Flood Risk Report

Plymouth County Coastal Flood Risk Project

Towns of Duxbury, Kingston, Marshfield, Norwell, Pembroke, Plymouth, and Scituate

Massachusetts

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Preface

The Department of Homeland Security (DHS), Federal Emergency Management Agency's (FEMA) Risk Mapping, Assessment, and Planning (Risk MAP) program provides states, tribes, and local communities with flood risk information and tools that they can use to increase their resilience to flooding and better protect their citizens. By pairing accurate floodplain maps with risk assessment tools and planning and outreach support, Risk MAP has transformed traditional flood mapping efforts into an integrated process of identifying, assessing, communicating, planning for, and mitigating flood-related risks.

This Flood Risk Report (FRR) provides non-regulatory information to help local or tribal officials, floodplain managers, planners, emergency managers, and others better understand their flood risk, take steps to mitigate those risks, and communicate those risks to their citizens and local businesses.

Flood risk is always changing, and there may be other studies, reports, or sources of information available that provide more comprehensive information. The FRR is not intended to be regulatory or the final authoritative source of all flood risk data in the project area. Rather, it should be used in conjunction with other data sources to provide a comprehensive picture of flood risk within the project area.

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FLOOD RISK REPORT

1 Introduction

1.1 About Flood Risk

Floods are naturally occurring phenomena that can and do happen almost anywhere. In its most basic form, a flood is an accumulation of water over normally dry areas. Floods become hazardous to people and property when they inundate an area where development has occurred, causing losses. Mild flood losses may have little impact on people or property, such as damage to landscaping or the generation of unwanted debris. Severe flooding can destroy buildings, ruin crops, and cause critical injuries or death.

Flooding is a natural part of our world and our communities. Flooding becomes a significant hazard, however, when it intersects with the built environment.

1.1.1 Calculating Flood Risk

It is not enough to simply identify where flooding may occur. Just because one knows where a flood occurs does not mean they know the **risk** of flooding. The most common method for determining flood risk, also referred to as vulnerability, is to identify the probability of flooding and the consequences of flooding. In other words:

Flood Risk (or Vulnerability) **= Probability x Consequences**; where
Probability = the likelihood of occurrence
Consequences = the estimated impacts associated with the occurrence

Which picture below shows more flood risk?

The probability of a flood is the likelihood that a flood will occur. The probability of flooding can change based on physical, environmental, and/or contributing engineering factors. Factors affecting the probability that a flood will impact an area range from changing weather patterns to the existence of mitigation projects. The ability to assess the probability of a flood and the level of accuracy for that assessment are also influenced by modeling methodology advancements, better knowledge, and longer periods of record for the water body in question.

The consequences of a flood are the estimated impacts associated with the flood occurrence. Consequences relate to human activities within an area and how a flood impacts the natural and built environments.

Even if you assume that the flood in both pictures was the same probability—let's say a 10-percent- annual-chance flood—the consequences in terms of property damage and potential injury as a result of the flood in the bottom picture are much more severe. Therefore, the flood risk in the area shown in the bottom picture is higher.

1.1.2 Risk MAP Flood Risk Products

Through Risk MAP, FEMA provides coastal communities with updated Flood Insurance Rate Maps (FIRMs) and Flood Insurance Studies (FISs) that focus on the probability of floods and that show where flooding

and significant wave action may occur as well as the calculated 1% annual chance flood elevation. The 1% annual chance flood, also known as the base flood, has a 1% chance of being equaled or exceeded in any given year. FEMA understands that flood risk is dynamic—that flooding does not stop at a line on a map—and as such, provides the following flood risk products:

- Flood Risk Report (FRR): The FRR presents key risk analysis data for the Flood Risk Project.
- Flood Risk Database (FRD): The FRD is in GIS format and houses the flood risk data developed during the course of the flood risk analysis that can be used and updated by the community. After the Flood Risk Project is complete, this data can be used in many ways to visualize and communicate flood risk within the Flood Risk Project.

Whether or not an area might flood is one consideration. The extent to which it might flood adds a necessary dimension to that understanding.

These Flood Risk Products provide flood risk information at the community level (for those portions of each community within the Flood Risk Project). Community-level information is particularly useful for mitigation planning and emergency management activities, which often occur at a jurisdictional level.

1.2 Uses of this Report

The goal of this report is to help inform and enable communities and tribes to take action to reduce flood risk. Possible users of this report include:

- Local elected officials
- Floodplain managers
- Community planners
- Emergency managers
- Public works officials
- Other special interests (e.g., coastal conservation groups, environmental awareness organizations, etc.)

Vulnerability of infrastructure is another important consideration.

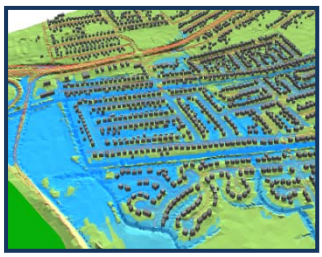
State, local, and tribal officials can use the summary information provided in this report, in conjunction with the data in the FRD, to:

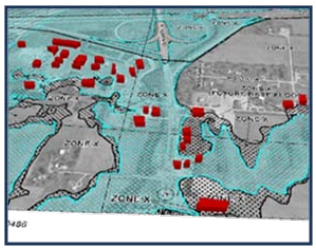
- **Update local hazard mitigation plans.** As required by the 2000 Federal Stafford Act, local hazard mitigation plans must be updated at least every five (5) years. Summary information presented in Section 3 of this report can be used to identify areas that may need additional focus when updating the risk assessment section of a local hazard mitigation plan. Information found in Section 4 pertains to the different mitigation techniques and programs and can be used to inform decisions related to the mitigation strategy of local plans.
- **Update community comprehensive plans.** Planners can use flood risk information in the development and/or update of comprehensive plans, future land use maps, and zoning regulations. For example, zoning codes may be changed to better provide for appropriate land uses in high-hazard areas.

- **Update emergency operations and response plans.** Emergency managers can identify low-risk areas for potential evacuation and sheltering and can help first responders avoid areas of high-depth flood water. Risk assessment results may reveal vulnerable areas, facilities, and infrastructure for which planning for continuity of operations plans (COOP), continuity of government (COG) plans, and emergency operations plans (EOP) would be essential.
- **Develop hazard mitigation projects.** Local officials (e.g., planners and public works officials) can use flood risk information to re-evaluate and prioritize mitigation actions in local hazard mitigation plans.
- **Communicate flood risk.** Local officials can use the information in this report to communicate with property owners, business owners, and other citizens about flood risks, changes since the last FIRM, and areas of mitigation interest. The report layout allows community information to be extracted in a fact sheet format.
- **Inform the modification of development standards.** Floodplain managers, planners, and public works officials can use information in this report to support the adjustment of development standards for certain locations. For example, structures built in areas with a moderate wave hazard could benefit from the same building standards as those built in high wave hazard areas.

Buildings with foundations that withstand wave action are more likely to survive coastal flooding.

The Flood Risk Database and Flood Risk Report are "non-regulatory" products. They are available and intended for community use but are neither mandatory nor tied to the regulatory development and insurance requirements of the National Flood Insurance Program (NFIP). They may be used as regulatory products by communities if authorized by state and local enabling authorities.





FEMA data can be leveraged to identify and measure vulnerability by including local building information (i.e. building type). The examples above show various ways to display flooding intersecting with buildings.

1.3 Sources of Flood Risk Assessment Data Used

To assess potential community losses, or the consequences portion of the "risk" equation, the following data is typically collected for analysis and inclusion in a Flood Risk Project:

- Information about local assets or resources at risk of flooding
- Information about the physical features and human activities that contribute to that risk
- Information about where the risk is most severe

For most Flood Risk Projects, FEMA uses the following sources of flood risk information to develop this report:

- Hazus estimated flood loss information
- New engineering analyses (e.g., coastal storm surge and wave modeling) to develop new flood elevations and boundaries
- Locally supplied data (see Section 7 for a description)
- Sources identified during the Discovery process

1.4 Related Resources

For a more comprehensive picture of flood risk, FEMA recommends that state and local officials use the information provided in this report in conjunction with other sources of flood risk data, such as those listed below.

- **FIRMs and FISs.** This information indicates areas with specific flood hazards by identifying the limit and extent of the 1-percent-annual-chance floodplain, the 0.2-percent-annual-chance floodplain, Primary Frontal Dunes, and wave hazards (VE Zones and the Limit of Moderate Wave Action (LiMWA)). FIRMs and FIS Reports do not necessarily identify all floodplains in a Flood Risk Project. The FIS Report includes summary information regarding other frequencies of stillwater (storm surge) flooding. In rural areas and areas for which flood hazard data are not available, the 1-percent-annual-chance floodplain may not be identified.
- **Hazus Flood Loss Estimation Reports.** Hazus can be used to generate reports, maps and tables on potential flood damage that can occur based on new/proposed mitigation projects or future development patterns and practices. Hazus can also run specialized risk assessments, such as what happens when a dam or levee fails. Flood risk assessment tools are available through other agencies as well, including the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Army Corps of Engineers (USACE). Other existing coastal or watershed reports may have a different focus, such as water quality, but may also contain flood risk and risk assessment information. See Section 6 for additional resources.
- **Flood or multi-hazard mitigation plans.** Local hazard mitigation plans include risk assessments that contain flood risk information and mitigation strategies that identify community priorities and actions to reduce flood risk. This report was informed by any existing mitigation plans in the Flood Risk Project.
- **Hurricane Evacuation Studies.** Produced through a joint effort by FEMA, NOAA, and USACE, Hurricane Evacuation Studies provide tools and information to the state and county emergency management offices to help determine who should evacuate during hurricane threats, and when those evacuations should occur. The information can be used to supplement or update hurricane evacuation plans and operational procedures for responding to hurricane threats.
- **Tsunami Inundation Maps.** Maps depicting tsunami inundation hazard zones are produced for coastal areas exposed to tsunami threats, typically those on with Pacific Ocean coasts. The mapping is accomplished through efforts coordinated by FEMA, NOAA, the U.S. Geological Survey (USGS), USACE, and numerous state and local agencies. The maps can be used by communities to supplement or update emergency management and evacuation plans.
- **FEMA Map Service Center (MSC).** The MSC has useful information, including fly sheets, phone numbers, data, etc. Letters of Map Change are also available through the MSC. The user can view FIRM databases and the National Flood Hazard Layer (NFHL) Database.

2 Flood Risk Analysis

2.1 Overview

Flood hazard identification uses FIRMs and FIS Reports to identify where flooding can occur along with the probability and depth of that flooding. Flood risk assessment is the systematic approach to identifying how flooding impacts the environment. In hazard mitigation planning, flood risk assessments serve as the basis for mitigation strategies and actions by defining the hazard and enabling informed decision making. Fully assessing flood risk requires the following:

- Identifying the flooding source and determining the flood hazard occurrence probability
- Developing a complete profile of the flood hazard including historical occurrence and previous impacts
- Inventorying assets located in the identified flood hazard area
- Estimating potential future flood losses caused by exposure to the flood hazard area

Flooding impacts non-populated areas too, such as agricultural lands and wildlife habitats.

Flood risk analyses are different methods used in flood risk assessment to help quantify and communicate flood risk. Coastal flood risk analysis can be performed on a large scale (state, county) level and on a very small scale (parcel, census block). Advantages of large-scale coastal flood risk analysis, especially at county level, include identifying how actions and development in one community can affect surge and wave propagation of adjacent coastal areas. On the parcel or census block level, flood risk analysis can provide actionable data to individual property owners so they can take appropriate mitigation steps.

2.2 Analysis of Risk

The FRR and FRD contain a variety of flood risk analysis information to help describe and visualize flood risk within the coastal study area. Depending on the scope of the Flood Risk Project for this project area, this information may include some or all of the following elements:

- Changes Since Last FIRM
- Coastal Wave Height Grids
- Coastal Flood Risk Assessments

State and Local Hazard Mitigation Plans are required to have a comprehensive all-hazard risk assessment. The flood risk analyses in the FRR and FRD can inform the flood hazard portion of a community's or state's risk assessment. Further, data in the FRD can be used to develop information that meets the requirements for risk assessments as it relates to the hazard of flood in hazard mitigation plans.

2.2.1 Changes Since Last FIRM

The Changes Since Last FIRM (CSLF) dataset, stored in the FRD and shown in Section 3 of this report, illustrates where changes to flood risk may have occurred since the last FIRM was published for the subject area. Communities can use this information to update their mitigation plans, specifically quantifying "what is at risk" and identifying possible mitigation activities.

The CSLF dataset identifies changes in the Special Flood Hazard Area (SFHA) and floodway boundary changes since the previous FIRM was developed. These datasets quantify land area increases and decreases to the SFHA and floodway, as well as areas where the flood zone designation has changed (e.g., Zone A to AE, AE to VE, shaded Zone X protected by levee to AE for de-accredited levees).

CSLF data can be used to communicate changes in the physical flood hazard area (size, location) as part of the release of new FIRMs. It can also be used in the development or update of hazard mitigation plans to describe changes in hazard as part of the hazard profile.

CSLF data is shown in the FRR, and underlying data is stored in the FRD.

The CSLF dataset is created in areas that were previously mapped using digital FIRMs. The CSLF dataset for this project area includes:

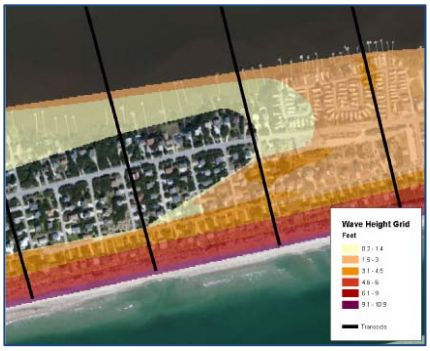
- Floodplain and/or Zone Break Boundary Changes: Any changes to the existing floodplain or zone boundaries are depicted in this dataset
- Floodplain Designation Changes: This includes changed floodplain designations (e.g., Zone AE to Zone VE).
- CSLF Information: Within this dataset additional information is provided to help explain the floodplain boundary changes shown on the FIRM. This information is stored as digital attributes within the CSLF polygons and may include some or all of the following:
  - Changes in 1% stillwater elevation (SWEL)
  - Changes in computed wave setup elevation
  - Changes to the modeling methodology (e.g., storm surge modeling)
  - New shore-protection structures (e.g., seawall, revetment etc.)

It should be noted that reasons for the changes in the coastal SFHAs (also known as Contributing Engineering Factors) are intended to give the user a general sense of what caused the change, as opposed to providing a reason for each and every area of change.

2.2.2 Flood Depth and Analysis Grids

Grids are FEMA datasets provided in the FRD to better describe the risk of the flood hazard. While the FIRM and FIS Report describe "what" is at risk by identifying the hazard areas, water surface, flood depth, and analysis grids can help define "how bad" the risk is within those identified areas. These grids are intended to be used by communities for additional analysis, enhanced visualization, and communication of flood risks for hazard mitigation planning and emergency management. The Flood Depth and Analysis Grids provide an alternative way to visualize how a particular flood characteristic (depth, wave heights, etc.) vary within the floodplain. Since they are derived from the engineering modeling results, they are typically associated with a particular frequency-based flooding event (e.g., 1% annual chance event). Grids provided in the FRD for Plymouth County include the following:

- **Coastal Wave Height Grid:** This dataset represents the controlling wave height for a given flood frequency. It depicts the exposure to the wave hazard component of coastal flooding. This raster reflects the controlling wave height typically computed along transects by the Wave Height Analysis for Flood Insurance Studies (WHAFIS) model for the 1-percent-annual-change (base) flood. Wave impacts are known to be a significant cause of damage to structures in the coastal zone.



2.2.3 Estimated Flood Loss Information

Flood loss estimates provided in the FRR were developed using a FEMA flood loss estimation tool, Hazus. Originally developed for earthquake risk assessment, Hazus has evolved into a multi-hazard tool developed and distributed by FEMA that can provide loss estimates for floods, earthquakes, and hurricane winds. Hazus is a nationally accepted, consistent flood risk assessment tool to assist individuals and communities to create a more accurate picture of flood risk. Some benefits of using Hazus include the following:

- Outputs that can enhance state and local mitigation plans and help screen for cost-effectiveness in FEMA mitigation grant programs
- Analysis refinement through updating inventory data and integrating data produced using other flood models
- Widely available support documents and networks (Hazus Users Groups)

Files from the FRD can be imported into Hazus to develop other risk assessment information including:

- Debris generated after a flood event
- Dollar loss of the agricultural products in a study region
- Utility system damages in the region
- Vehicle loss in the study region
- Damages and functionality of lifelines such as highway and rail bridges, potable water, and wastewater facilities

Scenario-Based Flood Loss Estimates:

Scenario-based flood losses have been calculated using Hazus for the 1-percent-annual-chance flood events. In this report, these losses are expressed in dollar amounts and are provided for the Flood Risk Project area only, even though results are shown for the entire watershed and at the local jurisdiction level.

Loss estimates are based on best available data, and the methodologies applied result in an approximation of risk. These estimates should be used to understand relative risk from flood and potential losses. Uncertainties are inherent in any loss estimation methodology, arising in part from approximations and simplifications that are necessary for a comprehensive analysis (e.g., incomplete inventories, demographics, or economic parameters).

Flood loss estimates are being provided at the project and community levels for multiple flood frequencies including:

- **Residential Asset Loss**: These include direct building losses (estimated costs to repair or replace the damage caused to the building) for all classes of residential structures including single family, multi-family, manufactured housing, group housing, and nursing homes. This value also includes content losses.
- **Commercial Asset Loss**: These include direct building losses for all classes of commercial buildings including retail, wholesale, repair, professional services, banks, hospitals, entertainment, and parking facilities. This value also includes content and inventory losses.
- **Other Asset Loss**: This includes losses for facilities categorized as industrial, agricultural, religious, government, and educational. This value also includes content and inventory losses.
- **Essential Facility Losses:** Essential facilities are defined in Hazus as facilities which provide services to the community and should be functional after a flood, including schools, police stations, fire stations, medical facilities, and emergency operation centers. These facilities would otherwise be considered critical facilities for mitigation planning purposes. Estimated damages (in terms of loss of function) for essential facilities are determined on a site-specific basis according to latitude and longitude. For this report, Hazus calculates the types and numbers of essential facilities impacted.

Hazus-estimated loss data can be used in many ways to support local decision making and explanation of flood risk. For mitigation planning purposes, loss data can be used to help meet requirements to develop loss information for the hazard of flood. For emergency management, Hazus data can help forecast losses based on predicted events, and resources can be assigned accordingly. Loss information can support floodplain management efforts, including those to adopt higher regulatory standards. *Also, awareness of exposed essential facilities and infrastructure encourages mitigation actions to protect citizens from service disruption should flooding occur*.

Hazus estimated loss data is summarized in the FRR and stored in the FRD.

- **Infrastructure:** For analysis of infrastructure, Hazus supports the analysis of transportation systems and lifeline utility systems. Transportation systems include highways, railways, light railways, busses, ports and harbors, ferries, and airport systems. Utility systems include potable water systems, wastewater, oil, natural gas, electric power, and communication systems. For this report, Hazus calculates the types of infrastructure impacted.
- **Business Disruption**: This includes the losses associated with the inability to operate a business due to the damage sustained during the flood. Losses include inventory, income, rental income, wage, and direct output losses, as well as relocation costs.
- **Annualized Losses**: Annualized losses are calculated using Hazus by taking losses from multiple events over different frequencies and expressing the long-term average by year. This factors in historic patterns of frequent smaller floods with infrequent but larger events to provide a balanced presentation of flood damage.
- **Loss Ratio:** The loss ratio expresses the scenario losses divided by the total building value for a local jurisdiction and can be a gage to determine overall community resilience as a result of a scenario event. For example, a loss ratio of 5 percent for a given scenario would indicate that a

local jurisdiction would be more resilient and recover more easily from a given event, versus a loss ratio of 75 percent which would indicate widespread losses. An annualized loss ratio uses the annualized loss data as a basis for computing the ratio. Loss ratios are not computed for business disruption. These data are presented in the FRR.

3 Flood Risk Analysis Results

The following pages provide summary flood risk results for the Flood Risk Project as follows:

- **Flood Risk Project Summary.** Within the Flood Risk Project area, summary data for some or all of the following datasets are provided for the entire project area and also on a jurisdiction by jurisdiction basis:
  - **Changes Since Last FIRM (CSLF).** This is a summary of where the floodplain and flood zones have increased or decreased (only analyzed for areas that were previously mapped using digital FIRMs).
  - **Wave Height Analysis Grids.** A general discussion of the data provided in the FRD.
  - **Flood Risk Assessment Information.** A loss estimation of potential flood damages using different flood scenarios.

3.1 Plymouth County, MA Coastal Flood Risk Project Area Summary

The Plymouth County Coastal Flood Risk Project area is located along the eastern coastline of Massachusetts. The coastal study area includes the Towns of Plymouth, Kingston, Duxbury, Pembroke, Marshfield, Norwell and Scituate. The Town of Pembroke has no special flood hazard areas within the Coastal Flood Risk Project area. No detailed data for this community will be provided in this report.

3.1.1 Overview

The Plymouth County Coastal Flood Risk Project area includes the following communities:

Community Name	CID	Total Community Population	Percent of Population in Project Area	Total Community Land Area (sq mi)	Percent of Land Area in Project Area	NFIP	CRS Rating	Mitigation Plan
Town of Plymouth	*250278*	*56,456*	*46.9%*	*110.4*	*31.1%*	*Y*	*9*	*Expired*
Town of Kingston	*250270*	*12,627*	*48.3%*	*20.5*	*42.9%*	*Y*	*N/A*	*Expired*
Town of Duxbury	*250263*	*14,979*	*66.5%*	*33.4*	*76.9%*	*Y*	*N/A*	*Expired*
Town of Pembroke	*250277*	*1,383*	*0%*	*23.5*	*0%*	*Y*	*N/A*	*Expired*
Town of Marshfield	*250273*	*25,124*	*91.7%*	*29.7*	*93.5*	*Y*	*8*	*Y*
Town of Norwell	*250276*	*10,423*	*11.8%*	*20.3*	*10.7%*	*Y*	*N/A*	*Expired*
Town of Scituate	*250282*	*18,132*	*100%*	*21.9*	*21.9%*	*Y*	*8*	*Y*

Community-specific results are provided on subsequent pages. Data provided below and on subsequent pages only includes areas located within the Plymouth County Flood Risk Project and do not necessarily represent community-wide totals.

Section 2 of the Flood Risk Report (FRR) provides more information regarding the source and methodology used to develop the information presented below. Datasets used toward the generation of results of this project are described in Section 7 of the FRR and are found in the Flood Risk Database (FRD).

3.1.2 Flood Risk Datasets

As a part of this Flood Risk Project, flood risk datasets were created for inclusion in the Flood Risk Database. Those datasets are summarized for this Flood Risk Project below:

- **Changes Since Last FIRM**
    - Special Flood Hazard Area (SFHA) boundaries and flood risk zones within this Flood Risk Project area were updated due to new engineering analysis that was performed. The updated modeling produced new flood zone areas and new base flood elevations in some areas and leveraged recently developed LiDAR-based topographic data for the Flood Risk Project. The data in this section reflects the comparison between the effective FIRM and the new analysis in this study.

The table below summarizes the increases, decreases, and net change of SFHAs and Coastal High Hazard Areas (CHHAs) for the project area.

Area of Study	Total Area (mi^2)	Increase (mi^2)	Decrease (mi^2)	Net Change (mi^2)
Within SFHA	***54.1***	***3.0***	***0.8***	***2.2***
Within CHHA (Zone VE or V)	***28.0***	***4.1***	***0.7***	***3.4***

Section 2 of the FRR provides more information regarding the source and methodology used to develop this table.

Evidence of actual flood losses can be one of the most compelling factors for increasing a community's flood risk awareness. FEMA encourages the communities within the project area to continue working with the State Hazard Mitigation Officer to further identify and mitigate these high-risk areas and structures.

- **Coastal Wave Height Grids**

    The FRD contains datasets in the form of wave height grids for the entire Flood Risk Project that can be used for additional analysis, enhanced visualization, and communication of flood risks for hazard mitigation planning and emergency management. The data provided within the FRD should be used to further isolate areas where flood mitigation potential is high and may be helpful in planning and implementing mitigation strategies. Properties located in areas expected to experience some depth of water or waves should seriously consider mitigation options for implementation. Section 2 of the FRR provides both general and specific information regarding the development of and potential uses for this data.

Coastal Wave Hazard Severity	*Total Area (mi^2)*
High	***29.5***
Moderate	***3.3***
Minimal	***9.8***

- **Flood Risk Results Information**
  - Plymouth County's flood risk analysis incorporates results from a FEMA-performed Hazus analysis which accounts for newly modeled areas in the Flood Risk Project and newly modeled depths for certain flood events. Potential losses were estimated as well as potential loss ratios. Additional information and data layers provided within the FRD should be used to further analyze potential losses and areas where they are likely to occur.

			Estimated Potential Losses	
	Total Inventory		1% (100-yr)	
	Estimated Value	% of Total	Dollar Losses[1]	Loss Ratio[2]
Residential Building and Contents Losses	$10,826,000,000	76%	$792,200,000	7%
Commercial Building and Contents Losses	$2,607,800,000	18%	$166,000,000	6%
Other Building and Contents Losses	$890,600,000	6%	$55,800,000	6%
Total Building and Contents Losses	$14,324,000,000	100%	$1,014,200,000	7%
Business Disruption	N/A	N/A	$7,200,000	N/A
TOTAL	$14,324,000,000	N/A	$1,021,400,000	N/A

Source: Hazus analysis results stored as the Flood Risk Assessment Dataset in the Flood Risk Database.
[1]Losses shown are rounded to nearest $10,000 for values under $100,000 and to the nearest $100,000 for values over $100,000.
[2]Loss ratio = Dollar Losses ÷ Estimated Value. Loss Ratios are rounded to the nearest integer percent.
[3]Total Building and Contents Losses = Residential Building and Contents Losses + Commercial Building and Contents Losses + Other Building and Contents Losses.
[4]Business Disruption = Inventory Loss + Relocation Cost + Income Loss + Rental Income Loss + Wage Loss + Direct Output Loss.
[5]Total Loss = Total Building and Contents Losses + Business Disruption

3.2 Communities

The following sections provide an overview of the community's floodplain management program as of the date of this publication, as well as summarize the flood risk analysis performed for this project. The Town of Pemborke is shown on the revised floodplain maps as an adjacent community, but is not affected by flooding. Consequently it is not included in this section of the report.

3.2.1 Town of Plymouth

The following pages include Flood Risk data for the Town of Plymouth.

3.2.1.1 Overview

The Town of Plymouth is the largest of the six towns within Plymouth County detailed in this report. The information below provides an overview of the community's floodplain management program information as of the date of this publication.

Community Name	CID	Total Community Population	Percent of Population in Project Area	Total Community Land Area (sq mi)	Percent of Land Area in Project Area	NFIP	CRS Rating	Mitigation Plan
Town of Plymouth	***250278***	***56,456***	***46.9%***	***110.4***	***31.1%***	***Y***	***9***	***Y***

- Multi-Hazard Mitigation Plan has expired
- Past Federal Disaster Declarations for flooding = 17
- National Flood Insurance Program (NFIP) policy coverage (policies/value) = 446 policies totaling approximately $101,955,500
- NFIP-recognized repetitive loss properties = 99

Data provided below only includes areas within the Town of Plymouth that area located within the Plymouth County Flood Risk Project, and do not necessarily represent community-wide totals. Section 2 of the Flood Risk Report (FRR) provides more information regarding the source and methodology used to develop the information presented below. Datasets used toward the generation of results of this project are described in Section 7 of the FRR and are found in the Flood Risk Database (FRD).

3.2.1.2 Community Analyses and Results

- **Changes Since Last FIRM**
  - Special Flood Hazard Area (SFHA) boundaries along Cape Cod Bay within the Town of Plymouth were updated due to the effects of the new coastal analysis that was performed. The updated modeling produced new flood zone areas and new base flood elevations and utilized LiDAR-based topographic data that was collected as part of the Flood Risk Project. The data in this section reflects the comparison between the effective FIRM and the new analysis in this study.

The table below summarizes the increases, decreases, and net change of SFHAs for the community.

Area of Study	Total Area (mi^2)	Increase (mi^2)	Decrease (mi^2)	Net Change (mi^2)
Within SFHA	***19.3***	***0.3***	***0.1***	***0.2***
Within CHHA (Zone VE or V)	***14.8***	***0.8***	***0.2***	***0.6***

Section 2 of the FRR provides more information regarding the source and methodology used to develop this table.

Evidence of actual flood losses can be one of the most compelling factors for increasing a community's flood risk awareness. FEMA encourages the communities within the project area to continue working with the State Hazard Mitigation Officer to further identify and mitigate these high-risk areas and structures.

- **Coastal Wave Height Grids**

  The FRD contains datasets in the form of wave height grids for the entire Flood Risk Project that can be used for additional analysis, enhanced visualization, and communication of flood risks for hazard mitigation planning and emergency management. The data provided within the FRD should be used to further isolate areas where flood mitigation potential is high and may be helpful in planning and implementing mitigation strategies. Properties located in areas expected to experience some depth of water or waves should seriously consider mitigation options for implementation. Section 2 of the FRR provides both general and specific information regarding the development of and potential uses for this data.

Coastal Wave Hazard Severity	*Total Area (mi^2)*
High	***8.3***
Moderate	***0.3***
Minimal	***1.0***

- **Flood Risk Results Information**

  Plymouth County's flood risk analysis incorporates results from a FEMA-performed Hazus analysis which accounts for newly modeled areas in the Flood Risk Project and newly modeled depths for certain flood events. Potential losses were estimated as well as potential loss ratios. Additional information and data layers provided within the FRD should be used to further analyze potential losses and areas where they are likely to occur.

	Total Inventory		Estimated Potential Losses 1% (100-yr)	
	Estimated Value	% of Total	Dollar Losses[1]	Loss Ratio[2]
Residential Building and Contents Losses	$3,233,200,000	71%	$68,400,000	2%
Commercial Building and Contents Losses	$1,027,000,000	23%	$19,900,000	2%
Other Building and Contents Losses	$282,800,000	6%	$5,400,000	2%
Total Building and Contents Losses	$4,543,100,000	100%	$93,700,000	2%
Business Disruption	N/A	N/A	$700,000	N/A
TOTAL	$4,543,100,000	N/A	$94,400,000	N/A

Source: Hazus analysis results stored as the Flood Risk Assessment Dataset in the Flood Risk Database.

[1]Losses shown are rounded to nearest $10,000 for values under $100,000 and to the nearest $100,000 for values over $100,000.

[2]Loss ratio = Dollar Losses ÷ Estimated Value. Loss Ratios are rounded to the nearest integer percent.

[3]Total Building and Contents Losses = Residential Building and Contents Losses + Commercial Building and Contents Losses + Other Building and Contents Losses.

[4]Business Disruption = Inventory Loss + Relocation Cost + Income Loss + Rental Income Loss + Wage Loss + Direct Output Loss.

[5]Total Loss = Total Building and Contents Losses + Business Disruption

3.2.2 Town of Kingston

The following pages include Flood Risk data for the Town of Kingston.

3.2.2.1 Overview

The Town of Kingston is within Plymouth County along the shoreline of Kingston Bay. The information below provides an overview of the community's floodplain management program information as of the date of this publication.

Community Name	CID	Total Community Population	Percent of Population in Project Area	Total Community Land Area (sq mi)	Percent of Land Area in Project Area	NFIP	CRS Rating	Mitigation Plan
Town of Kingston	250270	12,627	48.3%	20.5	42.9%	Y	N/A	Y

- Multi-Hazard Mitigation Plan has expired
- Past Federal Disaster Declarations for flooding = 17
- National Flood Insurance Program (NFIP) policy coverage (policies/value) = 75 policies totaling approximately $22,303,800
- NFIP-recognized repetitive loss properties = 0

Data provided below only includes areas within the Town of Kingston that area located within the Plymouth County Flood Risk Project, and do not necessarily represent community-wide totals. Section 2 of the Flood Risk Report (FRR) provides more information regarding the source and methodology used to develop the information presented below. Datasets used toward the generation of results of this project are described in Section 7 of the FRR and are found in the Flood Risk Database (FRD).

3.2.2.2 Community Analyses and Results

- **Changes Since Last FIRM**
  - Special Flood Hazard Area (SFHA) boundaries along Cape Cod Bay within the Town of Kingston were updated due to the effects of the new coastal analysis that was performed. The updated modeling produced new flood zone areas and new base flood elevations and utilized LiDAR-based topographic data that was collected as part of the Flood Risk Project. The data in this section reflects the comparison between the effective FIRM and the new analysis in this study.

The table below summarizes the increases, decreases, and net change of SFHAs for the community.

Area of Study	Total Area (mi^2)	Increase (mi^2)	Decrease (mi^2)	Net Change (mi^2)
Within SFHA	***2.8***	***0.1***	***0.1***	***0.0***
Within CHHA (Zone VE or V)	***1.4***	***0.1***	***0.1***	***0.0***

Section 2 of the FRR provides more information regarding the source and methodology used to develop this table.

- Evidence of actual flood losses can be one of the most compelling factors for increasing a community's flood risk awareness. FEMA encourages the communities within the project area to continue working with the State Hazard Mitigation Officer to further identify and mitigate these high-risk areas and structures.

- **Coastal Wave Height Grids**

  The FRD contains datasets in the form of wave height grids for the entire Flood Risk Project that can be used for additional analysis, enhanced visualization, and communication of flood risks for hazard mitigation planning and emergency management. The data provided within the FRD should be used to further isolate areas where flood mitigation potential is high and may be helpful in planning and implementing mitigation strategies. Properties located in areas expected to experience some depth of water or waves should seriously consider mitigation options for implementation. Section 2 of the FRR provides both general and specific information regarding the development of and potential uses for this data.

Coastal Wave Hazard Severity	*Total Area (mi^2)*
High	***1.5***
Moderate	***0.0***
Minimal	***0.4***

- **Flood Risk Results Information**

  Plymouth County's flood risk analysis incorporates results from a FEMA-performed Hazus analysis which accounts for newly modeled areas in the Flood Risk Project and newly modeled depths for certain flood events. Potential losses were estimated as well as potential loss ratios. Additional information and data layers provided within the FRD should be used to further analyze potential losses and areas where they are likely to occur.

	Total Inventory		Estimated Potential Losses 1% (100-yr)	
	Estimated Value	% of Total	Dollar Losses[1]	Loss Ratio[2]
Residential Building and Contents Losses	$680,700,000	57%	$10,500,000	2%
Commercial Building and Contents Losses	$420,700,000	35%	$3,600,000	1%
Other Building and Contents Losses	$100,900,000	8%	$1,600,000	2%
Total Building and Contents Losses	$1,202,300,000	100%	$15,700,000	1%
Business Disruption	N/A	N/A	$200,000	N/A
TOTAL	$1,202,300,000	N/A	$15,900,000	N/A

Source: Hazus analysis results stored as the Flood Risk Assessment Dataset in the Flood Risk Database.

[1]Losses shown are rounded to nearest $10,000 for values under $100,000 and to the nearest $100,000 for values over $100,000.

[2]Loss ratio = Dollar Losses ÷ Estimated Value. Loss Ratios are rounded to the nearest integer percent.

[3]Total Building and Contents Losses = Residential Building and Contents Losses + Commercial Building and Contents Losses + Other Building and Contents Losses.

[4]Business Disruption = Inventory Loss + Relocation Cost + Income Loss + Rental Income Loss + Wage Loss + Direct Output Loss.

[5]Total Loss = Total Building and Contents Losses + Business Disruption

3.2.3 Town of Duxbury

The following pages include Flood Risk data for the Town of Duxbury.

3.2.3.1 Overview

The Town of Duxbury is within Plymouth County along the shoreline of Duxbury Bay. The information below provides an overview of the community's floodplain management program information as of the date of this publication.

Community Name	CID	Total Community Population	Percent of Population in Project Area	Total Community Land Area (sq mi)	Percent of Land Area in Project Area	NFIP	CRS Rating	Mitigation Plan
Town of Duxbury	**250263**	**14,979**	**66.5%**	**33.4**	**76.9%**	**Y**	**N/A**	**Expired**

- Multi-Hazard Mitigation Plan has been returned for revisions
- Past Federal Disaster Declarations for flooding = 17
- National Flood Insurance Program (NFIP) policy coverage (policies/value) = 285 policies totaling approximately $76,749,200
- NFIP-recognized repetitive loss properties = 135

Data provided below only includes areas within the Town of Duxbury that area located within the Plymouth County Flood Risk Project, and do not necessarily represent community-wide totals. Section 2 of the Flood Risk Report (FRR) provides more information regarding the source and methodology used to develop the information presented below. Datasets used toward the generation of results of this project are described in Section 7 of the FRR and are found in the Flood Risk Database (FRD).

3.2.3.2 Community Analyses and Results

- **Changes Since Last FIRM**
  - Special Flood Hazard Area (SFHA) boundaries along Cape Cod within the Town of Duxbury were updated due to the effects of the new coastal analysis that was performed. The updated modeling produced new flood zone areas and new base flood elevations and utilized LiDAR-based topographic data that was collected as part of the Flood Risk Project. The data in this section reflects the comparison between the effective FIRM and the new analysis in this study.

The table below summarizes the increases, decreases, and net change of SFHAs for the community.

Area of Study	Total Area (mi^2)	Increase (mi^2)	Decrease (mi^2)	Net Change (mi^2)
Within SFHA	***7.4***	***0.1***	***0.2***	***-0.1***
Within CHHA (Zone VE or V)	***4.0***	***0.8***	***0.1***	***0.7***

Section 2 of the FRR provides more information regarding the source and methodology used to develop this table.

- Evidence of actual flood losses can be one of the most compelling factors for increasing a community's flood risk awareness. FEMA encourages the communities within the project area to continue working with the State Hazard Mitigation Officer to further identify and mitigate these high-risk areas and structures.

- **Coastal Wave Height Grids**

  The FRD contains datasets in the form of wave height grids for the entire Flood Risk Project that can be used for additional analysis, enhanced visualization, and communication of flood risks for hazard mitigation planning and emergency management. The data provided within the FRD should be used to further isolate areas where flood mitigation potential is high and may be helpful in planning and implementing mitigation strategies. Properties located in areas expected to experience some depth of water or waves should seriously consider mitigation options for implementation. Section 2 of the FRR provides both general and specific information regarding the development of and potential uses for this data.

Coastal Wave Hazard Severity	*Total Area (mi^2)*
High	***11.2***
Moderate	***0.0***
Minimal	***0.5***

- **Flood Risk Results Information**

  Plymouth County's flood risk analysis incorporates results from a FEMA-performed Hazus analysis which accounts for newly modeled areas in the Flood Risk Project and newly modeled depths for certain flood events. Potential losses were estimated as well as potential loss ratios. Additional information and data layers provided within the FRD should be used to further analyze potential losses and areas where they are likely to occur.

	Total Inventory		Estimated Potential Losses 1% (100-yr)	
	Estimated Value	% of Total	Dollar Losses[1]	Loss Ratio[2]
Residential Building and Contents Losses	$1,539,500,000	79%	$57,900,000	4%
Commercial Building and Contents Losses	$301,700,000	16%	$17,900,000	6%
Other Building and Contents Losses	$104,300,000	5%	$3,100,000	3%
Total Building and Contents Losses	$1,945,400,000	100%	$78,900,000	4%
Business Disruption	N/A	N/A	$500,000	N/A
TOTAL	$1,945,400,000	N/A	$79,400,000	N/A

Source: Hazus analysis results stored as the Flood Risk Assessment Dataset in the Flood Risk Database.

[1]Losses shown are rounded to nearest $10,000 for values under $100,000 and to the nearest $100,000 for values over $100,000.

[2]Loss ratio = Dollar Losses ÷ Estimated Value. Loss Ratios are rounded to the nearest integer percent.

[3]Total Building and Contents Losses = Residential Building and Contents Losses + Commercial Building and Contents Losses + Other Building and Contents Losses.

[4]Business Disruption = Inventory Loss + Relocation Cost + Income Loss + Rental Income Loss + Wage Loss + Direct Output Loss.

[5]Total Loss = Total Building and Contents Losses + Business Disruption

3.2.4 Town of Marshfield

The following pages include Flood Risk data for the Town of Marshfield.

3.2.4.1 Overview

The Town of Marshfield is located within Plymouth County along the shoreline of the Atlantic Ocean and the banks of the North River. The information below provides an overview of the community's floodplain management program information as of the date of this publication.

Community Name	CID	Total Community Population	Percent of Population in Project Area	Total Community Land Area (sq mi)	Percent of Land Area in Project Area	NFIP	CRS Rating	Mitigation Plan
Town of Marshfield	**250273**	**25,124**	**91.7%**	**29.7**	**93.5%**	**Y**	**8**	**Y**

- Multi-Hazard Mitigation Plan was adopted 9/17/2012
- Past Federal Disaster Declarations for flooding = 17
- National Flood Insurance Program (NFIP) policy coverage (policies/value) = 1396 policies totaling approximately $316,419,300
- NFIP-recognized repetitive loss properties = 393

Data provided below only includes areas within the Town of Marshfield that area located within the Plymouth County Flood Risk Project, and do not necessarily represent community-wide totals. Section 2 of the Flood Risk Report (FRR) provides more information regarding the source and methodology used to develop the information presented below. Datasets used toward the generation of results of this project are described in Section 7 of the FRR and are found in the Flood Risk Database (FRD).

3.2.4.2 Community Analyses and Results

- **Changes Since Last FIRM**
  - Special Flood Hazard Area (SFHA) boundaries along the Atlantic Ocean within the Town of Marshfield were updated due to the effects of the new coastal analysis that was performed. The updated modeling produced new flood zone areas and new base flood elevations and utilized LiDAR-based topographic data that was collected as part of the Flood Risk Project. The data in this section reflects the comparison between the effective FIRM and the new analysis in this study.

The table below summarizes the increases, decreases, and net change of SFHAs for the community.

Area of Study	Total Area (mi^2)	Increase (mi^2)	Decrease (mi^2)	Net Change (mi^2)
Within SFHA	***10.7***	***1.7***	***0.2***	***1.5***
Within CHHA (Zone VE or V)	***2.7***	***1.7***	***0.1***	***1.6***

Section 2 of the FRR provides more information regarding the source and methodology used to develop this table.

- Evidence of actual flood losses can be one of the most compelling factors for increasing a community's flood risk awareness. FEMA encourages the communities within the project area to continue working with the State Hazard Mitigation Officer to further identify and mitigate these high-risk areas and structures.

- **Coastal Wave Height Grids**

  The FRD contains datasets in the form of wave height grids for the entire Flood Risk Project that can be used for additional analysis, enhanced visualization, and communication of flood risks for hazard mitigation planning and emergency management. The data provided within the FRD should be used to further isolate areas where flood mitigation potential is high and may be helpful in planning and implementing mitigation strategies. Properties located in areas expected to experience some depth of water or waves should seriously consider mitigation options for implementation. Section 2 of the FRR provides both general and specific information regarding the development of and potential uses for this data.

Coastal Wave Hazard Severity	*Total Area (mi^2)*
High	***3.0***
Moderate	***1.8***
Minimal	***5.0***

- **Flood Risk Results Information**

  Plymouth County's flood risk analysis incorporates results from a FEMA-performed Hazus analysis which accounts for newly modeled areas in the Flood Risk Project and newly modeled depths for certain flood events. Potential losses were estimated as well as potential loss ratios. Additional information and data layers provided within the FRD should be used to further analyze potential losses and areas where they are likely to occur.

	Total Inventory		Estimated Potential Losses 1% (100-yr)	
	Estimated Value	% of Total	Dollar Losses[1]	Loss Ratio[2]
Residential Building and Contents Losses	$2,775,100,000	81%	$393,100,000	14%
Commercial Building and Contents Losses	$450,500,000	13%	$62,200,000	14%
Other Building and Contents Losses	$209,300,000	6%	$29,900,000	14%
Total Building and Contents Losses	$3,434,900,000	100%	$485,300,000	14%
Business Disruption	N/A	N/A	$3,300,000	N/A
TOTAL	$3,434,900,000	N/A	$488,600,000	N/A

Source: Hazus analysis results stored as the Flood Risk Assessment Dataset in the Flood Risk Database.

[1]Losses shown are rounded to nearest $10,000 for values under $100,000 and to the nearest $100,000 for values over $100,000.

[2]Loss ratio = Dollar Losses ÷ Estimated Value. Loss Ratios are rounded to the nearest integer percent.

[3]Total Building and Contents Losses = Residential Building and Contents Losses + Commercial Building and Contents Losses + Other Building and Contents Losses.

[4]Business Disruption = Inventory Loss + Relocation Cost + Income Loss + Rental Income Loss + Wage Loss + Direct Output Loss.

[5]Total Loss = Total Building and Contents Losses + Business Disruption

3.2.5 Town of Norwell

The following pages include Flood Risk data for the Town of Norwell.

3.2.5.1 Overview

The Town of Norwell is located within Plymouth County. The Town is inland and is subject to tidal influences along the North River. The information below provides an overview of the community's floodplain management program information as of the date of this publication.

Community Name	CID	Total Community Population	Percent of Population in Project Area	Total Community Land Area (sq mi)	Percent of Land Area in Project Area	NFIP	CRS Rating	Mitigation Plan
Town of Norwell	**250276**	**10,423**	**11.8%**	**20.3**	**10.7%**	**Y**	**N/A**	**N**

- Multi-Hazard Mitigation Plan was resubmitted for review
- Past Federal Disaster Declarations for flooding = 17
- National Flood Insurance Program (NFIP) policy coverage (policies/value) = 36 policies totaling approximately $8,572,000
- NFIP-recognized repetitive loss properties = 4

Data provided below only includes areas within the Town of Norwell that area located within the Plymouth County Flood Risk Project, and do not necessarily represent community-wide totals. Section 2 of the Flood Risk Report (FRR) provides more information regarding the source and methodology used to develop the information presented below. Datasets used toward the generation of results of this project are described in Section 7 of the FRR and are found in the Flood Risk Database (FRD).

3.2.5.2 Community Analyses and Results

- **Changes Since Last FIRM**
  - Special Flood Hazard Area (SFHA) boundaries along the Atlantic Ocean and the North River within the Town of Norwell were updated due to the effects of the new coastal analysis that was performed. The updated modeling produced new flood zone areas and new base flood elevations and utilized LiDAR-based topographic data that was collected as part of the Flood Risk Project. The data in this section reflects the comparison between the effective FIRM and the new analysis in this study.

The table below summarizes the increases, decreases, and net change of SFHAs for the community.

Area of Study	Total Area (mi^2)	Increase (mi^2)	Decrease (mi^2)	Net Change (mi^2)
Within SFHA	***2.9***	***0.1***	***0.1***	***0.0***
Within CHHA (Zone VE or V)	***0.0***	***0.0***	***0.0***	***0.0***

Section 2 of the FRR provides more information regarding the source and methodology used to develop this table.

- Evidence of actual flood losses can be one of the most compelling factors for increasing a community's flood risk awareness. FEMA encourages the communities within the project area to continue working with the State Hazard Mitigation Officer to further identify and mitigate these high-risk areas and structures.

- **Coastal Wave Height Grids**

  The FRD contains datasets in the form of wave height grids for the entire Flood Risk Project that can be used for additional analysis, enhanced visualization, and communication of flood risks for hazard mitigation planning and emergency management. The data provided within the FRD should be used to further isolate areas where flood mitigation potential is high and may be helpful in planning and implementing mitigation strategies. Properties located in areas expected to experience some depth of water or waves should seriously consider mitigation options for implementation. Section 2 of the FRR provides both general and specific information regarding the development of and potential uses for this data.

Coastal Wave Hazard Severity	*Total Area (mi^2)*
High	***0.0***
Moderate	***0.0***
Minimal	***0.3***

- **Flood Risk Results Information**

  Plymouth County's flood risk analysis incorporates results from a FEMA-performed Hazus analysis which accounts for newly modeled areas in the Flood Risk Project and newly modeled depths for certain flood events. Potential losses were estimated as well as potential loss ratios. Additional information and data layers provided within the FRD should be used to further analyze potential losses and areas where they are likely to occur.

	Total Inventory		Estimated Potential Losses 1% (100-yr)	
	Estimated Value	% of Total	Dollar Losses[1]	Loss Ratio[2]
Residential Building and Contents Losses	$177,500,000	87%	$10,000,000	6%
Commercial Building and Contents Losses	$17,500,000	9%	$1,100,000	6%
Other Building and Contents Losses	$8,100,000	4%	$100,000	1%
Total Building and Contents Losses	$203,100,000	100%	$11,300,000	6%
Business Disruption	N/A	N/A	$0	N/A
TOTAL	$203,100,000	N/A	$11,300,000	N/A

Source: Hazus analysis results stored as the Flood Risk Assessment Dataset in the Flood Risk Database.

[1]Losses shown are rounded to nearest $10,000 for values under $100,000 and to the nearest $100,000 for values over $100,000.

[2]Loss ratio = Dollar Losses ÷ Estimated Value. Loss Ratios are rounded to the nearest integer percent.

[3]Total Building and Contents Losses = Residential Building and Contents Losses + Commercial Building and Contents Losses + Other Building and Contents Losses.

[4]Business Disruption = Inventory Loss + Relocation Cost + Income Loss + Rental Income Loss + Wage Loss + Direct Output Loss.

[5]Total Loss = Total Building and Contents Losses + Business Disruption

3.2.6 Town of Scituate

The following pages include Flood Risk data for the Town of Scituate.

3.2.6.1 Overview

The Town of Scituate is within Plymouth County along the shoreline of the Atlantic Ocean and Cohasset Harbor. The information below provides an overview of the community's floodplain management program information as of the date of this publication.

Community Name	CID	Total Community Population	Percent of Population in Project Area	Total Community Land Area (sq mi)	Percent of Land Area in Project Area	NFIP	CRS Rating	Mitigation Plan
Town of Scituate	***250281***	***18,132***	***100%***	***21.9***	***100%***	***Y***	***8***	***Y***

- Multi-Hazard Mitigation Plan was adopted 6/28/2011
- Past Federal Disaster Declarations for flooding = 17
- National Flood Insurance Program (NFIP) policy coverage (policies/value) = 1,478 policies totaling approximately $375,592,600
- NFIP-recognized repetitive loss properties = 2

Data provided below only includes areas within the Town of Scituate that area located within the Plymouth County Flood Risk Project, and do not necessarily represent community-wide totals. Section 2 of the Flood Risk Report (FRR) provides more information regarding the source and methodology used to develop the information presented below. Datasets used toward the generation of results of this project are described in Section 7 of the FRR and are found in the Flood Risk Database (FRD).

3.2.6.2 Community Analyses and Results

- **Changes Since Last FIRM**
  - Special Flood Hazard Area (SFHA) boundaries along the Atlantic Ocean within the Town of Scituate were updated due to the effects of the new coastal analysis that was performed. The updated modeling produced new flood zone areas and new base flood elevations and utilized LiDAR-based topographic data that was collected as part of the Flood Risk Project. The data in this section reflects the comparison between the effective FIRM and the new analysis in this study.

The table below summarizes the increases, decreases, and net change of SFHAs for the community.

Area of Study	Total Area (mi^2)	Increase (mi^2)	Decrease (mi^2)	Net Change (mi^2)
Within SFHA	***11.0***	***0.7***	***0.1***	***0.6***
Within CHHA (Zone VE or V)	***5.1***	***0.7***	***0.2***	***0.5***

Section 2 of the FRR provides more information regarding the source and methodology used to develop this table.

- Evidence of actual flood losses can be one of the most compelling factors for increasing a community's flood risk awareness. FEMA encourages the communities within the project area to continue working with the State Hazard Mitigation Officer to further identify and mitigate these high-risk areas and structures.

- **Coastal Wave Height Grids**

  The FRD contains datasets in the form of wave height grids for the entire Flood Risk Project that can be used for additional analysis, enhanced visualization, and communication of flood risks for hazard mitigation planning and emergency management. The data provided within the FRD should be used to further isolate areas where flood mitigation potential is high and may be helpful in planning and implementing mitigation strategies. Properties located in areas expected to experience some depth of water or waves should seriously consider mitigation options for implementation. Section 2 of the FRR provides both general and specific information regarding the development of and potential uses for this data.

Coastal Wave Hazard Severity	*Total Area (mi^2)*
High	***5.4***
Moderate	***1.1***
Minimal	***2.5***

- **Flood Risk Results Information**

  Plymouth County's flood risk analysis incorporates results from a FEMA-performed Hazus analysis which accounts for newly modeled areas in the Flood Risk Project and newly modeled depths for certain flood events. Potential losses were estimated as well as potential loss ratios. Additional information and data layers provided within the FRD should be used to further analyze potential losses and areas where they are likely to occur.

	Total Inventory		Estimated Potential Losses 1% (100-yr)	
	Estimated Value	% of Total	Dollar Losses[1]	Loss Ratio[2]
Residential Building and Contents Losses	$2,420,000,000	81%	$252,300,000	10%
Commercial Building and Contents Losses	$390,400,000	13%	$61,300,000	16%
Other Building and Contents Losses	$185,200,000	6%	$15,700,000	8%
Total Building and Contents Losses	$2,995,600,000	100%	$329,300,000	11%
Business Disruption	N/A	N/A	$2,500,000	N/A
TOTAL	$2,995,600,000	N/A	$331,800,000	N/A

Source: Hazus analysis results stored as the Flood Risk Assessment Dataset in the Flood Risk Database.

[1]Losses shown are rounded to nearest $10,000 for values under $100,000 and to the nearest $100,000 for values over $100,000.

[2]Loss ratio = Dollar Losses ÷ Estimated Value. Loss Ratios are rounded to the nearest integer percent.

[3]Total Building and Contents Losses = Residential Building and Contents Losses + Commercial Building and Contents Losses + Other Building and Contents Losses.

[4]Business Disruption = Inventory Loss + Relocation Cost + Income Loss + Rental Income Loss + Wage Loss + Direct Output Loss.

[5]Total Loss = Total Building and Contents Losses + Business Disruption

4 Actions to Reduce Flood Risk

In order to fully leverage the Flood Risk Datasets and Products created for this Flood Risk Project, local stakeholders should consider many different flood risk mitigation tactics, including, but not limited the items shown in the sub-sections below.

4.1 Types of Mitigation Actions

Mitigation provides a critical foundation on which to reduce loss of life and property by avoiding or lessening the impact of hazard events. This creates safer communities and facilitates resiliency by enabling communities to return to normal function as quickly as possible after a hazard event. Once a community understands its flood risk, it is in a better position to identify potential mitigation actions that can reduce the risk to its people and property.

The mitigation plan requirements in 44 CFR Part 201 encourage communities to understand their vulnerability to hazards and take actions to minimize vulnerability and promote resilience. Flood mitigation actions generally fall into the following categories:

Building to Prevent Future Loss

The elevated building pictured above withstood Hurricane Katrina.

Communities will need to prioritize projects as part of the planning process. FEMA can then help route federal mitigation dollars to fund these projects.

4.1.1 Preventative Measures

Preventative measures are intended to keep flood hazards from getting worse. They can reduce future vulnerability to flooding, especially in areas where development has not yet occurred or where capital improvements have not been substantial. Examples include:

- Comprehensive land use planning
- Zoning regulations
- Subdivision regulations
- Open space preservation
- Building codes
- Floodplain development regulations
- Stormwater management
- Purchase development rights or conservation easements
- Participation in the NFIP Community Rating System (CRS)

NFIP's CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from community actions meeting the three goals of the CRS: to reduce flood losses, to facilitate accurate insurance rating, and to promote the awareness of flood insurance.

For CRS participating communities, flood insurance premium rates are discounted in increments of 5%; i.e., a Class 1 community would receive a 45% premium discount, while a Class 9 community would receive a 5% discount. (A Class 10 is not participating in the CRS and receives no discount.)

4.1.2 Property Protection Measures

Property protection measures protect existing buildings by modifying the building to withstand floods, or by removing buildings from hazardous locations. Examples include:

- Building relocation
- Acquisition and clearance
- Building elevation
- Barrier installation
- Building retrofit

4.1.3 Natural Resource Protection Activities

Natural resource protection activities reduce the impact of floods by preserving or restoring natural areas such as floodplains, wetlands, and dunes and their natural functions. Examples include:

- Wetland protection
- Living shorelines
- Habitat protection
- Erosion and sedimentation control
- Beach nourishment
- Primary frontal dune protection

4.1.4 Structural Mitigation Projects

Structural mitigation projects lessen the impact of floods by modifying the environmental natural progression of the flooding event. Structural protection such as upgrading dams/levees for already existing development and critical facilities may be a realistic alternative. However, citizens should be made aware of their residual risk. Examples include:

- Reservoirs, retention, and detention basins
- Levees, floodwalls, and coastal shoreline protection structures

4.1.5 Public Education and Awareness Activities

Public education and awareness activities advise residents, business owners, potential property buyers, and visitors about floods, hazardous areas, and mitigation techniques they can use to reduce the flood risk to themselves and their property. Examples include:

- Readily available and readable updated maps
- Outreach projects
- Libraries
- Technical assistance
- Real estate disclosure
- Environmental education

For more information regarding hazard mitigation techniques, best practices, and potential grant funding sources, visit www.fema.gov or contact your local floodplain manager, emergency manager, or State Hazard Mitigation Officer.

- Risk information via the nightly news

4.1.6 Emergency Service Measures

Although not typically considered a mitigation technique, emergency service measures minimize the impact of flooding on people and property. These are actions commonly taken immediately prior to, during, or in response to a hazard event. Examples include:

- Hazard warning system
- Emergency response plan
- COOP and COG planning
- Critical facilities protection
- Health and safety maintenance
- Post flood recovery planning

4.2 Identifying Specific Actions for Your Community

As many mitigation actions are possible to lessen the impact of floods, how can a community decide which ones are appropriate to implement? There are many ways to identify specific actions most appropriate for a community. Some factors to consider may include the following:

Refer to FEMA Mitigation Planning How To Guide #3 (FEMA 386-3) "Developing the Mitigation Plan - Identifying Mitigation Actions and Implementation Strategies" for more information on how to identify specific mitigation actions to address hazard risk in your community.

- **Site characteristics.** Does the site present unique challenges, such as significant slopes or erosion potential? These areas may be good candidates for beach nourishment or dune construction.
- **Flood characteristics.** Are the flood waters affecting the site fast or slow moving? Is there debris associated with the flow? How deep is the flooding? Review the Coastal Wave Height Grid to see a detailed analysis of the wave heights associated with the 1%-annual-chance flood event. Review the Limit of Moderate Wave Action (LiMWA) on the FIRM to see areas where potentially damaging waves can occur in the Coastal A Zone. Structural retrofits or elevation may be potential mitigation solutions for areas with high wave hazard risks.
- **Social acceptance.** Will the mitigation action be acceptable to the public? Does it cause social or cultural problems? Talk to FEMA's outreach specialists for a tailored outreach plan for your community. Use the Flood Risk Database to "show" the public the potential risks for a particular area.
- **Technical feasibility.** Is the mitigation action technically feasible (e.g., making a building watertight to a reasonable depth)? Work with engineers or other certified professionals when designing mitigation activities.
- **Administrative feasibility.** Is there administrative capability to implement the mitigation action? Review your community's Hazard Mitigation Plan to see

FEMA in collaboration with the American Planning Association has released the publication, "Integrating Hazard Mitigation into Local Planning." This guide explains how hazard mitigation can be incorporated into several different types of local planning programs. For more information go to www.planning.org. or http://www.fema.gov/library.

which specific mitigation projects already receive administrative support. Use the Flood Risk Database to match planned mitigation projects with the highest risk areas to help prioritize future projects.

- **Legal.** Does the mitigation action meet all applicable codes, regulations, and laws? Public officials may have a legal responsibility to act and inform citizens if a known hazard has been identified.
- **Economic.** Is the mitigation action affordable? Is it eligible under grant or other funding programs? Can it be completed within existing budgets?
- **Environmental.** Does the mitigation action cause adverse impacts on the environment or can they be mitigated? Is it the most appropriate action among the possible alternatives?

A local Hazard Mitigation Plan is a valuable place to identify and prioritize possible mitigation actions. The plan includes a mitigation strategy with mitigation actions that were developed through a public and open process. You can then add to or modify those actions based on what is learned during the course of the Risk MAP project and the information provided within this FRR.

Also review the Flood Risk Database products to see areas with a high risk such as areas with high wave height potential. These products can help the community understand which areas have a higher risk, allowing the community to focus resources on these areas.

4.3 Mitigation Programs and Assistance

Not all mitigation activities require funding (e.g., local policy actions such as strengthening a flood damage prevention ordinance), and those that do are not limited to outside funding sources (e.g., inclusion in local capital improvements plan, etc.). For those mitigation actions that require assistance through funding or technical expertise, several state and federal agencies have flood hazard mitigation grant programs and offer technical assistance. These programs may be funded at different levels over time or may be activated under special circumstances such as after a presidential disaster declaration.

Communities can link hazard mitigation plans and actions to the right FEMA grant programs to fund flood risk reduction. More information about FEMA HMA programs can be found at http://www.fema.gov/government/grant/hma/index.shtm.

4.3.1 FEMA Mitigation Programs and Assistance

FEMA awards many mitigation grants each year to states and communities to undertake mitigation projects to prevent future loss of life and property resulting from hazard impacts, including flooding. The FEMA Hazard Mitigation Assistance (HMA) programs provide grants for mitigation through the programs listed in Table 4.1 below.

Table 4-1 - FEMA Hazard Mitigation Assistance Programs

Mitigation Grant Program	Authorization	Purpose
Hazard Mitigation Grant Program (HMGP)	Robert T. Stafford Disaster Relief and Emergency Assistance Act	Activated after a presidential disaster declaration; provides funds on a sliding scale formula based on a percentage of the total federal assistance for a disaster for long-term mitigation measures to reduce vulnerability to natural hazards
Flood Mitigation Assistance (FMA)	National Flood Insurance Reform Act	Reduce or eliminate claims against the NFIP
Pre-Disaster Mitigation (PDM)	Disaster Mitigation Act	National competitive program focused on mitigation project and planning activities that address multiple natural hazards

The HMGP and PDM programs offer funding for mitigation planning and project activities that address multiple natural hazard events. The FMA program focuses funding efforts on reducing claims against the NFIP. Funding under the HMA programs is subject to availability of annual appropriations, and HMGP funding is also subject to the amount of FEMA disaster recovery assistance provided under a presidential major disaster declaration.

FEMA's HMA grants are awarded to eligible states, tribes, and territories (applicant) that, in turn, provide subgrants to local governments and communities (subapplicant). The applicant selects and prioritizes subapplications developed and submitted to them by subapplicants and submits them to FEMA for funding consideration. Prospective subapplicants should consult the office designated as their applicant for further information regarding specific program and application requirements. Contact information for the FEMA Regional Offices and State Hazard Mitigation Officers (SHMO) is available on the FEMA website (www.fema.gov).

4.3.2 Additional Mitigation Programs and Assistance

Several additional agencies including USACE, Natural Resource Conservation Service (NRCS), U.S. Geological Survey (USGS), and others have specialists on staff and can offer further information on flood hazard mitigation. The State NFIP Coordinator and SHMO are state-level sources of information and assistance, which vary among different states.

The Silver Jackets program, active in several states, is a partnership of USACE, FEMA, and state agencies. The Silver Jackets program provides a state-based strategy for an interagency approach to planning and implementing measures for risk reduction.

5 Acronyms and Definitions

5.1 Acronyms

A

AAL	Average Annualized Loss
ALR	Annualized Loss Ratio
AoMI	*Areas of Mitigation Interest*

B

BCA	Benefit-Cost Analysis
BFE	Base Flood Elevation
BMP	Best Management Practices

C

CFR	Code of Federal Regulations
CHHA	Coastal High Hazard Areas
COG	Continuity of Government Plan
COOP	Continuity of Operations Plan
CRS	Community Rating System
CSLF	Changes Since Last FIRM

D

DHS	Department of Homeland Security
DMA 2000	Disaster Mitigation Act of 2000

E

EAP	Emergency Action Plan
EOP	Emergency Operations Plan

F

FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
FRD	Flood Risk Database
FRM	Flood Risk Map
FRR	Flood Risk Report
FY	Fiscal Year

G

GIS	Geographic Information System

H

HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program

I

IA	Individual Assistance

N

NFIA	National Flood Insurance Act
NFIP	National Flood Insurance Program
NRCS	Natural Resource Conservation Service

P

PA	Public Assistance
PDM	Pre-Disaster Mitigation
PFD	Primary Frontal Dune
PMF	Probable Maximum Flood

R

RFC	Repetitive Flood Claims
Risk MAP	Mapping, Assessment, and Planning

S

SFHA	Special Flood Hazard Area
SHMO	State Hazard Mitigation Officer
SRL	Severe Repetitive Loss

U

USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey

5.2 Definitions

0.2-percent-annual-chance flood – The flood elevation that has a 0.2-percent chance of being equaled or exceeded each year. Sometimes referred to as the 500-year flood.

1-percent-annual-chance flood – The flood elevation that has a 1-percent chance of being equaled or exceeded each year. Sometimes referred to as the 100-year flood.

Annualized Loss Ratio (ALR) – Expresses the annualized loss as a fraction of the value of the local inventory (total value/annualized loss).

Average Annualized Loss (AAL) – The estimated long-term weighted average value of losses to property in any single year in a specified geographic area.

Base Flood Elevation (BFE) – Elevation of the 1-percent-annual-chance flood. This elevation is the basis of the insurance and floodplain management requirements of the NFIP.

Berm – A small levee, typically built from earth.

Cfs – Cubic feet per second, the unit by which discharges are measured (a cubic foot of water is about 7.5 gallons).

Coastal High Hazard Area (CHHA)—Portion of the SFHA extending from offshore to the inland limit of a primary frontal dune along an open coast or any other area subject to high velocity wave action from storms or seismic sources.

Consequence (of flood) – The estimated damages associated with a given flood occurrence.

Crest – The peak stage or elevation reached or expected to be reached by the floodwaters of a specific flood at a given location.

Dam – An artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material, for the purpose of storage or control of water.

Design flood event – The greater of the following two flood events: (1) the base flood, affecting those areas identified as SFHAs on a community's FIRM; or (2) the flood corresponding to the area designated as a flood hazard area on a community's flood hazard map or otherwise legally designated.

Erosion – Process by which floodwaters lower the ground surface in an area by removing upper layers of soil.

Essential facilities – Facilities that, if damaged, would present an immediate threat to life, public health, and safety. As categorized in Hazus, essential facilities include hospitals, emergency operations centers, police stations, fire stations, and schools.

Flood – A general and temporary condition of partial or complete inundation of normally dry land areas from (1) the overflow of inland or tidal waters or (2) the unusual and rapid accumulation or runoff of surface waters from any source.

Flood Insurance Rate Map (FIRM) – An official map of a community, on which FEMA has delineated both the SFHAs and the risk premium zones applicable to the community. See also Digital Flood Insurance Rate Map.

Flood Insurance Study (FIS) Report – Contains an examination, evaluation, and determination of the flood hazards of a community, and if appropriate, the corresponding water-surface elevations.

Flood risk – Probability multiplied by consequence; the degree of probability that a loss or injury may occur as a result of flooding. This is sometimes referred to as flood vulnerability.

Flood vulnerability – Probability multiplied by consequence; the degree of probability that a loss or injury may occur as a result of flooding. This is sometimes referred to as flood risk.

Flood-borne debris impact – Floodwater moving at a moderate or high velocity can carry flood-borne debris that can impact buildings and damage walls and foundations.

Floodwall – A long, narrow concrete or masonry wall built to protect land from flooding.

Floodway (regulatory) – The channel of a river or other watercourse and that portion of the adjacent floodplain that must remain unobstructed to permit passage of the base flood without cumulatively increasing the water surface elevation more than a designated height (usually 1 foot).
Floodway fringe – The portion of the SFHA that is outside of the floodway.

Freeboard – A factor of safety usually expressed in feet above a flood level for purposes of flood plain management. "Freeboard" tends to compensate for the many unknown factors that could contribute to flood heights greater than the height calculated for a selected size flood and floodway conditions, such as wave action, bridge openings, and the hydrological effect of urbanization of the watershed (44CFR§59.1).

Hazus – A GIS-based risk assessment methodology and software application created by FEMA and the National Institute of Building Sciences for analyzing potential losses from floods, hurricane winds and storm surge, and earthquakes.

High velocity flow – Typically comprised of floodwaters moving faster than 5 feet per second.

Levee – A human-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide protection from temporary flooding. (44CFR§59.1)

Loss ratio – Expresses loss as a fraction of the value of the local inventory (total value/loss).

Mudflow – Mudslide (i.e., mudflow) describes a condition where there is a river, flow or inundation of liquid mud down a hillside usually as a result of a dual condition of loss of brush cover, and the subsequent accumulation of water on the ground preceded by a period of unusually heavy or sustained rain. A mudslide (i.e., mudflow) may occur as a distinct phenomenon while a landslide is in progress, and will be recognized as such by the Administrator only if the mudflow, and not the landslide, is the proximate cause of damage that occurs. (44CFR§59.1)

Primary frontal dune (PFD)—A continuous or nearly continuous mound or ridge of sand with relatively steep seaward and landward slopes immediately landward and adjacent to the beach and subject to erosion and overtopping from high tides and waves during major coastal storms. The inland limit of the primary frontal dune occurs at the point where there is a distinct change from a relatively steep slope to a relatively mild slope.

Probability (of flood) – The likelihood that a flood will occur in a given area.

Risk MAP – Risk Mapping, Assessment, and Planning, a FEMA strategy to work collaboratively with state, local, and tribal entities to deliver quality flood data that increases public awareness and leads to action that reduces risk to life and property.

Riverine – Of or produced by a river. Riverine floodplains have readily identifiable channels.

Special Flood Hazard Area (SFHA) – Portion of the floodplain subject to inundation by the 1-percent-annual or base flood.

Stafford Act – Robert T. Stafford Disaster Relief and Emergency Assistance Act, PL 100-707, signed into law November 23, 1988; amended the Disaster Relief Act of 1974, PL 93-288. This Act constitutes the statutory authority for most federal disaster response activities especially as they pertain to FEMA and FEMA programs.

Stillwater –Projected elevation that flood waters would assume, referenced to National Geodetic Vertical Datum of 1929, North American Vertical Datum of 1988, or other datum, in the absence of waves resulting from wind or seismic effects.

Stream Flow Constrictions – A point where a human-made structure constricts the flow of a river or stream.

6 Additional Resources

ASCE 7 – National design standard issued by the American Society of Civil Engineers (ASCE), *Minimum Design Loads for Buildings and Other Structures*, which gives current requirements for dead, live, soil, flood, wind, snow, rain, ice, and earthquake loads, and their combinations, suitable for inclusion in building codes and other documents.

ASCE 24-05 – National design standard issued by the ASCE, *Flood Resistant Design and Construction*, which outlines the requirements for flood resistant design and construction of structures in flood hazard areas.

National Flood Insurance Program (NFIP), Federal Emergency Management Agency (FEMA), www.floodsmart.gov

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7 Data Used to Develop Flood Risk Products

GIS base map information was acquired from the following sources:

- Massachusetts Office of Geographic Information (MassGIS)
- United States Geological Survey
- United States Census Bureau