Explanation of Capability	Responsible Department	Natural Hazard(s)
Tree Trimming Program	The electric and telephone utility companies trim branches near the electric lines while Town staff maintains trees in other areas.	DPW	
Snow Disposal	The town conducts general snow removal operations with its own equipment and generally has adequate space for snow storage	DPW	Winter Storms
Flood Insurance Rate Maps	Flood Insurance Rate Map (FIRM): voters amended the Wellfleet Zoning Bylaw in 2014 to make it consistent with the newly updated Flood Insurance Rate Maps for Barnstable County and will continue to make map updates as required.	Conservation, Building	Flooding
Floodplain Zoning	Floodplain Zoning District: Zoning is intended to protect the public health and safety through the regulation of land use. The Wellfleet Zoning Bylaw includes Floodplain District regulations that are consistent with NFIP regulations and the State Building Code, but it does not dissuade new construction in flood-prone areas. Improvements to further strengthen the floodplain and zoning bylaws to provide greater hazard mitigation are underway. The Town is working with regional partners to update its floodplain zoning to meet the state's model bylaw. The town could seek additional technical assistance from Barnstable County to make the bylaw more restrictive in the future.	Conservation/ Planning	Flooding, Sea Level Rise

Existing Capability	Explanation of Capability	Responsible Department	Natural Hazard(s)
Wellfleet Environmental Protection Regulations (WEPR)	The Wellfleet WEPR set forth the Conservation Commission's process for reviewing projects under its jurisdiction to protect the wetlands, related water resources and adjoining land areas. The by-law reinforces the State Wetlands Protection Act. The Town will be adopting a new coastal resiliency bylaw (through the Conservation Commission) before the next hazard plan update.	Conservation	
Rules and Regulations Governing the Subdivision of Land:	The Wellfleet Subdivision Rules and Regulations contain provisions intended to reduce flood damage and erosion.	Planning Board	
Community Rating System	Community Rating System (CRS) The 5 Year Community Rating System evaluation of the Town's participation was completed in 2021. Wellfleet is at a Class 8.	Conservation, Building	Flooding
Barnstable County Mutual Aid	Wellfleet opted-in to the Public Works Mutual Aid Agreement through MEMA. By opting in, Wellfleet can send and/or request assets from any other community within the Commonwealth that has also opted into the agreement. This agreement can be used for everyday use and/or be activated for any public safety incident/event. Wellfleet also has mutual aid agreements with neighboring communities.	Police and Fire, Harbormaster	All Hazards
Emergency Communication	Emergency Communication: The town owns large variable message boards which display 3-4 lines of text. They are usually placed on Route 6 to notify residents of hazards, lane closures and parking instructions. The Code Red system listed in the previous Hazard Plan is now called Civic Ready. Town administration DPW, and police post announcements on Town website and social media.	Police and Fire	All Hazards

Existing Capability	Explanation of Capability	Responsible Department	Natural Hazard(s)
Sheltering Education/Outreach	Wellfleet Police and Fire Departments collaborate with other departments to send out press releases about the locations of regional or local shelter, warming/charging stations and natural hazard responses.	Police and Fire	All Hazards
Eversource	In 2012, an Act Relative to Emergency Response of Public Utility Companies was signed into law, requiring a more robust response to emergencies from power companies. Additionally, Eversource has MOUs with private companies to provide accommodations during all but the summer seasons.	Police and Fire Departments, DPW	All Hazards

D3

An Assessment of the Changes in Priorities from 2016 to 2022

Below is a list of activities that remain a priority for the Town of Wellfleet in 2022:

- Wellfleet remains dedicated to public outreach on emergency preparedness, communication with residents and visitors before, during and after a hazard event, and communicating with the public about the impact of natural hazards.
- Wellfleet remains committed to assessing local infrastructure for damage from coastal hazards such as storm surge, flooding and shoreline change in the National Flood Insurance Program.
- Wellfleet remains dedicated to reducing the potential for life, property, infrastructure, and environmental, cultural, and economic resources in the Town from natural hazards.
- Wellfleet will continue to ensure that mitigation measures are sensitive to natural features, historic resources, and character of the community

Current Focus/Priorities

Since completing the 2016 Wellfleet Hazard Mitigation Plan, the Town has developed a greater sense of urgency

in addressing hazards and climate change impacts. Wellfleet staff have pursued and received several grants to conduct studies and projects to increase public education and outreach; emergency preparedness, infrastructure redesign/upgrades to reduce flooding and better protect the town from flooding impacts. The January and March 2018 nor'easters, which caused flooding to homes and businesses and roadways in the downtown, Indian Neck, and other coastal locations, were instrumental in spurring public understanding of the urgency to address natural hazards/climate change impacts, particularly those related to storm surge and sea level rise. Wellfleet has increased its efforts to engage with stakeholders and the public on issues related to hazard mitigation and climate change. Completion of the MVP workshop with the Town of Truro in 2019 reflects the Town's expanded interest in both educating the public on hazard and climate change issues and seeking community input on mitigation actions.

Wellfleet has been successful in partnering with neighboring communities, regional, state, federal agencies to address hazards/climate change impacts. In addition to the MVP workshop/certification, recent efforts include the 2019/2020 CZM resiliency grants/Intermunicipal Shoreline Management plan; the 2021 EDA/MVP Low Lying Roads Project; and the District Local Technical Assistance Model Coastal Bylaw project. This joint/partnership approach will continue as the town implements the hazard mitigation plan actions.

Wellfleet also faces challenges that could affect its ability to address hazards and climate change impacts. The lack of affordable housing has grown into a significant crisis on the Outer Cape. Skyrocketing housing costs and lack of supply have made it difficult for local employers to keep staff and attract new workers. The Town of Wellfleet has experienced substantial staffing turnover and vacancies since the 2016 hazard plan, which has impacted its capacity to pursue additional hazard/climate change actions. Join efforts with neighboring communities and regional, state, and federal partners will help the Town manage future efforts to address hazard impacts.

Plan Evaluation and Maintenance

Chapter Six

Once the 2022 Wellfleet Hazard Plan is adopted by the Wellfleet Select Board, the plan enters a five-year “maintenance” phase. **Chapter 6 describes how the Wellfleet Hazard Mitigation Plan will be evaluated, updated and enhanced over the next five years.**

A6d

Who is involved?

Each department identified in the Wellfleet Hazard Mitigation Plan is responsible for implementing specific mitigation actions as listed in the Mitigation Action section of the plan (Chapter 5). "Lead" departments are assigned to each proposed action listed in the Mitigation Action to ensure responsibility and increase the likelihood of subsequent implementation.

The Wellfleet Town Administrator will be responsible for ensuring that the plan is monitored, evaluated, and updated throughout the next five years

How will the plan be maintained?

Below is a list of the activities describing how the plan will be maintained and updated over the next five years:

Plan Monitoring:

- Members of the Planning Team will meet annually to discuss the implementation status of each Mitigation Action identified in Chapter 5. During these meetings, the Planning Team will also describe and document any new hazard data that can be incorporated in the Hazard Profile section of the plan such as new hazard locations, extent and impacts.
- After the annual meeting, members of the Planning Team will present to the Select Board on the implementation status of the Mitigation Actions identified in Chapter 5. This presentation will occur once per year and will include an evaluation of the appropriateness of Mitigation Actions. If an amendment, change or update is needed, the Select Board can vote to adopt the change and amend the Hazard Mitigation Plan.

Plan Evaluation:

A6b

A subset of the Planning Team will meet annually to evaluate the stated purpose and goals of the Wellfleet Hazard Plan. During this annual meeting, this smaller group will ensure that the plan continues to serve its purpose through the following activities:

- Review the Mitigation Goals in the 2022 Wellfleet Hazard Mitigation Plan
- Discuss any recent activities to reduce the loss of life and property in Wellfleet such as grants received/applied for and any completed Mitigation Actions.
- Distribute an online survey to gauge the public's awareness of the risks posed by natural hazards. Discuss ongoing or recent planning efforts that are consistent with the Mitigation Goals and Actions of the Wellfleet Hazard Mitigation Plan

Plan Update:

A6c

The Wellfleet Hazard Mitigation Plan will be reviewed and updated every five years to ensure that there is no lapse in plan coverage. The Hazard Mitigation Plan update process should begin one to one and half years before the plan is set to expire.

When will the plan be maintained?

A start date and time period were assigned to each Mitigation Action in Chapter 5 to assess whether actions are being implemented in a timely fashion. Also, the Planning Team will also reconvene annually to discuss progress on the Mitigation Actions.

Following a disaster declaration, the Wellfleet Hazard Mitigation Plan will be revised as necessary to reflect lessons learned or to address specific issues and circumstances arising from the event. It will be the responsibility of the Planning Team to reconvene the Local Emergency Planning Committee and to ensure the appropriate stakeholders are invited to participate in the plan revision and update process following declared disaster events.

Plan Adoption

Chapter Seven

Once the draft of the Wellfleet Hazard Mitigation Plan is reviewed by the Planning Team, stakeholders and the general public, Massachusetts Emergency Management Agency (MEMA) and the Federal Emergency Management Agency (FEMA) review it. Following their approval, the Wellfleet Select Board can officially adopt the plan. Once adopted, it enters a five year "maintenance" phase. **Chapter 7 describes the timeline for plan adoption and includes documentation for Select Board adoption.**

The timeline for Plan Adoption is as follows:

May 2022: After approval by the Select Board, the Planning Team submitted the draft Wellfleet Hazard Mitigation Plan to the Massachusetts Emergency Management Agency (MEMA). MEMA reviewed the plan and returned it to the Town of Wellfleet with required edits. The updated Plan was then submitted to the Federal Emergency Management Agency (FEMA) for final review.

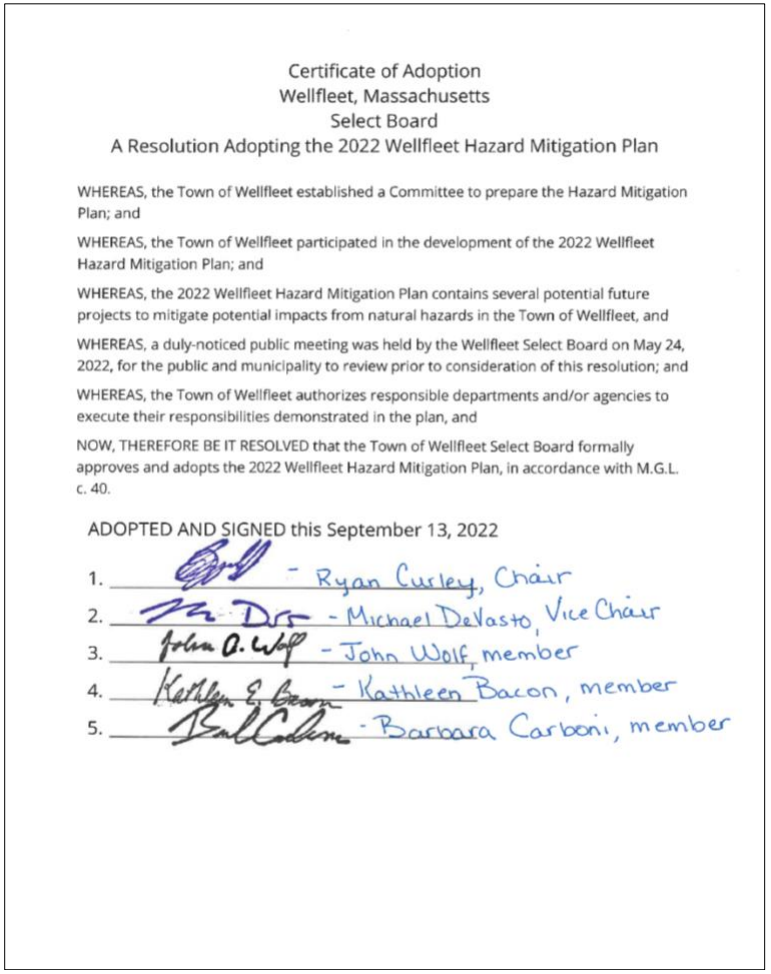
September 2022: FEMA issued an Approved Pending Adoption status and the Wellfleet Select Board officially adopted the 2022 Hazard Mitigation Plan during its meeting on September 27, 2022.

E1a

Plan Adoption

The Certificate of Adoption signed by the Wellfleet Select Board is shown in *Figure 7.1*.

Figure 7.1 | Certificate of Adoption signed by the Wellfleet Select Board.



Certificate of Adoption
Wellfleet, Massachusetts
Select Board
A Resolution Adopting the 2022 Wellfleet Hazard Mitigation Plan

WHEREAS, the Town of Wellfleet established a Committee to prepare the Hazard Mitigation Plan; and

WHEREAS, the Town of Wellfleet participated in the development of the 2022 Wellfleet Hazard Mitigation Plan; and

WHEREAS, the 2022 Wellfleet Hazard Mitigation Plan contains several potential future projects to mitigate potential impacts from natural hazards in the Town of Wellfleet, and

WHEREAS, a duly-noticed public meeting was held by the Wellfleet Select Board on May 24, 2022, for the public and municipality to review prior to consideration of this resolution; and

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

NOW, THEREFORE BE IT RESOLVED that the Town of Wellfleet Select Board formally approves and adopts the 2022 Wellfleet Hazard Mitigation Plan, in accordance with M.G.L. c. 40.

ADOPTED AND SIGNED this September 13, 2022

1. _____ - Ryan Curley, Chair
2. _____ - Michael DeVasto, Vice Chair
3. _____ - John Wolf, member
4. _____ - Kathleen Bacon, member
5. _____ - Barbara Carboni, member

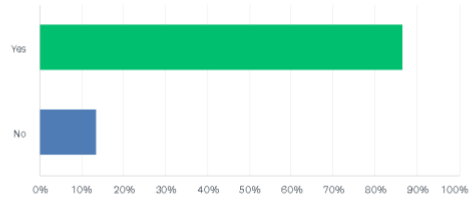
Appendix

Hazard Survey Results

Public Survey for the Wellfleet Hazard Mitigation Plan

Q1 Have you experienced a weather-related event or disaster while living, working or visiting Wellfleet?

Answered: 225 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	86.67%	195
No	13.33%	30
TOTAL		225

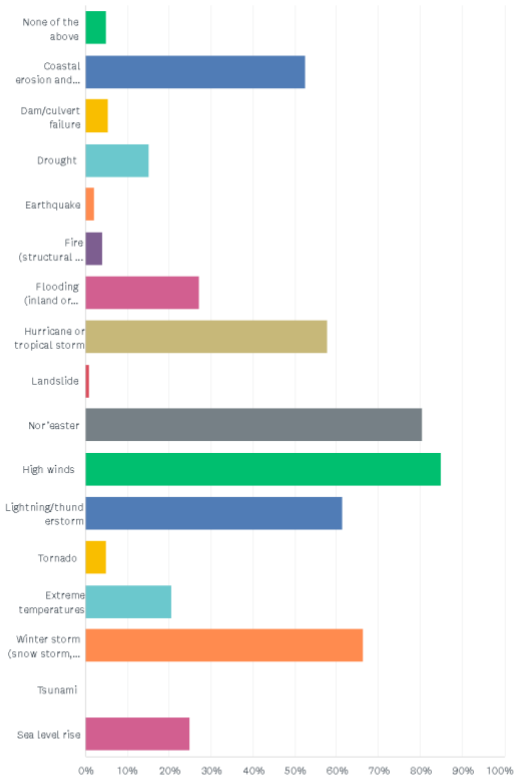
Public Survey for the Wellfleet Hazard Mitigation Plan

Q2 Which of the following hazards have you experienced while in Wellfleet? The hazards listed below are from the 2018 Massachusetts State Hazard and Climate Adaptation Plan.

Answered: 225 Skipped: 0

Hazard Survey Results

Public Survey for the Wellfleet Hazard Mitigation Plan



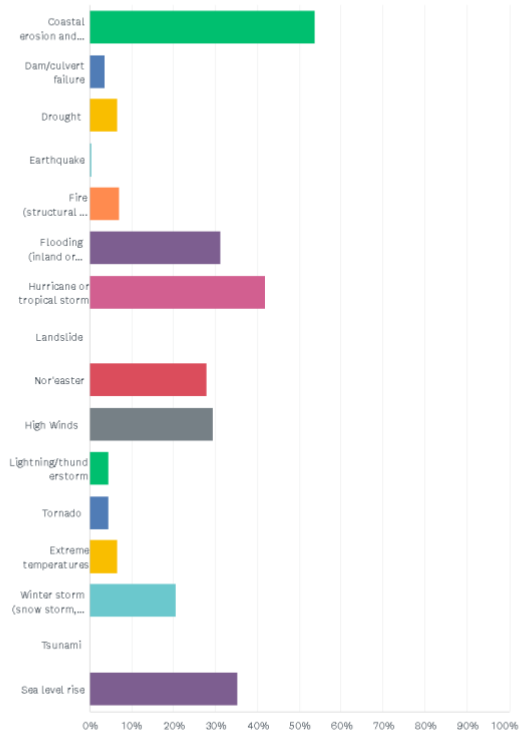
Public Survey for the Wellfleet Hazard Mitigation Plan

ANSWER CHOICES	RESPONSES	
None of the above	4.89%	11
Coastal erosion and shoreline change	52.44%	118
Dam/culvert failure	5.33%	12
Drought	15.11%	34
Earthquake	2.22%	5
Fire (structural or wildfire)	4.00%	9
Flooding (inland or coastal)	27.11%	61
Hurricane or tropical storm	57.78%	130
Landslide	0.89%	2
Nor'easter	80.44%	181
High winds	84.89%	191
Lightning/thunderstorm	61.33%	138
Tornado	4.89%	11
Extreme temperatures	20.44%	46
Winter storm (snow storm, blizzard, ice storm)	66.22%	149
Tsunami	0.00%	0
Sea level rise	24.89%	56
Total Respondents: 225		

Public Survey for the Wellfleet Hazard Mitigation Plan

Q3 Which of the following hazards are you most concerned about? (Choose up to 3.)

Answered: 225 Skipped: 0



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Public Survey for the Wellfleet Hazard Mitigation Plan

ANSWER CHOICES	RESPONSES	
Coastal erosion and shoreline change	53.78%	121
Dam/culvert failure	3.56%	8
Drought	6.67%	15
Earthquake	0.44%	1
Fire (structural or wildfire)	7.11%	16
Flooding (inland or coastal)	31.11%	70
Hurricane or tropical storm	41.78%	94
Landslide	0.00%	0
Nor'easter	28.00%	63
High Winds	29.33%	66
Lightning/thunderstorm	4.44%	10
Tornado	4.44%	10
Extreme temperatures	6.67%	15
Winter storm (snow storm, blizzard, ice storm, etc.)	20.44%	46
Tsunami	0.00%	0
Sea level rise	35.11%	79
Total Respondents: 225		

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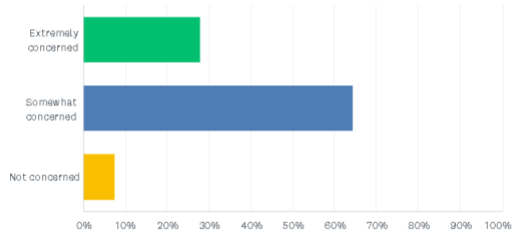
Hazard Survey Results

Public Survey for the Wellfleet Hazard Mitigation Plan

Q4 How concerned are you about the possibility of a natural disaster impacting Wellfleet?

Answered: 225 Skipped: 0

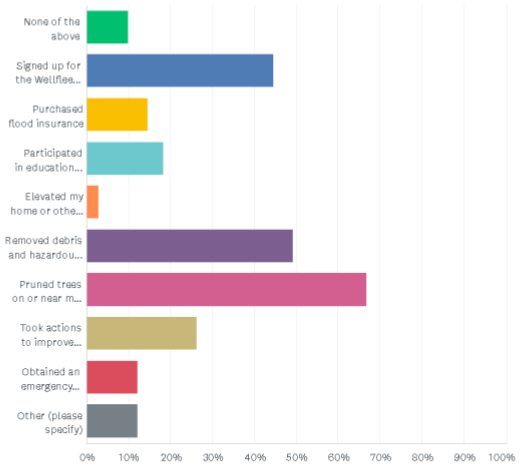


ANSWER CHOICES	RESPONSES	
Extremely concerned	28.00%	63
Somewhat concerned	64.44%	145
Not concerned	7.56%	17
TOTAL		225

Public Survey for the Wellfleet Hazard Mitigation Plan

Q5 Which of the following actions have you taken to be more hazard resistant? (Select all that apply.)

Answered: 213 Skipped: 12



Public Survey for the Wellfleet Hazard Mitigation Plan

ANSWER CHOICES	RESPONSES	
None of the above	9.86%	21
Signed up for the Wellfleet Alert System (Civic Ready) through the Wellfleet Police Department	44.60%	95
Purchased flood insurance	14.55%	31
Participated in educational activities and trainings about hazard and emergency preparedness	18.31%	39
Elevated my home or other building on my property	2.82%	6
Removed debris and hazardous materials from my property	49.30%	105
Pruned trees on or near my property	66.67%	142
Took actions to improve drainage on my property	26.29%	56
Obtained an emergency response kit	12.21%	26
Other (please specify)	12.21%	26
Total Respondents: 213		

#	OTHER (PLEASE SPECIFY)	DATE
1	installed backup generator	1/28/2022 3:16 PM
2	Installed an emergency generator.	1/22/2022 1:59 PM
3	installed generater	1/21/2022 12:45 AM
4	wood stove	1/20/2022 11:08 AM
5	Stored water	1/20/2022 9:19 AM
6	Took steps to secure porch furniture as storm approached	1/16/2022 4:47 PM
7	purchased generators	1/15/2022 7:28 PM
8	Installed a generator	1/15/2022 5:51 PM
9	Installed back-up generator	1/15/2022 1:00 PM
10	reinforced roofing	1/15/2022 12:17 PM
11	Installed generator	1/15/2022 11:28 AM
12	Stay Informed of the issues	1/15/2022 10:59 AM
13	Installed a whole generator.	1/15/2022 10:50 AM
14	Installed jotul propane stove for some heat during outages	1/15/2022 9:06 AM
15	Installed a generator, signed up for Mass alerts	1/14/2022 3:04 PM
16	I work on coastal restoration projects	1/14/2022 2:44 PM
17	have a generator since early 2000s	1/14/2022 2:43 PM
18	Installed storm panels	1/14/2022 2:39 PM
19	Installed a generator	1/14/2022 2:25 PM
20	New foundation and landscape to reduce water damage.	1/14/2022 2:10 PM
21	Actively engage in government to assess and reduce risks	1/13/2022 1:20 PM
22	Exploring flood mitigation options	1/13/2022 10:00 AM
23	Installed Generator	1/12/2022 10:58 AM

Public Survey for the Wellfleet Hazard Mitigation Plan

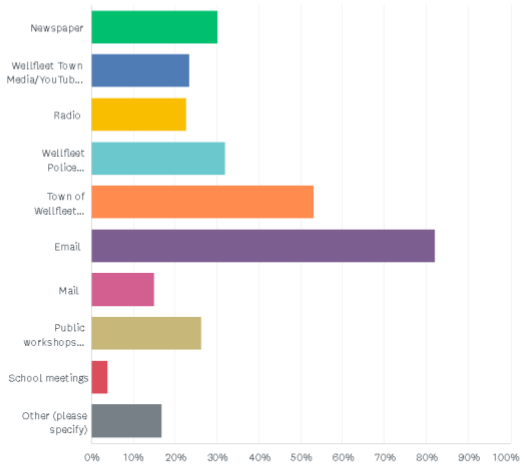
24	added battery/generator	1/11/2022 6:22 PM
25	First aid kit, batteries, flashlights, fire extinguishers, etc.	1/10/2022 6:58 PM
26	Generator	1/10/2022 3:11 PM

Hazard Survey Results

Public Survey for the Wellfleet Hazard Mitigation Plan

Q6 What is the most effective way to inform or engage you in hazard planning and emergency preparedness activities? (Select all that apply.)

Answered: 213 Skipped: 12



Public Survey for the Wellfleet Hazard Mitigation Plan

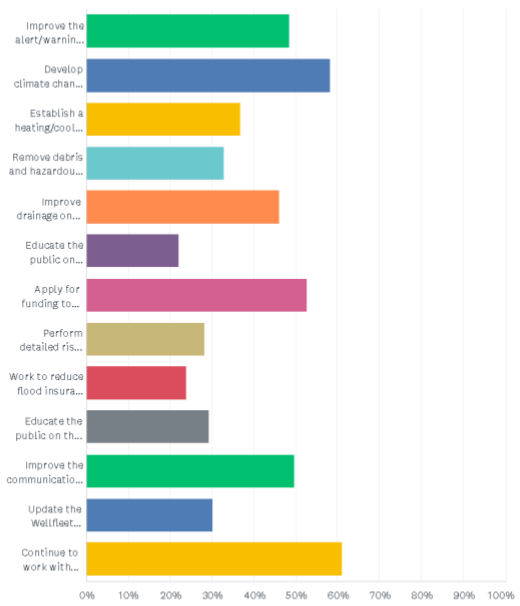
ANSWER CHOICES	RESPONSES	
Newspaper	30.05%	64
Wellfleet Town Media/YouTube channel	23.47%	50
Radio	22.54%	48
Wellfleet Police Department Facebook page	31.92%	68
Town of Wellfleet website	53.05%	113
Email	82.16%	175
Mail	15.02%	32
Public workshops and/or meetings	26.29%	56
School meetings	3.76%	8
Other (please specify)	16.90%	36
Total Respondents: 213		

#	OTHER (PLEASE SPECIFY)	DATE
1	Text	1/25/2022 8:35 PM
2	Text messages	1/22/2022 1:59 PM
3	phone	1/21/2022 12:45 AM
4	text	1/20/2022 1:42 PM
5	text notifications with a link to the notice	1/19/2022 6:15 PM
6	Facebook group: Wellfleet Community Space	1/19/2022 4:22 PM
7	Text	1/17/2022 12:10 PM
8	Phone/text	1/16/2022 4:47 PM
9	Text message alerts	1/15/2022 10:41 PM
10	phone messages	1/15/2022 6:44 PM
11	TV	1/15/2022 5:51 PM
12	TV	1/15/2022 12:40 PM
13	Text messge	1/15/2022 10:50 AM
14	Wellfleet community space Facebook	1/15/2022 8:19 AM
15	Facebook	1/15/2022 7:30 AM
16	Text	1/14/2022 11:35 PM
17	Text	1/14/2022 9:57 PM
18	Texts	1/14/2022 8:20 PM
19	Social media : Wellfleet Community Space page on Facebook	1/14/2022 8:08 PM
20	Text	1/14/2022 6:49 PM
21	None	1/14/2022 6:40 PM
22	Reverse 911 call	1/14/2022 6:34 PM
23	Text message	1/14/2022 3:20 PM

24	gordonpeabody@gmail.com	1/14/2022 2:44 PM
25	Lower Cape TV	1/14/2022 2:43 PM
26	text	1/14/2022 2:39 PM
27	Wellfleet Alert System	1/14/2022 2:18 PM
28	Facebook	1/14/2022 2:10 PM
29	Wellfleet Community Space Facebook	1/14/2022 1:51 PM
30	Wellfleet Community Facebook Page, phone text message	1/14/2022 1:49 PM
31	Create a postcard or postcard with 5 to 10 of the most important things to do.	1/14/2022 1:49 PM
32	texts on mobile phone	1/14/2022 1:38 PM
33	Wellfleet COA	1/14/2022 10:16 AM
34	The town website has been awful for so long we all know not to bother with it.	1/12/2022 2:29 PM
35	Phone	1/12/2022 9:18 AM
36	text	1/11/2022 6:22 PM

Q7 What steps would you like your local government to take to reduce the risk and protect Wellfleet's buildings and people from natural hazards? (Select all that apply.)

Answered: 213 Skipped: 12



Hazard Survey Results

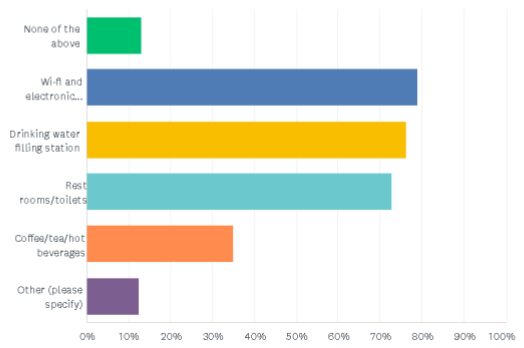
Public Survey for the Wellfleet Hazard Mitigation Plan

ANSWER CHOICES	RESPONSES	
Improve the alert/warning/notification system	48.36%	103
Develop climate change adaptation plans and implement them	58.22%	124
Establish a heating/cooling center in a Town building for use during emergencies, power outages, etc.	36.62%	78
Remove debris and hazardous materials as well as prune trees on town property	32.86%	70
Improve drainage on area roads	46.01%	98
Educate the public on evacuation methods	22.07%	47
Apply for funding to reduce Wellfleet's risk to natural hazards	52.58%	112
Perform detailed risk assessments	28.17%	60
Work to reduce flood insurance for residents through the Community Rating System	23.94%	51
Educate the public on the science of natural hazards and emergency preparedness	29.11%	62
Improve the communication system during hazard events (i.e. radio towers, cellular services)	49.77%	106
Update the Wellfleet Zoning Bylaws (or other development regulations) as they relate to flooding	30.05%	64
Continue to work with regional partners to prepare for and recover from natural disasters	61.03%	130
Total Respondents: 213		

Public Survey for the Wellfleet Hazard Mitigation Plan

Q8 If the Town were to create a local heating/cooling center in a public building for use during power outages, hazardous weather events, etc. what type(s) of services would you likely use or need?

Answered: 209 Skipped: 16



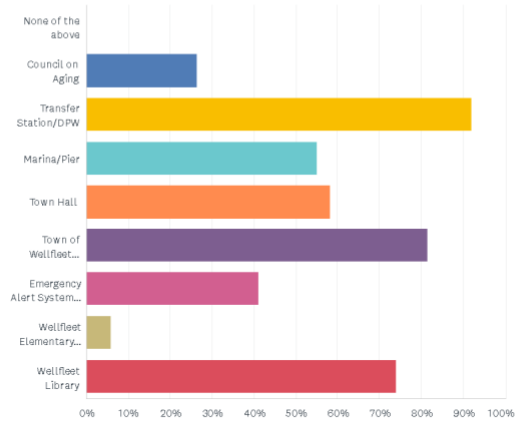
ANSWER CHOICES	RESPONSES	
None of the above	12.92%	27
Wi-fi and electronic device charging	78.95%	165
Drinking water filling station	76.08%	159
Rest rooms/toilets	72.73%	152
Coffee/tea/hot beverages	34.93%	73
Other (please specify)	12.44%	26
Total Respondents: 209		

#	OTHER (PLEASE SPECIFY)	DATE
1	accomodation for pets	1/18/2022 2:29 PM
2	laundry facilities	1/16/2022 6:25 PM
3	All of the above	1/16/2022 12:10 PM
4	Food, beds if prolonged over 3 days	1/16/2022 10:31 AM
5	water filling station for toilet flushing buckets	1/15/2022 6:44 PM

6	Food	1/15/2022 1:11 PM
7	Food	1/15/2022 12:40 PM
8	Cooking	1/15/2022 10:59 AM
9	Showers	1/14/2022 8:20 PM
10	Cots, bedding	1/14/2022 8:08 PM
11	Bagels would be nice…	1/14/2022 7:06 PM
12	comfortable furniture, cots if we need to sleep there	1/14/2022 5:58 PM
13	Showers	1/14/2022 4:36 PM
14	Single malt scotch	1/14/2022 4:02 PM
15	Cooling as our generator can't power the mini aolits	1/14/2022 3:04 PM
16	water for flushing toilets at homes on wells	1/14/2022 2:27 PM
17	food, if the emergency was long-lasting; possibly blankets	1/14/2022 2:24 PM
18	Place to sleep and shower	1/14/2022 1:51 PM
19	I don't have pets and farm animals, but they need help too.	1/14/2022 1:49 PM
20	Loved the P D after the last outage!	1/14/2022 1:32 PM
21	Very Simple sleeping accommodations in case of extended outages.	1/14/2022 1:06 PM
22	Sheltering	1/13/2022 2:47 PM
23	Heat in cold months	1/13/2022 10:00 AM
24	Heat and air-conditioning. Use town buildings already in existence.	1/12/2022 2:29 PM
25	I have town water, propane cooking stove, wood stove and lanterns so feel protected but many others do not	1/12/2022 9:18 AM
26	Place for pets as well	1/10/2022 3:16 PM

Q9 Do you use any of the following services? (Select all that apply.)

Answered: 211 Skipped: 14



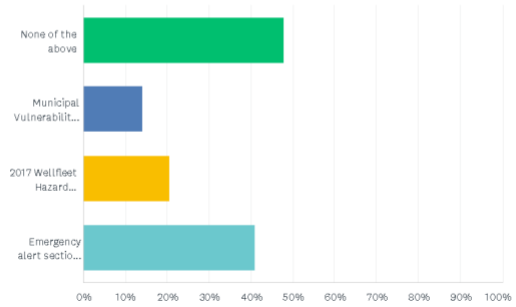
ANSWER CHOICES	RESPONSES	
None of the above	0.00%	0
Council on Aging	26.54%	56
Transfer Station/DPW	91.94%	194
Marina/Pier	54.98%	116
Town Hall	58.29%	123
Town of Wellfleet Website	81.52%	172
Emergency Alert System (CivicReady)	41.23%	87
Wellfleet Elementary School	5.69%	12
Wellfleet Library	73.93%	156
Total Respondents: 211		

Hazard Survey Results

Public Survey for the Wellfleet Hazard Mitigation Plan

Q10 Please check the corresponding box of any item below that you have heard of or are familiar with.

Answered: 205 Skipped: 20

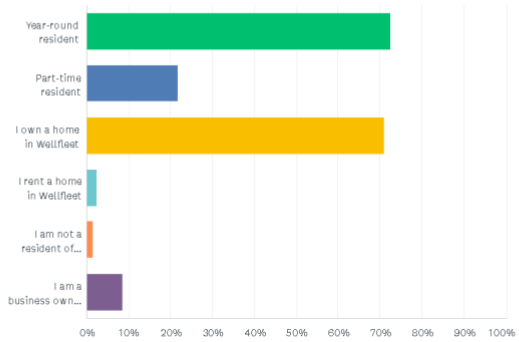


ANSWER CHOICES	RESPONSES	
None of the above	47.80%	98
Municipal Vulnerability Plan (commonly referred to as "MVP")	14.15%	29
2017 Wellfleet Hazard Mitigation Plan	20.49%	42
Emergency alert section of Town of Wellfleet website	40.98%	84
Total Respondents: 205		

Public Survey for the Wellfleet Hazard Mitigation Plan

Q11 Please tell us about yourself. Select all that apply to you.

Answered: 211 Skipped: 14



ANSWER CHOICES	RESPONSES	
Year-round resident	72.51%	153
Part-time resident	21.80%	46
I own a home in Wellfleet	71.09%	150
I rent a home in Wellfleet	2.37%	5
I am not a resident of Wellfleet, but I am employed in Wellfleet	1.42%	3
I am a business owner in Wellfleet	8.53%	18
Total Respondents: 211		

#	OTHER (PLEASE SPECIFY)	DATE
1	Voter in wellfleet	1/29/2022 9:33 AM
2	grew up here in summers only	1/18/2022 2:32 PM
3	Utilize marinia facilities	1/15/2022 5:54 PM
4	I am a town elected official.	1/15/2022 2:41 PM
5	am working towards full time residency.	1/15/2022 1:42 PM
6	I rent an ADU (accessory dwelling unit) in my former residence. I sold the house because I have concerns about road flooding and other climate issues. I don't want homeowner headaches.	1/15/2022 1:15 PM

7	I have checked year-round but actually I live here about 8 months out of the year. I vote here and consider this my main residence.	1/14/2022 6:00 PM
8	property owner	1/14/2022 2:46 PM
9	I am on the Board of the Lower Cape TV Station	1/14/2022 2:45 PM
10	Gov Official so not necessary;y reflective of the community as a whole.	1/14/2022 1:08 PM
11	Currently a part time resident but will be a year-round resident soon. Recently retired.	1/12/2022 10:29 PM
12	I am employed in Wellfleet	1/12/2022 2:31 PM
13	shellfish farmer	1/11/2022 10:37 AM

Q12 If you would like to be more involved in the hazard planning process, please provide your name, email and/or alternate contact information.

Answered: 47 Skipped: 178

ANSWER CHOICES	RESPONSES	
Name	97.87%	46
Email	95.74%	45
Alternate Contact Information	51.06%	24

#	NAME	DATE
1	[redacted]	1/29/2022 9:33 AM
2	[redacted]	1/28/2022 3:18 PM
3	[redacted]	1/22/2022 2:00 PM
4	[redacted]	1/20/2022 11:09 AM
5	[redacted]	1/17/2022 12:12 PM
6	[redacted]	1/16/2022 6:27 PM
7	[redacted]	1/16/2022 10:43 AM
8	[redacted]	1/15/2022 10:42 PM
9	[redacted]	1/15/2022 8:53 PM
10	[redacted]	1/15/2022 6:16 PM
11	[redacted]	1/15/2022 1:15 PM
12	[redacted]	1/15/2022 12:42 PM
13	[redacted]	1/15/2022 12:01 PM
14	[redacted]	1/15/2022 11:01 AM
15	[redacted]	1/15/2022 10:52 AM
16	[redacted]	1/15/2022 9:07 AM
17	[redacted]	1/15/2022 8:21 AM
18	[redacted]	1/14/2022 9:04 PM
19	[redacted]	1/14/2022 8:09 PM
20	[redacted]	1/14/2022 7:25 PM
21	[redacted]	1/14/2022 7:07 PM
22	[redacted]	1/14/2022 6:36 PM
23	[redacted]	1/14/2022 4:23 PM
24	[redacted]	1/14/2022 3:52 PM
25	[redacted]	1/14/2022 2:46 PM
26	[redacted]	1/14/2022 2:45 PM
27	[redacted]	1/14/2022 2:13 PM

Contact information obscured for privacy.

Hazard Survey Results

Public Survey for the Wellfleet Hazard Mitigation Plan

28	[illegible]	1/14/2022 1:56 PM
29	[illegible]	1/14/2022 1:53 PM
30	[illegible]	1/14/2022 1:51 PM
31	[illegible]	1/14/2022 1:37 PM
32	[illegible]	1/14/2022 1:33 PM
33	[illegible]	1/14/2022 1:08 PM
34	[illegible]	1/13/2022 2:48 PM
35	[illegible]	1/13/2022 1:22 PM
36	[illegible]	1/13/2022 10:03 AM
37	[illegible]	1/13/2022 9:26 AM
38	[illegible]	1/13/2022 9:24 AM
39	[illegible]	1/13/2022 7:08 AM
40	[illegible]	1/12/2022 10:29 PM
41	[illegible]	1/12/2022 2:31 PM
42	[illegible]	1/11/2022 7:52 PM
43	[illegible]	1/11/2022 6:49 PM
44	[illegible]	1/11/2022 10:37 AM
45	[illegible]	1/11/2022 9:41 AM
46	[illegible]	1/10/2022 4:29 PM
#	EMAIL	DATE
1	[illegible]	1/29/2022 9:33 AM
2	[illegible]	1/28/2022 3:18 PM
3	[illegible]	1/22/2022 2:00 PM
4	[illegible]	1/20/2022 11:09 AM
5	[illegible]	1/16/2022 6:27 PM
6	[illegible]	1/16/2022 10:43 AM
7	[illegible]	1/15/2022 10:42 PM
8	[illegible]	1/15/2022 8:53 PM
9	[illegible]	1/15/2022 6:16 PM
10	[illegible]	1/15/2022 1:15 PM
11	[illegible]	1/15/2022 12:01 PM
12	[illegible]	1/15/2022 11:01 AM
13	[illegible]	1/15/2022 10:52 AM
14	[illegible]	1/15/2022 9:07 AM
15	[illegible]	1/15/2022 8:21 AM
16	[illegible]	1/14/2022 9:04 PM
17	[illegible]	1/14/2022 8:09 PM
18	[illegible]	1/14/2022 7:25 PM

23 / 25

Public Survey for the Wellfleet Hazard Mitigation Plan

19	[illegible]	1/14/2022 7:07 PM
20	[illegible]	1/14/2022 6:36 PM
21	[illegible]	1/14/2022 4:23 PM
22	[illegible]	1/14/2022 3:52 PM
23	[illegible]	1/14/2022 2:46 PM
24	[illegible]	1/14/2022 2:45 PM
25	[illegible]	1/14/2022 2:13 PM
26	[illegible]	1/14/2022 1:56 PM
27	[illegible]	1/14/2022 1:53 PM
28	[illegible]	1/14/2022 1:51 PM
29	[illegible]	1/14/2022 1:37 PM
30	[illegible]	1/14/2022 1:33 PM
31	[illegible]	1/14/2022 1:08 PM
32	[illegible]	1/13/2022 2:48 PM
33	[illegible]	1/13/2022 1:22 PM
34	[illegible]	1/13/2022 10:03 AM
35	[illegible]	1/13/2022 9:26 AM
36	[illegible]	1/13/2022 9:24 AM
37	[illegible]	1/13/2022 7:08 AM
38	[illegible]	1/12/2022 10:29 PM
39	[illegible]	1/12/2022 2:31 PM
40	[illegible]	1/12/2022 1:00 PM
41	[illegible]	1/11/2022 7:52 PM
42	[illegible]	1/11/2022 6:49 PM
43	[illegible]	1/11/2022 10:37 AM
44	[illegible]	1/11/2022 9:41 AM
45	[illegible]	1/10/2022 4:29 PM
#	ALTERNATE CONTACT INFORMATION	DATE
1	[illegible]	1/29/2022 9:33 AM
2	[illegible]	1/28/2022 3:18 PM
3	[illegible]	1/22/2022 2:00 PM
4	[illegible]	1/17/2022 12:12 PM
5	[illegible]	1/16/2022 6:27 PM
6	[illegible]	1/16/2022 10:43 AM
7	[illegible]	1/15/2022 10:42 PM
8	[illegible]	1/15/2022 6:16 PM
9	[illegible]	1/15/2022 1:15 PM
10	[illegible]	1/15/2022 10:52 AM

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Contact information obscured for privacy.

Public Survey for the Wellfleet Hazard Mitigation Plan

11	[redacted]	1/14/2022 9:04 PM
12	[redacted]	1/14/2022 7:25 PM
13	[redacted]	1/14/2022 7:07 PM
14	[redacted]	1/14/2022 4:23 PM
15	[redacted]	1/14/2022 2:46 PM
16	[redacted]	1/14/2022 2:45 PM
17	[redacted]	1/14/2022 2:13 PM
18	[redacted]	1/14/2022 1:08 PM
19	[redacted]	1/13/2022 1:22 PM
20	[redacted]	1/13/2022 9:26 AM
21	[redacted]	1/13/2022 7:08 AM
22	[redacted]	1/12/2022 10:29 PM
23	[redacted]	1/11/2022 7:52 PM
24	[redacted]	1/11/2022 6:49 PM

Contact information obscured for privacy.

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Planning Team Meeting Agendas

Wellfleet Multi-Hazard Mitigation Plan

Planning Team Meeting

December 15, 2021

1:00 PM

Virtual Meeting via Zoom

Link: https://capecodcommission.org/mhm/join

Passcode: join

Meeting ID: 922 0959 7528

Agenda

1. Follow-up on remaining Meeting 1 agenda items (Powerpoint presentation)
2. 2017 Actions Summary – Review status
3. Draft public survey
4. Hazard Profiles
5. Tasks for next meeting:
    a) New development since 2017
    b) Capabilities Assessment (per FEMA Worksheet 4.1)
6. Schedule next meeting

Handouts sent before meeting:

- Meeting Packet: Agenda and 2017 Actions Status Summary
- Draft public survey (email attachment)

For reference: Status Explanation

Completed	The project was implemented and completed in 2017-2022
Ongoing/Existing Capability	The project was implemented and completed in 2017-2022 and it will continue to be implemented on an annual basis in the future. These action items will also be identified in the capability assessment.
In Progress	The project was started in 2017-2022 timeframe and is still in progress
Deferred	The project is important, but it was deferred because there was no funding available or it is not feasible to complete the project
Deleted	The project is no longer important to the community

Wellfleet Multi-Hazard Mitigation Plan

Planning Team Meeting

January 5, 2022

1:00 PM

Virtual Meeting via Zoom

Link: https://capecodcommission.org/mhm/join

Passcode: join

Meeting ID: 922 0959 7528

Agenda

1. Follow-up on December meeting agenda items
   a. 2017 Actions Status Summary - edits/changes
   b. Draft public survey - edits/changes and outreach strategy
   c. Hazard Profiles - events/updates needed
2. Capabilities Assessment (per FEMA Worksheet 4.1)
3. New development since 2017
4. Changes in Town priorities since 2017
5. Relevant plans & documents

Handouts sent before meeting:

- ☐ Meeting Packet: Agenda; 2017 Action status updated; sample capabilities assessment and FEMA worksheet
- ☐ Link to draft survey – demo https://www.surveymonkey.com/r/D3L7K9T

Wellfleet Multi-Hazard Mitigation Plan

Planning Team Meeting

February 8, 2022

1:00 PM

Virtual Meeting via Zoom

Link: https://capecodcommission.org/mhm/join

Passcode: join

Meeting ID: **Meeting ID**: 943 7659 5383 ← New

Phone: (929) 205-6099

Agenda

1. *Review of 2022 Draft Actions table* – Table has list of carried over 2016 actions. The Planning Team will review them and add new actions for 2022. Also review MVP actions & decide which to include/modify for Hazard Plan.
2. *Check-in on progress of other plan pieces and outreach* - If we have enough time, will discuss other plan sections under way.

Files sent before meeting:

1. 2022 Draft Actions Table for meeting

Planning Team Meeting Agendas

Meeting 1 – Kickoff Meeting with Local Planning Team -December 1,2021 (Teams)

- Town staff to provide overview of update work to date
- Overview of Plan Update process – required content, timeline, tasks, Planning Team responsibilities
- Develop an outreach strategy
- Identify relevant town plans
- Review of relevant hazards and critical facilities
- Schedule planning team meetings

[POST-MEETING NOTE: This meeting focused on the scope of work and tasks, rather than follow this agenda. Continue these topics in Meeting 2]

FEMA Local Mitigation Plan Review Guide, October 1, 2011 edition

FEMA Local Mitigation Plan Review Guide, October 1, 2011 edition

Local Mitigation Plan Review Guide

October 1, 2011

FEMA

4.1 ELEMENT A: PLANNING PROCESS

Requirement §201.6(b)	An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:
§201.6(b)(1)	(1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;
§201.6(b)(2)	(2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and
§201.6(b)(3)	(3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.
§201.6(c)(1)	[The plan shall document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.
§201.6(c)(4)(i)	[The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.
§201.6(c)(4)(iii)	[The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.

Overall Intent. The planning process is as important as the plan itself. Any successful planning activity, such as developing a comprehensive plan or local land use plan, involves a cross-section of stakeholders and the public to reach consensus on desired outcomes or to resolve a community problem. The result is a common set of community values and widespread support for directing financial, technical, and human resources to an agreed upon course of action, usually identified in a plan. The same is true for mitigation planning. An effective and open planning process helps ensure that citizens understand risks and vulnerability, and they can work with the jurisdiction to support policies, actions, and tools that over the long-term will lead to a reduction in future losses.

Leadership, staffing, and in-house knowledge in local government may fluctuate over time. Therefore, the description of the planning process serves as a permanent record that explains how decisions were reached and who involved. FEMA will accept the planning process as defined by the community, as long as the mitigation plan includes a narrative

description of the process used to develop the mitigation plan—a systematic account about how the mitigation plan evolved from the formation of a planning team, to how the public participated, to how each section of the plan was developed, to what plans or studies were incorporated into the plan, to how it will be implemented. Documentation of a current planning process is required for both new and updated plans.

ELEMENT	REQUIREMENTS
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? ***44 CFR 201.6(c)(1)*** ***Intent****: To inform the public and other readers about the overall approach to the plan's development and serve as a permanent record of how decisions were made and who was involved. This record also is useful for the next plan update.*	a. Documentation of how the plan was prepared **must** include the schedule or timeframe and activities that made up the plan's development as well as who was involved. Documentation typically is met with a narrative description, but may also include, for example, other documentation such as copies of meeting minutes, sign-in sheets, or newspaper articles. ***Document*** *means provide the factual evidence for how the jurisdictions developed the plan.* b. The plan **must** list the jurisdiction(s) participating in the plan that seek approval. c. The plan **must** identify who represented each jurisdiction. The Plan **must** provide, at a minimum, the jurisdiction represented and the person's position or title and agency within the jurisdiction. d. For each jurisdiction seeking plan approval, the plan **must** document how they were involved in the planning process. For example, the plan may document meetings attended, data provided, or stakeholder and public involvement activities offered. Jurisdictions that adopt the plan without documenting how they participated in the planning process will not be approved. ***Involved in the process*** *means engaged as participants and given the chance to provide input to affect the plan's content.* This is more than simply being invited (*See "**opportunity to be involved in the planning process**"* in A2 below) or only adopting the plan. e. Plan updates **must** include documentation of the current planning process undertaken to update the plan.
A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? ***44 CFR 201.6(b)(2)***	a. The plan **must** identify all stakeholders involved or given an opportunity to be involved in the planning process. At a minimum, stakeholders **must** include: 1) Local and regional agencies involved in hazard mitigation activities; 2) Agencies that have the authority to regulate development; and 3) Neighboring communities. *An* ***opportunity to be involved in the planning process*** *means that the stakeholders are engaged or invited as participants and given the chance to provide input to affect the plan's content.*

ELEMENT	REQUIREMENTS
***Intent**: To demonstrate a deliberative planning process that involves stakeholders with the data and expertise needed to develop the plan, with responsibility or authority to implement hazard mitigation activities, and who will be most affected by the plan's outcomes.*	b. The Plan **must** provide the agency or organization represented and the person's position or title within the agency. c. The plan **must** identify how the stakeholders were invited to participate in the process. Examples of stakeholders include, but are not limited to: • Local and regional agencies involved in hazard mitigation include public works, zoning, emergency management, local floodplain administrators, special districts, and GIS departments. • Agencies that have the authority to regulate development include planning and community development departments, building officials, planning commissions, or other elected officials. • Neighboring communities include adjacent counties and municipalities, such as those that are affected by similar hazard events or may be partners in hazard mitigation and response activities. • Other interests may be defined by each jurisdiction and will vary with each one. These include, but are not limited to, business, academia, and other private and non-profit interests depending on the unique characteristics of the community.
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? ***44 CFR 201.6(b)(1) and 201.6(c)(1)*** ***Intent**: To ensure citizens understand what the community is doing on their behalf, and to provide a chance for input on community vulnerabilities and mitigation activities that will inform the plan's content. Public involvement is also an opportunity to educate the public about hazards and risks in the community, types of activities to mitigate those risks, and how these impact them.*	a. The plan **must** document how the public was given the opportunity to be involved in the planning process and how their feedback was incorporated into the plan. Examples include, but are not limited to, sign-in sheets from open meetings, interactive websites with drafts for public review and comment, questionnaires or surveys, or booths at popular community events. b. The opportunity for participation **must** occur during the plan development, which is prior to the comment period on the final plan and prior to the plan approval / adoption.

ELEMENT	REQUIREMENTS
A4. Does the Plan document the review and incorporation of existing plans, studies, reports, and technical information? ***44 CFR 201.6(b)(3)*** ***Intent****: To identify existing data and information, shared objectives, and past and ongoing activities that can help inform the mitigation plan. It also helps identify the existing capabilities and planning mechanisms to implement the mitigation strategy.*	a. The plan **must** document *what* existing plans, studies, reports, and technical information were reviewed. Examples of the types of existing sources reviewed include, but are not limited to, the state hazard mitigation plan, local comprehensive plans, hazard specific reports, and flood insurance studies. b. The plan **must** document *how* relevant information was incorporated into the mitigation plan. ***Incorporate*** *means to reference or include information from other existing sources to form the content of the mitigation plan.*
A5. Is there discussion on how the community(ies) will continue public participation in the plan maintenance process? ***44 CFR 201.6(c)(4)(iii)*** ***Intent****: To identify how the public will continue to have an opportunity to participate in the plan's maintenance and implementation over time.*	a. The plan **must** describe how the jurisdiction(s) will continue to seek public participation after the plan has been approved and during the plan's implementation, monitoring and evaluation. ***Participation*** *means engaged and given the chance to provide feedback.* Examples include, but are not limited to, periodic presentations on the plan's progress to elected officials, schools or other community groups, annual questionnaires or surveys, public meetings, postings on social media and interactive websites.
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? ***44 CFR 201.6(c)(4)(i)*** ***Intent****: To establish a process for jurisdictions to track the progress of the plan's implementation. This also serves as the basis of the next plan update.*	*a.* The plan **must** identify how, when, and by whom the plan will be monitored. ***Monitoring*** *means tracking the implementation of the plan over time. For example, monitoring may include a system for tracking the status of the identified hazard mitigation actions.* *b.* The plan **must** identify how, when, and by whom the plan will be evaluated. ***Evaluating*** *means assessing the effectiveness of the plan at achieving its stated purpose and goals.* *c.* The plan **must** identify how, when, and by whom the plan will be updated. ***Updating*** *means reviewing and revising the plan at least once every five years.* d. The plan **must** include the title of the individual or name of the department/ agency responsible for leading each of these efforts.

4.2 ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT

Requirement §201.6(c)(2)(i)	[The risk assessment shall include a] description of the type, location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.
§201.6(c)(2)(ii)	[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. All plans approved after October 1, 2008 must also address NFIP insured structures that have been repetitively damaged by floods. The plan should describe vulnerability in terms of:
§201.6(c)(2)(ii)(A)	(A) The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas;
§201.6(c)(2)(ii)(B)	(B) An estimate of the potential dollar losses to vulnerable structures identified in … this section and a description of the methodology used to prepare the estimate.
§201.6(c)(2)(ii)(C)	(C) Providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.
§201.6(c)(2)(iii)	For multi-jurisdictional plans, the risk assessment section must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

Overall Intent. The risk assessment provides the factual basis for activities proposed in the strategy that will reduce losses from identified hazards. A quality risk assessments makes a clear connection between the community's vulnerability and the hazard mitigation actions. In other words, it provides sufficient information to enable the jurisdiction(s) to identify and prioritize appropriate hazard mitigation actions.

Local risk assessments do not need to be based on the most sophisticated technology, but do need to be accurate, current, and relevant. During a plan update, local jurisdictions assess current and expected future vulnerability to all hazards and integrate new hazard data such as recent hazard events and new flood studies. In the mitigation plan review, FEMA looks at the quality of the information in the risk assessment, not the quantity of information in the risk assessment.

The Mitigation Planning regulation includes several "optional" requirements for the vulnerability assessment. These are easily recognizable with the use of the term "should" in the requirement (*See* §201.6(c)(2)(ii)(A-C)). Although not required, these are strongly recommended to be included in the plan. However, their absence will not cause FEMA to disapprove the plan. These "optional" requirements were originally intended to meet the overall vulnerability assessment, and this analysis can assist with identifying mitigation actions.

ELEMENT	REQUIREMENTS
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction? ***44 CFR 201.6(c)(2)(i) and 44 CFR 201.6(c)(2)(iii)*** ***Intent****: To understand the potential and chronic hazards affecting the planning area in order to identify which hazard risks are most significant and which jurisdictions or locations are most adversely affected.*	a. The plan **must** include a description of the natural hazards that can affect the jurisdiction(s) in the planning area. *A* ***natural hazard*** *is a source of harm or difficulty created by a meteorological, environmental, or geological event*[3]. The plan **must** address natural hazards. Manmade or human-caused hazards may be included in the document, but these are not required and will not be reviewed to meet the requirements for natural hazards. In addition, FEMA will not require the removal of this extra information prior to plan approval. b. The plan **must** provide the rationale for the omission of any natural hazards that are commonly recognized to affect the jurisdiction(s) in the planning area. c. The description, or profile, **must** include information on location, extent, previous occurrences, and future probability for each hazard. Previous occurrences and future probability are addressed in sub-element B2. The information does not necessarily need to be described or presented separately for location, extent, previous occurrences, and future probability. For example, for some hazards, one map with explanatory text could provide information on location, extent, and future probability. ***Location*** *means the geographic areas in the planning area that are affected by the hazard.* For many hazards, maps are the best way to illustrate location. However, location may be described in other formats. For example, if a geographically-specific location cannot be identified for a hazard, such as tornados, the plan may state that the entire planning area is equally at risk to that hazard. ***Extent*** *means the strength or magnitude of the hazard.* For example, extent could be described in terms of the specific measurement of an occurrence on a scientific scale (*for example*, Enhanced Fujita Scale, Saffir-Simpson Hurricane Scale, Richter Scale, flood depth grids) and/or other hazard factors, such as duration and speed of onset. Extent is not the same as impacts, which are described in sub-element B3.

[3] DHS Risk Lexicon, 2010 Edition. http://www.dhs.gov/xlibrary/assets/dhs-risk-lexicon-2010.pdf

ELEMENT	REQUIREMENTS
	d. For participating jurisdictions in a multi-jurisdictional plan, the plan **must** describe any hazards that are unique and/or varied from those affecting the overall planning area.
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? ***44 CFR 201.6(c)(2)(i)*** ***Intent****: To understand potential impacts to the community based on information on the hazard events that have occurred in the past and the likelihood they will occur in the future.*	a. The plan **must** include the history of previous hazard events for each of the identified hazards. b. The plan **must** include the probability of future events for each identified hazard. ***Probability*** *means the likelihood of the hazard occurring and may be defined in terms of general descriptors (for example, unlikely, likely, highly likely), historical frequencies, statistical probabilities (for example: 1% chance of occurrence in any given year), and/or hazard probability maps.* If general descriptors are used, then they **must** be defined in the plan. For example, "highly likely" could be defined as equals near 100% chance of occurrence next year or happens every year. c. Plan updates **must** include hazard events that have occurred since the last plan was developed.
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? ***44 CFR 201.6(c)(2)(ii)*** ***Intent****: For each jurisdiction to consider their community as a whole and analyze the potential impacts of future hazard events and the vulnerabilities that could be reduced through hazard mitigation actions.*	a. For each participating jurisdiction, the plan **must** describe the potential impacts of each of the identified hazards on the community. ***Impact*** *means the consequence or effect of the hazard on the community and its assets. Assets are determined by the community and include, for example, people, structures, facilities, systems, capabilities, and/or activities that have value to the community.* For example, impacts could be described by referencing historical disaster impacts and/or an estimate of potential future losses (such as percent damage of total exposure). b. The plan **must** provide an overall summary of each jurisdiction's vulnerability to the identified hazards. The overall summary of vulnerability identifies structures, systems, populations or other community assets as defined by the community that are susceptible to damage and loss from hazard events. A plan will meet this sub-element by addressing the requirements described in §201.6(c)(2)(ii)(A-C). Vulnerable assets and potential losses is more than a list of the total exposure of population, structures, and critical facilities in the planning area. An example of an overall summary is a list of key issues or problem statements that clearly describes the community's greatest vulnerabilities and that will be addressed in the mitigation strategy.

ELEMENT	REQUIREMENTS
B4. Does the Plan address NFIP insured structures within each jurisdiction that have been repetitively damaged by floods? *44 CFR 201.6(c)(2)(ii)* ***Intent**: To inform hazard mitigation actions for properties that have suffered repetitive damage due to flooding, particularly problem areas that may not be apparent on floodplain maps. Information on repetitive loss properties helps inform FEMA hazard mitigation assistance programs under the National Flood Insurance Act.*	a. The plan **must** describe the types (residential, commercial, institutional, etc.) and estimate the numbers of repetitive loss properties located in identified flood hazard areas. ***Repetitive loss properties** are those for which two or more losses of at least $1,000 each have been paid under the National Flood Insurance Program (NFIP) within any 10-year period since 1978.* ***Severe repetitive loss properties** are residential properties that have at least four NFIP payments over $5,000 each and the cumulative amount of such claims exceeds $20,000, or at least two separate claims payments with the cumulative amount exceeding the market value of the building.* Use of flood insurance claim and disaster assistance information is subject to The Privacy Act of 1974, as amended, which prohibits public release of the names of policy holders or recipients of financial assistance and the amount of the claim payment or assistance. However, maps showing general areas where claims have been paid can be made public. If a plan includes the names of policy holders or recipients of financial assistance and the amount of the claim payment or assistance, the plan cannot be approved until this Privacy Act covered information is removed from the plan.

4.3 ELEMENT C. MITIGATION STRATEGY

Requirement §201.6(c)(3)	[The plan shall include the following:] A *mitigation strategy* that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools.
§201.6(c)(3)(i)	[The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.
§201.6(c)(3)(ii)	[The hazard mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. All plans approved by FEMA after October 1, 2008, must also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.
§201.6(c)(3)(iii)	[The hazard mitigation strategy shall include an] action plan, describing how the action identified in paragraph (c)(3)(ii) of this section will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.
§201.6(c)(3)(iv)	For multi-jurisdictional plans, there must be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.
§201.6(c)(4)(ii)	[The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvements, when appropriate.

Overall Intent. The mitigation strategy serves as the long-term blueprint for reducing the potential losses identified in the risk assessment. The Stafford Act directs Local Mitigation Plans to describe hazard mitigation actions and establish a strategy to implement those actions.[4] Therefore, all other requirements for a Local Mitigation Plan lead to and support the mitigation strategy.

[4] Section 322(b), Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), as amended, 42 U.S.C. 5165.

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The mitigation strategy includes the development of goals and prioritized hazard mitigation actions. Goals are long-term policy statements and global visions that support the mitigation strategy. A critical step in the development of specific hazard mitigation actions and projects is assessing the community's existing authorities, policies, programs, and resources and its capability to use or modify local tools to reduce losses and vulnerability from profiled hazards.

In the plan update, goals and actions are either reaffirmed or updated based on current conditions, including the completion of hazard mitigation initiatives, an updated or new risk assessment, or changes in State or local priorities.

ELEMENT	REQUIREMENTS
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources, and its ability to expand on and improve these existing policies and programs? *44 CFR 201.6(c)(3)* ***Intent**: To ensure that each jurisdiction evaluates its capabilities to accomplish hazard mitigation actions, through existing mechanisms. This is especially useful for multi-jurisdictional plans where local capability varies widely.*	a. The plan **must** describe each jurisdiction's existing authorities, policies, programs and resources available to accomplish hazard mitigation. Examples include, but are not limited to: staff involved in local planning activities, public works, and emergency management; funding through taxing authority, and annual budgets; or regulatory authorities for comprehensive planning, building codes, and ordinances.
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? *44 CFR 201.6(c)(3)(ii)* ***Intent**: To demonstrate flood hazard mitigation efforts by the community through NFIP activities. Where FEMA is the official administering Federal agency of the NFIP, participation in the program is a basic community capability and resource for flood hazard mitigation activities.*	a. The plan **must** describe each jurisdiction's participation in the NFIP and describe their floodplain management program for continued compliance. Simply stating "The community will continue to comply with NFIP," will not meet this requirement. The description could include, but is not limited to: • Adoption and enforcement of floodplain management requirements, including regulating new construction in Special Flood Hazard Areas (SFHAs); • Floodplain identification and mapping, including any local requests for map updates; or • Description of community assistance and monitoring activities. Jurisdictions that are currently not participating in the NFIP and where an FHBM or FIRM has been issued may meet this requirement by describing the reasons why the community does not participate.

ELEMENT	REQUIREMENTS
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? *44 CFR 201.6(c)(3)(i)* ***Intent**: To guide the development and implementation of hazard mitigation actions for the community(ies). Goals are statements of the community's visions for the future.*	a. The plan **must** include general hazard mitigation goals that represent what the jurisdiction(s) seeks to accomplish through mitigation plan implementation. ***Goals** are broad policy statements that explain what is to be achieved.* b. The goals **must** be consistent with the hazards identified in the plan.
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? *44 CFR 201.6(c)(3)(ii) and 44 CFR 201.6(c)(3)(iv)* ***Intent**: To ensure the hazard mitigation actions are based on the identified hazard vulnerabilities, are within the capability of each jurisdiction, and reduce or avoid future losses. This is the heart of the mitigation plan, and is essential to leading communities to reduce their risk. Communities, not FEMA, "own" the hazard mitigation actions in the strategy.*	a. The plan **must** include a mitigation strategy that 1) analyzes actions and/or projects that the jurisdiction considered to reduce the impacts of hazards identified in the risk assessment, and 2) identifies the actions and/or projects that the jurisdiction intends to implement. ***Mitigation actions and projects** means a hazard mitigation action, activity or process (for example, adopting a building code) or it can be a physical project (for example, elevating structures or retrofitting critical infrastructure) designed to reduce or eliminate the long term risks from hazards.* This sub-element can be met with either actions or projects, or a combination of actions and projects. The mitigation plan may include non-mitigation actions, such as actions that are emergency response or operational preparedness in nature. These will not be accepted as hazard mitigation actions, but neither will FEMA require these to be removed from the plan prior to approval. *A **comprehensive range** consists of different hazard mitigation alternatives that address the vulnerabilities to the hazards that the jurisdiction(s) determine are most important.* b. Each jurisdiction participating in the plan **must** have mitigation actions specific to that jurisdiction that are based on the community's risk and vulnerabilities, as well as community priorities. c. The action plan **must** reduce risk to existing buildings and infrastructure as well as limit any risk to new development and redevelopment. ***With emphasis on new and existing building and infrastructure** means that the action plan includes a consideration of actions that address the built environment.*

ELEMENT	REQUIREMENTS
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? *44 CFR 201.6(c)(3)(iii) and 44 CFR (c)(3)(iv)* ***Intent***: *To identify how the plan will directly lead to implementation of the hazard mitigation actions. As opportunities arise for actions or projects to be implemented, the responsible entity will be able to take action towards completion of the activities.*	a. The plan **must** describe the criteria used for prioritizing implementation of the actions. b. The plan **must** demonstrate when prioritizing hazard mitigation actions that the local jurisdictions considered the benefits that would result from the hazard mitigation actions versus the cost of those actions. The requirement is met as long as the economic considerations are summarized in the plan as part of the community's analysis. A complete benefic-cost analysis is not required. Qualitative benefits (*for example*, quality of life, natural and beneficial values, or other "benefits") can also be included in how actions will be prioritized. c. The plan **must** identify the position, office, department, or agency responsible for implementing and administering the action (for each jurisdiction), and identify potential funding sources and expected timeframes for completion.
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? *44 CFR 201.6(c)(4)(ii)* ***Intent***: *To assist communities in capitalizing on all available mechanisms that they have at their disposal to accomplish hazard mitigation and reduce risk.*	a. The plan **must** describe the community's process to integrate the data, information, and hazard mitigation goals and actions into other planning mechanisms. b. The plan **must** identify the local planning mechanisms where hazard mitigation information and/or actions may be incorporated. ***Planning mechanisms*** *means governance structures that are used to manage local land use development and community decision-making, such as comprehensive plans, capital improvement plans, or other long-range plans.* c. A multi-jurisdictional plan **must** describe each participating jurisdiction's individual process for integrating hazard mitigation actions applicable to their community into other planning mechanisms. d. The updated plan **must** explain how the jurisdiction(s) incorporated the mitigation plan, when appropriate, into other planning mechanisms as a demonstration of progress in local hazard mitigation efforts. e. The updated plan **must** continue to describe how the mitigation strategy, including the goals and hazard mitigation actions will be incorporated into other planning mechanisms.

4.4 ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION *(Plan Updates Only)*

Requirement §201.6(d)(3)	A local jurisdiction must review and revise its plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities, and resubmit if for approval within 5 years in order to continue to be eligible for mitigation project grant funding.

Overall Intent. In order to continue to be an effective representation of the jurisdiction's overall strategy for reducing its risks from natural hazards, the mitigation plan must reflect current conditions. This will require an assessment of the current development patterns and development pressures as well as an evaluation of any new hazard or risk information. The plan update is an opportunity for the jurisdiction to assess its previous goals and action plan, evaluate progress in implementing hazard mitigation actions, and adjust its actions to address the current realities.

Where conditions of growth and revisions in priorities may have changed very little in a community, much of the text in the updated plan may be unchanged. This is acceptable as long as it still fits the priorities of their community, and it reflects current conditions. The key for plan readers to recognize a good plan update is documentation of the community's progress or changes in their hazard mitigation program, along with the community's continued engagement in the mitigation planning process.

ELEMENT	REQUIREMENTS
D1. Was the plan revised to reflect changes in development? *44 CFR 201.6(d)(3)* ***Intent****: To ensure that the mitigation strategy continues to address the risk and vulnerabilities to existing and potential development, and takes into consideration possible future conditions that can impact the vulnerability of the community.*	a. The plan **must** describe changes in development that have occurred in hazard prone areas and increased or decreased the vulnerability of each jurisdiction since the last plan was approved. If no changes in development impacted the jurisdiction's overall vulnerability, plan updates may validate the information in the previously approved plan. ***Changes in development*** means recent development (*for example*, construction completed since the last plan was approved), potential development (*for example*, development planned or under consideration by the jurisdiction), or conditions that may affect the risks and vulnerabilities of the jurisdictions (*for example*, climate variability, declining populations or projected increases in population, or foreclosures). Not all development will affect a jurisdiction's vulnerability.

ELEMENT	REQUIREMENTS
D2. Was the plan revised to reflect progress in local mitigation efforts? *44 CFR 201.6(d)(3)* ***Intent**: To evaluate and demonstrate progress made in the past five years in achieving goals and implementing actions outlined in their mitigation strategy.*	a. The plan **must** describe the status of hazard mitigation actions in the previous plan by identifying those that have been completed or not completed. For actions that have not been completed, the plan **must** either describe whether the action is no longer relevant or be included as part of the updated action plan.
D3. Was the plan revised to reflect changes in priorities? *44 CFR 201.6(d)(3)* ***Intent**: To ensure the plan reflects current conditions, including financial, legal, and political realities as well as post-disaster conditions.*	a. The plan **must** describe if and how any priorities changed since the plan was previously approved. If no changes in priorities are necessary, plan updates may validate the information in the previously approved plan.

4.5 ELEMENT E. PLAN ADOPTION

Requirement §201.6(c)(5)	[The plan shall include…] Documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County commissioner, Tribal Council). For multi-jurisdictional plans, each jurisdiction requesting approval of the plan must document that it has been formally adopted.

Overall Intent. Adoption by the local governing body demonstrates the jurisdiction's commitment to fulfilling the hazard mitigation goals and actions outlined in the plan. Adoption legitimizes the plan and authorizes responsible agencies to execute their responsibilities. Updated plans also are adopted anew to demonstrate community recognition of the current planning process, changes that have occurred within the previous five years, and validate community priorities for hazard mitigation actions.

ELEMENT	REQUIREMENTS
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? *44 CFR 201.6(c)(5)* ***Intent****: To demonstrate the jurisdiction's commitment to fulfilling the hazard mitigation goals outlined in the plan, and to authorize responsible agencies to execute their responsibilities.*	a. The plan **must** include documentation of plan adoption, usually a resolution by the governing body or other authority. If the local jurisdiction has not passed a formal resolution, or used some other documentation of adoption, the clerk or city attorney **must** provide written confirmation that the action meets their community's legal requirements for official adoption and/or the highest elected official or their designee **must** submit written proof of the adoption. The signature of one of these officials is required with the explanation or other proof of adoption. Minutes of a council or other meeting during which the plan is adopted will be sufficient if local law allows meeting records to be submitted as documentation of adoption. The clerk of the governing body, or city attorney, **must** provide a copy of the law and a brief, written explanation such as, "in accordance with section ___ of the city code/ordinance, this constitutes formal adoption of the measure," with an official signature. If adopted after FEMA review, adoption **must** take place within one calendar year of receipt of FEMA's "Approval Pending Adoption." See Section 5, *Plan Review Procedure* for more information on "Approvable Pending Adoption."

ELEMENT	REQUIREMENTS
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? *44 CFR 201.6(c)(5)* ***Intent**: To demonstrate the jurisdiction's commitment to fulfilling the hazard mitigation goals outlined in the plan, and to authorize responsible agencies to execute their responsibilities.*	a. Each jurisdiction that is included in the plan **must** have its governing body adopt the plan prior to FEMA approval, even when a regional agency has the authority to prepare such plans. As with single jurisdictional plans, in order for FEMA to give approval to a multi-jurisdictional plan, at least one participating jurisdiction **must** formally adopt the plan within one calendar year of FEMA's designation of the plan as "Approvable Pending Adoption." See Section 5, *Plan Review Procedure* for more information on "Approvable Pending Adoption."

Comments on Draft Hazard Mitigation Plan

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