Buzzards Bay Climate Change Vulnerability Assessment

In support of the Buzzards Bay Comprehensive Conservation and Management Plan Update

Damage to a Buzzards Bay facing seawall in Woods Hole from the April 2014 Nor'easter. Photo by Joe Costa

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Acknowledgments

This document is the culmination of several projects that the Buzzards Bay National Estuary Program (NEP) undertook, or participated in, during the past decade. I would like to thank Ivy Mlsna at United States Environmental Protection Agency (EPA) Region I for providing guidance during the conceptual development of this document and providing a model for the effort. The document benefited greatly from comments by NEP Steering Committee member Norm Hills on an earlier draft, and the editorial work of NEP staffer Sarah Williams on all drafts. Thanks to Rachel Jakuba of the Buzzards Bay Coalition for hosting the online workshops and summarizing the feedback provided. Thanks to EPA staff Romell Nandi and Michael Creighton of the Climate Ready Estuaries Program for providing grants to fund the development of this document and past projects. This assessment was funded wholly by the EPA under assistance agreement FC00A00623 and FC00A00860 to the Massachusetts Executive Office of Energy and Environmental Affairs Buzzards Bay National Estuary Program.

Introduction

The Buzzards Bay National Estuary Program (NEP) is one of 28 National Estuary Programs designated as estuaries of national significance under Section 320 of the Clean Water Act (CWA) of 1987. Administered by the U.S. Environmental Protection Agency (EPA), NEPs incorporate scientific research and planning activities into Comprehensive Conservation and Management Plans (CCMP). The Buzzards Bay CCMP, created in 1991, and updated in 2013, is a broad, risk-based, planning document designed to protect and restore water quality and living resources of Buzzards Bay and its surrounding watershed. The 1991 CCMP is notable in that it was the only NEP CCMP during the 1990s to include recommendations to address climate change related sea level rise. In 2023, the NEP will issue an update to the CCMP. This Climate Change Vulnerability Assessment is both an evaluation of the 2013 CCMP, and an assessment of changes needed in the 2023 CCMP update to accommodate climate change and climate resilience.

As described in greater detail below, we have adopted in this Climate Change Vulnerability Assessment (CCVA) approaches defined in EPA's Climate Ready Estuaries Program's *Being Prepared for Climate Change: A Workbook for Developing Risk-Based Adaptation Plans* (U.S. EPA 2014). This workbook provides guidance on conducting risk-based CCVAs and developing adaptation action plans. However, rather than assessing species, habitat, or species-level impacts due to predicted climate stressors, this climate change vulnerability assessment characterizes how climate change may impact the NEP's ability to meet management goals outlined in the 2013 CCMP and planned 2023 update. This decision was made in part because, as described below, the NEP participated in an EPA-funded New England-wide vulnerability assessment in 2015-2016 to identify risks to meeting Clean Water Act water quality and habitat protection goals. In this respect, elements of this report are modeled or taken from Mlsna (2019), who adopted the same approach. Documents and information used in the Mlsna study are included in Appendix A. More specifically, this CCVA highlights management goals and priorities that should be refocused to address climate vulnerabilities and provides recommendations for adaptation or mitigation action to respond to those challenges. This report also describes the process used by the NEP to undertake the CCVA using the framework and ten steps outlined in *The Workbook.*

We recognize that EPA's Workbook is but one approach in undertaking a CCVA. Adaptation to climate change is a rapidly developing field and new approaches are constantly emerging. Moreover, our understanding of how global and local ecosystems respond to climate stressors is evolving. In recognition of these limitations, this report provides links to some of those resources.

Watershed Characteristics and Political Boundaries

The Buzzards Bay watershed covers 435 square miles (1209 square kilometers) and includes portions of 21 municipalities in two states. However, six towns, including the two in Rhode Island, have small areas within the Buzzards Bay watershed, so the principal target municipalities for this assessment are the City of New Bedford and the towns of Acushnet, Bourne, Carver, Dartmouth, Fairhaven, Falmouth, Gosnold, Marion, Mattapoisett, Middleborough, Plymouth, Rochester, Wareham, and Westport (Fig. 1). Within these municipalities, Boards of Selectmen (or the Mayor and City Council in the City of New Bedford), Conservation Commissions, Boards of Health, Planning Boards, Zoning Boards of Appeals, Shellfish Wardens, Harbor Masters, and other natural resource staff are the key audiences. These municipalities are spread across four counties (Bristol, Plymouth, Dukes, and Barnstable), but only one of these (Barnstable) has a strong county government with environmental regulatory authority (the Cape Cod Commission). However, municipalities in Bristol and Plymouth counties are served by the regional planning agency (Southeastern Regional Planning & Economic Development District).

Table 1. Summary of town areas and population (U.S. 2020 Census) within the Buzzards Bay watershed.

Town	BB Coastal Waters (sq. miles)	BB Land sq. miles (2)	% in the watershed	US Census 2020 population	2020 population estimate in watershed (3)	% of 2020 population in the watershed
Acushnet	0.1	18.9	100.0%	10,559	10,559	100%
Bourne	11.4	34.2	83.3%	20,452	15,346	75%
Carver	0	33.2	83.6%	11,645	9,364	80%
Dartmouth	34.2	61.9	100.0%	33,783	33,781	100%
Fairhaven	28.5	12.4	100.0%	15,924	15,924	100%
Fall River	0	10.7	27.7%	94,000	456	0%
Falmouth	35.7	18.6	41.2%	32,517	8,621	27%
Freetown	0	4.9	13.8%	9,206	1,689	18%
Gosnold	58.1	7.1	52.8%	70	34	49%
Lakeville	0	0.2	0.6%	11,523	53	0%
Marion	13.9	14.1	100.0%	5,347	5,347	100%
Mattapoisett	24.8	17.5	100.0%	6,508	6,508	100%
Middleborough	0	17.3	24.0%	24,245	2,038	8%
New Bedford	13.2	19.5	96.1%	101,079	99,132	98%
Plymouth	0	33.8	33.2%	61,217	7,771	13%
Rochester	0	33	91.5%	5,717	5,226	91%
Sandwich	0	2.2	5.0%	20,259	0	0%
Wareham	9.2	37.1	100.0%	23,303	23,303	100%
Westport	21.8	44.4	85.3%	16,339	12,311	75%
Little Compton, RI	0	0.7	3.0%	3,616	289	8%
Tiverton, RI	0	6.2	20.4%	7,996	960	12%
Watershed Totals	250.9	427.9		515,305	258,712	50%

Notes: (1) data source = Boundary file from MassGIS, (2) Includes ponds and fresh surface waters, (3) U.S. 2020 Census tiger files census blocks were clipped to Buzzards Bay watershed and population was presumed proportional to clipped area in the watershed (RI based on 2020 total pop and 2010 ratios). This analysis was based on the 2021 Buzzards Bay study area in Fig. 1.

Watershed Demographics and Environmental Justice

Approximately 259,000 people reside in the Buzzards Bay watershed, with roughly 99,000 residing in the City of New Bedford alone (2020 Census statistics; see Table 1; population declined by 5% since 2010). The Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA) has adopted an Environmental Justice (EJ) policy based on the principle that all people have a right to be protected from environmental hazards and to live in and enjoy a clean and healthful environment. The policy seeks equal protection and meaningful involvement of all people with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies and the equitable distribution of environmental benefits. In Massachusetts, a U.S. Census block is recognized as an EJ community if its population meets certain criteria with respect to either household income, minority population, or lack English language proficiency[1]. Fig. 1 shows census blocks defined as EJ populations. These EJ Census blocks contain more than 93,000 people (Table 2). The EPA uses a different definition of disadvantaged communities, and a comparison between the state and EPA definition of disadvantaged communities is

[1] The MA EOEEA defines an Environmental Justice population as ”a neighborhood that meets 1 or more of the following criteria: (i) the annual median household income is not more than 65 per cent of the statewide annual median household income; (ii) minorities comprise 40 per cent or more of the population; (iii) 25 per cent or more of households lack English language proficiency; or (iv) minorities comprise 25 per cent or more of the population and the annual median household income of the municipality in which the neighborhood is located does not exceed 150 per cent of the statewide annual median household income."

shown in Table 3.

Table 2. Total Population and disadvantaged populations within the Buzzards Bay watershed by municipality and disadvantaged population category. Disadvantaged populations categories are not mutually exclusive and are not additive.

Municipality	population in watershed [a]	minority	low income	linguistically isolated	education
Acushnet	10594	1131	2090	47	1231
Bourne	13939	1044	2529	0	400
Carver	8589	441	1903	31	307
Dartmouth	34059	4521	4641	294	3113
Fairhaven	16068	1166	3240	41	995
Fall River*	1313	79	149	30	127
Falmouth*	8427	674	684	11	239
Freetown*	1526	112	198	0	75
Gosnold*	21	0	1	0	3
Kingston	2	0	0	0	0
Lakeville*	52	3	6	0	2
Little Compton*	88	1	10	0	4
Marion	5148	1003	1116	20	235
Mattapoisett	6375	347	236	0	130
Middleborough*	3603	302	534	1	112
New Bedford	93218	38785	37674	4535	14304
Plymouth*	10686	795	869	21	448
Rochester	5232	91	335	6	147
Sandwich*	64	12	26	0	1
Tiverton*	1418	14	108	0	118
Wareham	22690	3707	5387	67	1481
Westport	11880	301	2133	59	800
Total	254,992	54,529	63,869	5,163	24,272
% of watershed population (categories not additive)		*21.4%*	*25.0%*	*2.0%*	*9.5%*

[a] Based on 2020 Census ***blockgroup*** data from U.S. EPA. These data differ from Table 1 which are calculated from Census ***block*** data. Census Blocks in Table 1 are derived from smaller statistical unit areas that do not cross municipal boundaries and is the more accurate estimate of watershed population. However, disadvantaged population statistics are calculated only by blockgroup, so that estimate of watershed population is presented in this table.

*Only a portion of the municipality is within the Buzzards Bay watershed. Populations are estimated from the percentage of the blockgroup polygon within the watershed.

Table 3. Total populations within MA EEA EJ designated block groups and U.S. EPA disadvantaged block groups within the Buzzards Bay watershed [a].

Municipality	MA EJ block group	EPA disadvantaged community
Acushnet	1431	0
Bourne	1766	0
Carver	2579	0
Dartmouth	8673	0
Fairhaven	1808	941
Falmouth	0	0
Marion	1211	0
Mattapoisett	0	0
New Bedford	75413	40772
Sandwich	64	0
Wareham	5618	1392
Westport	1526	0
Grand Total	**100089**	**43105**

[a] 2020 Census data; Population is 231,437 in the watershed in the EJ dataset.

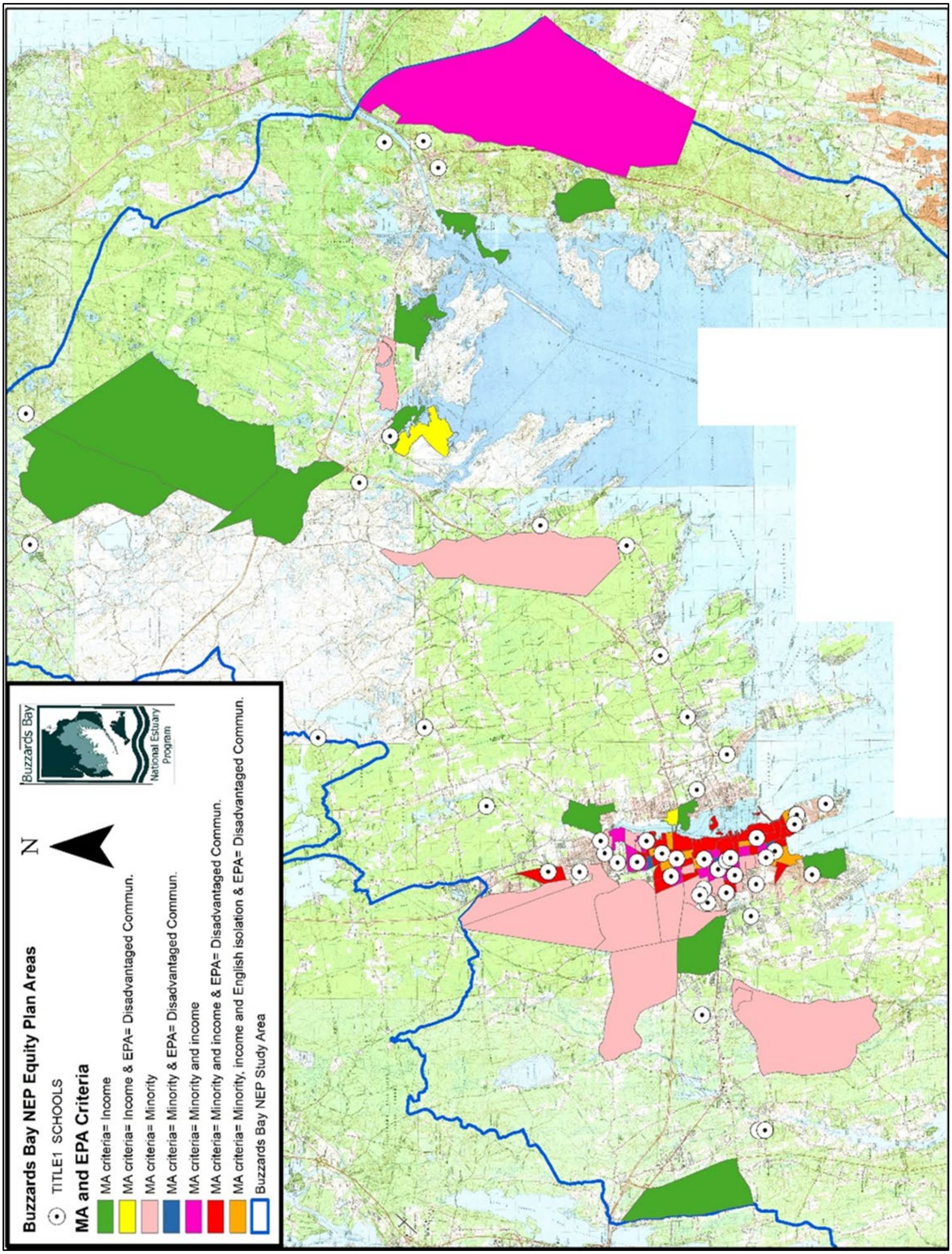

Fig. 1. Massachusetts defined EJ populations in the Buzzards Bay watershed.

NEP Structure

The NEP is a management unit within of the Massachusetts Office of Coastal Zone Management (CZM), within the EOEEA, a cabinet office of the Commonwealth of Massachusetts. Staff are state employees.

The NEP Management Conference consists of a Policy Committee and Steering Committee. The Policy Committee heads up the NEP's Management Conference and consists of the EOEEA Secretary and the EPA New England Regional Administrator, or their designees. The Policy Committee approves the NEP's annual work plan and budget through the signing of an annual Cooperative Agreement between the U.S. EPA and the Commonwealth of Massachusetts.

The six-member Steering Committee is composed of staff from CZM, the U.S. EPA, the Southeast Regional Planning and Economic Development District, the Massachusetts Department of Environmental Protection, and two nonprofits: the Buzzards Bay Action Committee (BBAC), a non-profit composed of municipal officials, and the Buzzards Bay Coalition (BBC), a citizen-based group. Both the BBAC and the BBC are offshoots of the NEP's original Citizens Advisory Committee. The Steering Committee advises the NEP Executive Director in developing the program's annual work plan and budget, reviews progress on implementation activities, and assists in building active partnerships.

The BBC is a broad-based non-profit with comprehensive programs to protect land, monitor water quality and advocate for environmental change. Notably the BBC implements the award winning BayWatchers program that collects water quality data for Buzzards Bay, issues the *Buzzards Bay State of the Bay* reports (with some technical support from the NEP), and maintains the Science Advisory Committee (that includes the NEP director). The NEP Executive Director also attends the monthly meetings of the BBAC, and quarterly meetings of the BBC's Science Advisory Committee to guide program funding and technical assistance. The NEP's participation in these meetings ensures that the program has a mechanism for identifying existing and emerging monitoring, research, and environmental issues. Both the BBC and BBAC were important conduits for disseminating information about this assessment.

Key Climate Drivers Affecting Buzzards Bay

Between 1895 and 2011, temperatures in the Northeast U.S. rose by almost 2°F. However, by the 2080s, some models project a warming air temperature between 4.5°F to 10°F (Horton et al. 2014), with the frequency, intensity, and length of heat waves also increasing. While heat waves are a threat to human health, increases in mean summertime and wintertime temperatures, and changes in dates of first and last frosts, will affect bird migration, species growth, timing of life events, reproductive success, and the geographic range of many species, which will generally shift northward. Similar changes in water temperatures will concurrently occur, also causing range shifts in species, with cooler water species declining in abundance, and warm water species increasing. The decline in lobster abundances in Narragansett Bay has been attributed to increased stressful summertime water temperatures coupled with shell disease, and the increase of an invasive crab species (Wahle et al. 2015).

A warming climate also changes precipitation patterns. Since 1950, increased averaged global temperature resulted in overall increase in volume and intensity of global precipitation, although at the same time, certain regions are experiencing agricultural and ecological droughts (Masson-Delmotte et al. 2021). Increased annual precipitation during the past century can be seen in the rainfall data for New Bedford (Fig. 2). Between 1958 and 2012, heavy precipitation events in the Northeast U.S. increased more than 70%, more than in any other region in the U.S. (Melillo, Richmond, and Yohe 2014). The increase in the number of higher accumulation precipitation events is illustrated by East Wareham, MA weather station data (Fig. 3). Collectively these shifts in precipitation will strain stormwater management networks designed for less intense storms. For stormwater treatment systems very close to shore, groundwater levels may raise as sea level rises affect infiltration of existing systems. For the Northeast, models predict an additional 7-14%

increase of annual precipitation by the year 2100, mostly the result of increased rainfall in cooler months (Frumhoff et al. 2007; Melillo, Richmond, and Yohe 2014). Thus, Buzzards Bay may concurrently see an increase in annual precipitation with a potential of increase in summertime dry periods.

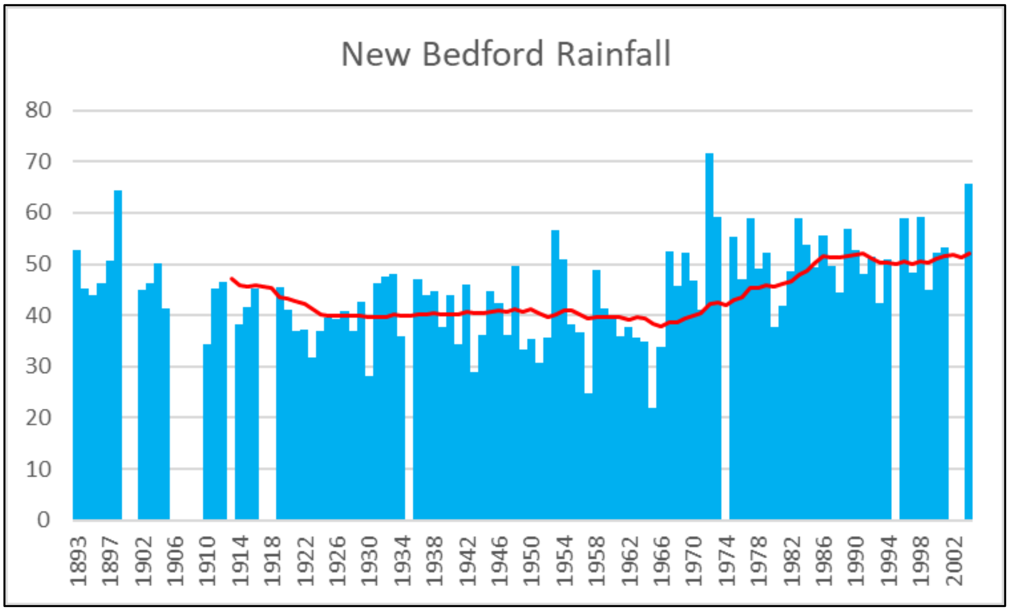

Fig. 2. New Bedford annual precipitation with 20-year rolling average (red line). Years with incomplete data omitted. Data for New Bedford COOP station GHCND-USC00195246 (NEW BEDFORD COOP, MA US (Data downloaded from (www.ncei.noaa.gov/cdo-web/datatools/findstation).

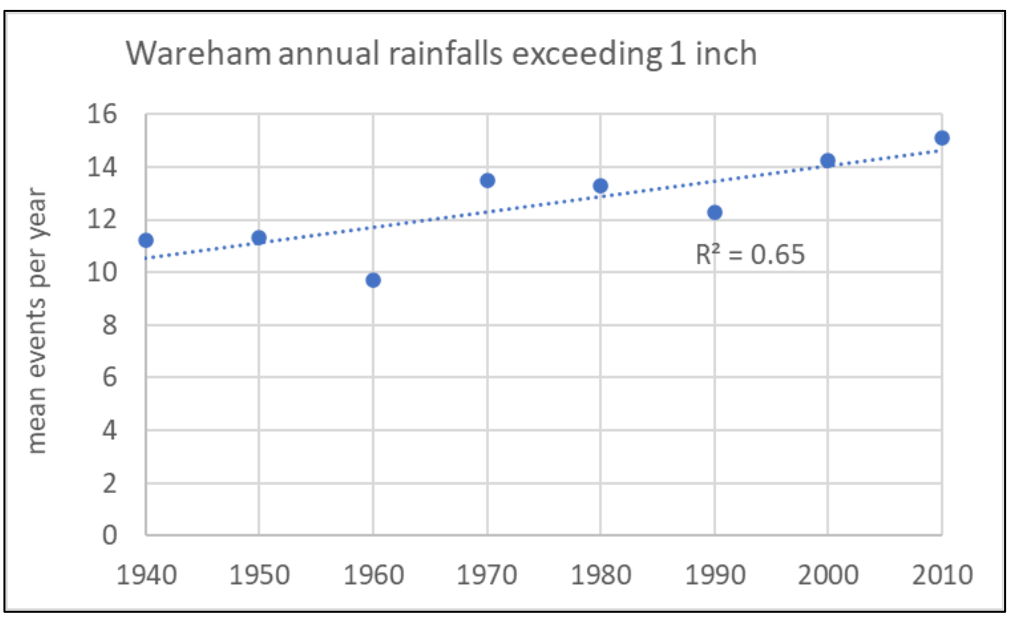

Fig. 3. Wareham decadal mean annual number daily precipitation events exceeding 1 inch. Data for East Wareham COOP station GHCND-USC00192451.

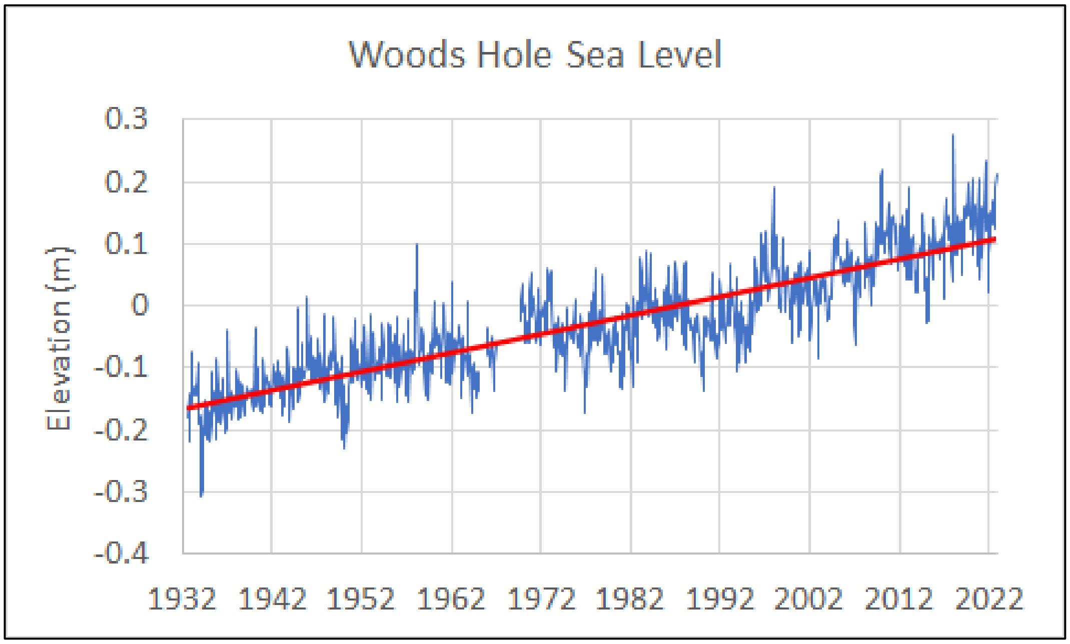

Fig. 4. Ninety-year record of sea level at Woods Hole, MA. Data from tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml.

Relative Sea level (sea level rise relative to land uplift or subsidence) along the Northeast U.S. coastline is projected to increase, on average, 10 - 12 inches (0.25 - 0.30 meters) in the next 30 years (2020 - 2050), which equals the rise measured over the last 100 years (Sweet et al. 2022). The ninety-year record for Woods Hole is shown in Fig. 4, which has a mean annual increase of 3.0 mm per year, which equals about 1 foot per century. The increase in sea level rise will exacerbate the effects of storms and tidal surge of vulnerable areas.

Another impact from climate changes is increased C)2 in the atmosphere reduces the pH of precipitation, which in turn is lowering the pH of the Ocean. This ocean acidification reduces the availability of calcium carbonate in the water, which in turn affects the ability animals like shellfish and corals to build shells and coral skeletons. This in turn may affect survival from predators and reproduction.

Past Climate Change Vulnerability Assessments for Buzzards Bay

In 2012, the NEP conducted sea level rise assessments in Fairhaven, Westport, Dartmouth, New Bedford, Mattapoisett, Marion, and Wareham[2]. Using Federal Emergency Management Agency (FEMA) LiDAR data, the NEP evaluated the potential expansion of the FEMA one percent ("100-year") floodplain given projected 1-foot, 2-foot, and 4-foot rises in sea level using a simple bathtub model of flood plain expansion. The NEP produced maps and identified municipal structures within the floodplain expansion scenarios. This effort preceded the 2013 updated Army Corps Sea, Lake, and Overland Surges from Hurricanes (SLOSH) maps and subsequent CZM online mapping efforts. The reports helped municipalities identify infrastructure facilities that would become subjects of state coastal resilience grants.

Building upon the 2012 NEP effort, in 2014, with funding from the U.S. EPA Climate Ready Estuaries program, the NEP hired SeaPlan, an environmental planning firm, to conduct a climate ready estuary assessment and planning effort for the municipalities surrounding New Bedford Harbor. The purpose of this project was to

[2] Reports available at https://climate.buzzardsbay.org/floodplain-expansion-results.html.

develop an understanding of possible impacts of climate change and potential future responses by the towns of Acushnet and Fairhaven, and the City of New Bedford. Of specific concern was how future increases of sea level, precipitation, and frequency or intensity of storms may affect public infrastructure related to water quality and habitat protection. A special focus of the effort was to understand many vulnerabilities of the hurricane barrier built around New Bedford in the 1960s to protect the harbor, industrial, and city center, including large populations of disadvantaged communities. This funding was part of a national effort by the U.S. EPA to encourage municipalities to enact long-term strategies to adapt to anticipated climate change impacts.

One goal of the SeaPlan study was to improve public and governmental understanding of the vulnerabilities of New Bedford Harbor to future sea level rise and increased precipitation, frequency, and intensity of storms. This was achieved through meetings, workshops, and an interactive website, and with products that included Global Information System (GIS) data, and a final report. The report identified strategies and actions needed to be implemented by the three participating municipalities, particularly to protect important infrastructure, and is included in Appendix B.

Also in 2015, the NEP conducted a pilot assessment of the potential migration of salt marshes at selected sites[3]. This analysis was like the floodplain expansion study in that it evaluated salt marsh expansion and migration by applying 1-foot, 2-foot, and 4-foot increases in sea level to LiDAR data (Fig. 5). The analysis and EPA-approved quality assurance project plan established methodologies and approaches the NEP would use in its subsequent studies of salt marsh loss.

In 2015, the EPA Climate Ready Estuaries program administered a grant to support the New England NEPs in meeting their CCVA needs. The product of this effort was a report modeled after the EPA program's CCVA work. The report was prepared by Battelle (2016a; 2016b) and excerpts of the report are included in Appendix C, and the report recommendations for Acushnet, Fairhaven, and New Bedford, which were largely based on the SeaPlan study findings, are included in Appendix D.

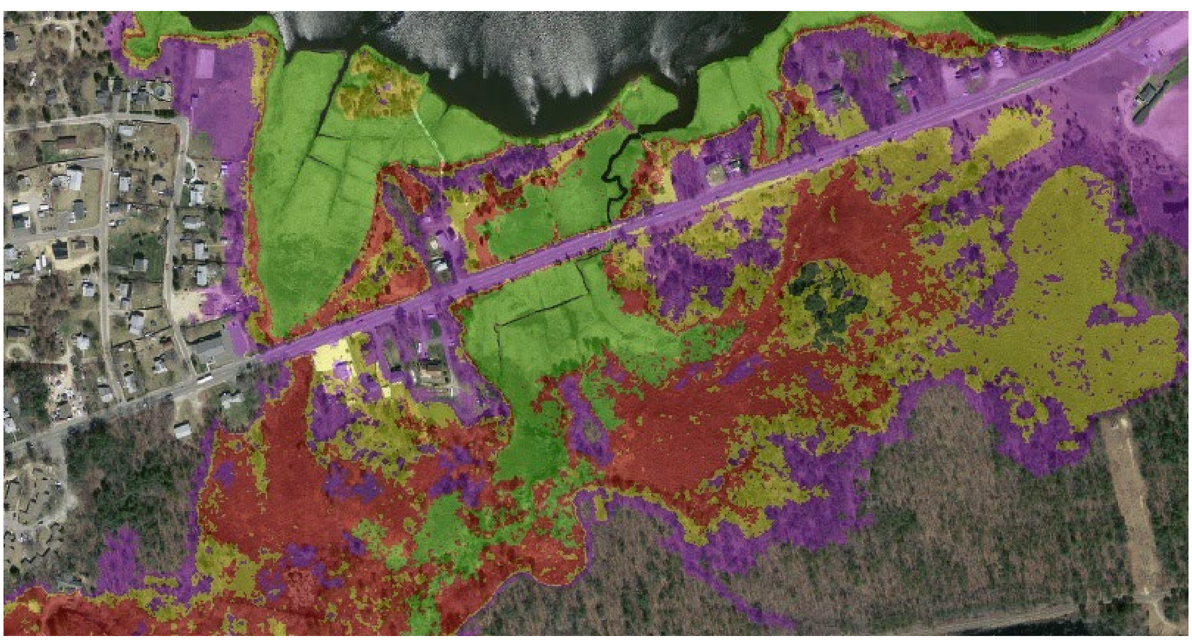

Fig. 5. NEP analysis of salt marsh expansion potential in an area of Wareham (along Rt. 6 near the Agawam River). The green shaded areas show elevations below the high tide line. Red = +1-foot sea level rise, yellow is +2 feet, and purple is +4 feet.

[3] Description and maps available at https://climate.buzzardsbay.org/migrating-salt-marshes.html.

Climate Change Vulnerability Assessment Steps

As described earlier, because many of the CWA water quality and habitat priorities of Buzzards Bay were assessed in tasks contained in the 2016 Climate Change Vulnerabilities Scoping Reports produced by Battelle in 2015 and 2016 (excerpts in Appendix C), this assessment primarily focused on the vulnerability of achieving CCMP goals in the face of climate change. Nonetheless, we followed the framework and recommend steps in EPA's *Workbook for Developing Risk-Based Adaptation Plans*.

Step 1: Communication and Consultation

> *The objective of this step is to list your key stakeholders and learn their particular interests or concerns about climate change risks and the adaptation planning process. You will also prepare a schedule for stakeholder involvement.* -EPA Workbook

To facilitate the development of the CCVA, the BBC was hired under a contract subaward with funding provided by EPA headquarters as outlined in the NEP's federal FY21 Workplan and Budget. The stakeholders consulted in this assessment included municipal, state, and federal government, a county government agency, a regional planning agency, the Buzzards Bay Steering Committee, environmental non-profits and lands trusts within the watershed, and area scientists, including those participating on the BBC's Science Advisory Committee.

The NEP developed a draft assessment summarizing existing CCMP goals and objectives and identifying new climate related goals and objectives as outlined in this document. The draft document was circulated to the BBC's Science Advisory Committee to refine, then posted on the NEP's website. This document was the basis of three public workshops held in February, March, and April 2022 via Zoom. The outreach for the workshops was conducted through the NEP and BBC websites, and through a local list serve (Southeastern Massachusetts Coastal Outreach, SEMCO). A summary of the BBC facilitated meetings and workshop, a list of attendees, and responses to interactive polls during the meeting are shown in Appendix E.

Prior to and during the workshops the NEP posted an online questionnaire about climate vulnerabilities and priorities, particularly with respect to each action plan. The BBC also included a summary of the effort in an email to their members with links to the NEP's web page. The online questionnaire is shown in Appendix F, and responses are shown in Appendix G. The feedback from the online action plan ratings sheets was provided to virtual meeting participants and informed the development of the draft CCVA, which was updated after each workshop. The online forms help inform needed updates to the CCMP.

Step 2: Establishing Context

"The objective of this step is to find and list your organizational goals." -EPA Workbook

The mission of the NEP is to protect and restore water quality and living resources in Buzzards Bay and its surrounding watershed through the implementation of the CCMP. The goals and objectives of the CCMP 2013 update are organized in 21 action plans. The vulnerability of these Action Plans was evaluated as described below.

Achievement of many CCMP goals and objectives are threatened by climate change, and some of these threats were explicitly addressed in the CCMP 2013 update. At a kick-off meeting for the CCVA, which was held in the Fall of 2021 with the Science Advisory Committee, climate change stressors identified in the *Workbook,* including warmer summers, warmer winters, warmer water, increasing drought, increasing storminess, sea level rise, and ocean acidification were discussed in the context of protecting and restoring water quality and living resources in Buzzards Bay and its surrounding watershed. The meeting focused on identification of climate risks to CCMP goals, identification of risks that may be alleviated by existing CCMP actions, and the identification of opportunities to mitigate or avoid risks through the addition or alteration of CCMP actions.

Numerous climate change vulnerability assessment and policy reports have been published in Massachusetts. These data and publications were reviewed and leveraged as much as practical as work to address climate risks is continued throughout the state. Of note, were documents and resources on the Resilient MA website, a Climate Change Clearinghouse for the Commonwealth.

Table 4. Mean rank scores of the Buzzards Bay CCMP Action Plans

Shifting Shorelines	**2.8**
Stormwater	**2.5**
Wetlands	**2.5**
Rare and Endangered	**2.5**
Nitrogen	**2.5**
Water Withdrawals	**2.4**
Shellfish	**2.4**
Waterfront and Watersheet	2.3
Onsite Wastewater	2.3
Migratory Fish	2.2
Ponds and Streams	2.2
Invasive Species	2.2
Toxic Pollution	2.1
Land Use	2.1
Swimming Beaches	2.1
Open Space	2.0
Monitoring	1.9
Oil Pollution	1.9
Debris and Litter	1.8
Public Education and Participation	1.8
Boating	1.7

Step 3: Risk Identification

"The objective of this step is to create a broad list of climate change risks that might affect your organization's ability to achieve its goals." -EPA Workbook

The Buzzards Bay study area CCVA used as a starting point a climate vulnerability assessment of New England estuaries prepared by Battelle (2016a; 2016b), and borrowed elements of the Piscataqua Estuary Partnership vulnerability assessment (Mlsna 2019). The Battelle study was informed by national and regional climate assessments (Cialone et al. 2015; Kunkel et al. 2013; Melillo, Richmond, and Yohe 2017; Wake et al. 2011; 2014), and closely followed the EPA guidance document *Climate Change: A Workbook for Developing Risk-Based Adaptation Plans* (U.S. EPA 2014). Collectively, these documents were used to identify regionally applicable climate risks and to evaluate the likelihood of occurrence and degree of impact to existing goals and objectives of the CCMP, and to identify new climate related goals and objectives for the CCMP update.

Climate stressors such as sea level rise, ocean acidification, more frequent floods, and droughts are consequences of climate change. A risk is defined as a specific climate stressor outcome affecting goals or objectives in a specific action plan.

Informing the risk identification were the results of the workshops in Appendix E, and the results of the online questionnaire in Appendix F is shown in Appendix G. Those responses were further synthesized below. In terms of climate driver effects on Buzzards Bay water quality and natural resources (bay and watershed) over the next 30 years, respondents were concerned with all, but rankings placed them in this order of concern: warmer summer temps (4.4), warmer winter temps (4.3), ocean acidification (4.1), sea level rise (4.0), drought (3.9), and storminess (3.9). in terms of perceived Impediments to local action, the highest mean score rank was costs and funding (3.0), followed by lack of elected official leadership (2.8), lack of local data (2.7), and lack of public understanding (2.6).

Respondents to the questionnaire ranked each action plan to the degree that they would be affected by climate change. The mean response score (1 = not concerned, 5 = highly concerned) for all action plans is shown in Table 4 As shown, the top seven action plans (scores of 2.4 or higher) were shifting shorelines, wetlands, stormwater, nitrogen, rare and endangered species, water withdrawals, and shellfish. Climate change was viewed as less likely of an impact to achieving goals in other action plans like boating, public education, and participation, and controlling debris and litter on beaches and wetlands. The ranking of action plans and priority concerns were similar in both the workshops and online questionnaire, even though more participated in the online questionnaire.

For the goals and objectives of each CCMP action plan, we characterized plausible risks associated with agreed upon climate stressors. As summarized in Table 5, in this analysis we characterized the likelihood or probability of the climate risk actually and meaningfully occurring by 2050 (low, moderate, or high), and the expected severity of the impacts of that risk (low, moderate, or high) on meeting CCMP goals and objectives (not necessarily the overall impact to the environment).

A matrix of the likelihood of occurrence and expected severity of impact of climate risks on meeting CCMP goals and objectives was used to define a prioritization of climate risk vulnerabilities (Table 6). The likelihood of occurrence and expected severity of impact were each ranked Low, Medium, or High. These climate risk vulnerabilities were classified and color-coded as low, medium/moderate, or high. Climate risks that are highly likely to occur and have a high consequence of impact were perceived as among the highest risk by some particpants, but not identified in this way in this report. In this study, preliminary rankings of likelihood of occurrence and expected severity of impact were compiled by the NEP; and through the meetings and online survey forms described elsewhere in this report, refined with input from the Science Advisory Committee, technical experts, regulators, and others. This process helped ensure that a broad range of potential climate related stressors were considered, and the findings of this report thus represent consensus rankings and prioritizations. Because assembling the results of assessment in a matrix like Table 6 for each action were found to be too limiting, results are presented in tabular form for each action plan. In developing new recommended climate related goals and objectives for the planned 2023 CCMP update, and to develop recommendations for new research and assessments, participants considered potential consequences to the goals of the CWA and Estuaries and Clean Waters Act of 2000 (Table 7).

Table 5. Definitions of risk of occurrence and expected severity of impact used in this study

Probability of climate risk occurrence by 2050

	Low	Unlikely
	Medium	Possible; about as likely as unlikely
	High	Probable; more likely than not

Climate risk severity of impact by 2050

	Low	Minor to no impact that require no adaptation action or can be readily adapted to with little disruption to ecosystems, communities, or economy.
	Moderate	Moderate impact that will require some adaptation effort. Adaptation to meet CCMP goals is likely to be successful and not impose high costs.
	High	Expected severe impacts that threaten meeting CCMP goals and objectives; adaptation actions are likely to be expensive or disruptive.

Table 6. Matrix of assessed probabilities and severity of impact used to prioritize risk vulnerabilities.

Risk probability occurring by 2050	Expected severity of impact by 2050 on CCMP goals and objectives: *Low*	*Moderate*	*High*
High	high likelihood of occurrence X low severity of impact = **Moderate Risk**	high likelihood of occurrence X moderate severity of impact = **High Risk**	high likelihood of occurrence X high severity of impact = **High Risk**
Medium	medium likelihood of occurrence X low severity of impact = **Low Risk**	medium likelihood of occurrence X moderate severity of impact = **Moderate Risk**	medium likelihood of occurrence X high severity of impact = **High Risk**
Low	low likelihood of occurrence X low severity of impact = **Low Risk**	low likelihood of occurrence X moderate severity of impact = **Low Risk**	low likelihood of occurrence X high severity of impact = **Moderate Risk**

Step 4: Risk Analysis

To facilitate review of and potential expansion upon the preliminary matrices, online action plan ratings forms and a questionnaire were posted on the NEP website. The purpose was to ensure all potential risks to meeting CCMP action plan goals and objectives have been considered, and to solicit recommendations for assigning probabilities to likelihood of occurrence and severity of impact ratings. This process also created opportunities to identify new goals and objectives for the planned 2023 CCMP update, recommendations for critical research, and the inclusion of key references. For each CCMP action plan set of goals and objectives, a preliminary ranking of climate risk probability and severity of outcome assigned by NEP and BBC staff and the Science Advisory Committee was presented in online forms. The public, agency staff, scientists, non-profits, and local and regional reviewers were given the opportunity to submit their own rankings and provide comments or identify missing information or goals. Each participant was asked the following question:

1) **For each risk:** identify the likelihood of occurrence, severity of impact, time horizon, and spatial scope, or comment upon the draft report.
2) **For each action plan:** Are there other vulnerabilities/risks that should be included for this action plan?
3) **For each action plan:** Do you have any recommendations for critical new research on this subject?

Input from the online forms was summarized and incorporated into final consequence/probability tables for each NEP CCMP action plan. The final risk summaries presented in this report represents a consensus of input developed during meetings, submitted reviews, and online questionnaires. This evaluation will be used to inform the development of the 2023 CCMP update and will be referred to in that document. These matrices might also be used as a starting point for other partner organizations who are interested in exploring their own risk-based climate vulnerability.

Table 7. Key goals of the Clean Water Act and Estuary Restoration Act of 2000 (from Mlsna 2019)

CWA §320 goals:

- Clean-up and control point and nonpoint sources of pollution
- Maintain and improve aquatic habitat
- Protect and propagate fish, shellfish, and wildlife – including control of nonnative species
- Protect public water supplies and recreational activities, in and on the water

Estuary Restoration Act of 2000 goals:

- Promote the restoration of estuary habitat
- Develop a national estuary habitat restoration strategy for creating and maintaining effective estuary habitat restoration partnerships among public agencies at all levels of government and to establish new partnerships between the public and private sectors
- Provide Federal assistance for estuary habitat restoration projects and promote efficient financing of such projects

Action Plan 1 Managing Nitrogen Sensitive Embayments

Goal 1.1. Ensure that no designated uses will be lost, nor ecosystems adversely affected by excessive contributions of nitrogen to any area of Buzzards Bay.
Goal 1.2. Restore lost designated uses and adversely affected ecosystems impaired by the excessive contribution of nitrogen to any area within Buzzards Bay.

Objective 1.1. To develop and adopt scientifically based nitrogen total maximum daily loads (TMDLs) for nitrogen impaired areas of Buzzards Bay.
Objective 1.2. To reduce the amount of nitrogen currently entering nitrogen-impacted embayments, including all areas identified on 303(d) and Integrated Lists, according to limits specified in approved TMDLs.
Objective 1.3. To ensure new additions of nitrogen to coastal waters do not cause, or contribute to, a violation of state surface water quality standards, or exceed federally approved TMDLs.
Objective 1.4. To ensure that state and federal discharge permits meet nitrogen loading limits and waste load allocations specified in approved TMDLs.
Objective 1.5. To promote the development and implementation of local plans to manage nitrogen sources to meet TMDLs and waste load allocations.
Objective 1.6. To promote the development and support the use of alternative and advanced nitrogen reducing wastewater treatment technologies at all scales of flow.
Objective 1.7. Monitor water quality and natural resources like eelgrass beds at a sufficient frequency to document management needs, assess the effectiveness of actions taken, and to document ongoing changes and variability in water quality and ecosystems health.

Outlook

Warmer summers, warmer waters, increasing storminess, increased annual precipitation, increasing frequency of summer drought, sea level rise, warmer water, and warmer summers all pose some risk to the goals and objectives of this action plan. Increased algal growth in waterways will likely occur unless non-point and point sources of nitrogen are further reduced. The impact of these stressors varies in severity to this action plan and CWA goals. The most important impact may be that water quality will likely decline for fixed rates or watershed loading. This means that estuary total nitrogen water quality targets must be lowered to achieve the water quality and habitat goals of adopted watershed nitrogen TMDLs.

Risk Assessment

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
1	Warmer waters will lead to lower oxygen, more rapid algal growth, decreased water transparency, increased nutrient fluxes of ammonium from benthos resulting in decreased water quality for any given watershed load.	High	High	High	Additional reductions in watershed nutrient loading required, adopt lower total nitrogen action limits in TMDL models.
2	Multiple climate stressors will cause elevated total nitrogen concentrations resulting in inadequate TMDL reduction targets to achieve living resource goals.	High	High	High	Additional reductions in watershed nutrient loading required, adopt lower total nitrogen action limits in TMDL models.
3	Multiple climate stressors will result in more adverse effects for the target total nitrogen concentrations adopted in existing TMDLs.	High	High	High	Existing TMDLs must be revised to achieve lower total nitrogen concentration targets in existing to achieve water quality and habitat goals.
4	Warmer water holds less dissolved oxygen and increases plant and animal respiration, which will increase hypoxia stress on populations and lead to failure to achieve dissolved oxygen standards.	High	Moderate	High	

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
5	Sea level rise will cause sea water intrusion into sewer networks through combined sewer overflows, reducing wastewater treatment capacity and nitrogen removal efficiency.	High	Low	Moderate	This is already occurring in New Bedford, but consequences with respect to new nitrogen load not studied.
6	Warmer water will increase algal growth leading to lower nighttime oxygen concentrations and lower water quality index scores	Medium	Moderate	Moderate	
7	Increased precipitation intensity will increase the frequency of discharges from combined sewer overflows resulting in increased N-loading to New Bedford waters.	Medium	Low	Low	Only important around New Bedford.
8	Increasing storminess and freshwater discharges will cause increased water stratification of estuaries leading to increased hypoxia.	Low	Low	Low	May affect certain large estuaries with large riverine discharges, although the higher discharges are expected during cooler times of year.
9	Warmer winters will create a longer lawn maintenance season, increasing use and discharge of fertilizers and pesticides.	Low	Low	Low	Resulting changes probably tiny compared to impacts from other sources and new development.
10	Warmer water will create additional stress to eelgrass survival on top of eutrophication.	High	Moderate	High	Eelgrass recovery is the habitat goal for many Buzzards Bay TMDLs. Eelgrass in lower nutrient environments is more resilient, so lower nitrogen targets are needed to achieve habitat goal in face of rising water temperatures and occurrence of ocean heat waves.
11	Warmer water will lead to more algal growth and blooms, decreasing water clarity and limiting light availability for eelgrass.	High	High	High	Eelgrass recovery is the habitat goal for many Buzzards Bay TMDLs. Eelgrass in lower nutrient environments is more resilient, so lower nitrogen targets are needed to achieve habitat goal.
12	Warmer temperatures will extend growing season and lead to additional crop planting and additional fertilizer and pesticide inputs.	High	Moderate (Estuary-dependent)	High (Estuary-dependent)	Some farmers in the region are already planting additional crops because of an extended warm season. Need to account for additional fertilizer in TMDL budgets where agriculture is a significant proportion of nutrient load. Also addressed in Action Plan 16.
13	Increased precipitation amount and intensity will change nutrient inputs from rivers (amount, forms of nitrogen, rate of delivery, etc.).	Medium	Low	Low	Severity and net risks are unknown and could be more severe than indicated. Will big storms flush the watershed, moving N quickly out to sea?
14	Increases in freshwater to sewer networks will reduce wastewater treatment capacity and nitrogen removal efficiency due to increased inflow and infiltration from sea level rise raising groundwater near the coast and due to increased precipitation intensity leading to higher flows from sump pumps illegally connected to sewer network.	High	Moderate	High	
15	Certain climate stressors, like increasing rates of sea level rise and increased storm intensity, will increase the rate of salt marsh loss in Buzzards Bay	High	Moderate	High	Nutrient TMDLs that modelled salt marshes as net sinks for nitrogen will need to be revised to account for the loss of that sink over time.

Recommended changes to action plan goals and objectives

Add new Goal 1.3: Ensure that watershed nitrogen TMDLs include an adequate margin of safety to accommodate synergistic effects between coastal eutrophication and climate stressors like temperature, precipitation, and acidification.

Revise Objective 1.1. To develop and adopt scientifically based nitrogen TMDLs that include margins of safety for synergistic climate effects for nitrogen impaired areas of Buzzards Bay.

Recommendations for further research

Gain a better understanding of the relationship between water quality and temperature and chance in precipitation patterns on total nitrogen and TMDL water quality goals.

Continue collection and analysis of central Buzzards Bay temperature data (BBC maintains one seasonal station, plus a year-round logger at mouth of canal).

Collect stream flow and water temperature data at streams/rivers throughout the watershed to be able to characterize climate change impacts.

Gain a better understanding of how stormwater management strategies can contribute to nutrient load reductions.

Develop groundwater flow models and groundwater nutrient measurements to be able to better characterize watershed loading and predict impacts of climate change stressors.

Research to understand whether the mix of nitrogen sources will change with climate change (e.g., will there be a higher proportion of dissolved organic nitrogen from increased precipitation/storm intensity?)

Will climate-driven changes in ocean circulation, such as those influencing the Gulf of Maine, impact Buzzards Bay circulation? How will that impact flushing of estuaries, sediment transport, etc.?

Action Plan 2 Protecting and Enhancing Shellfish Resources

Goal 2.1. Increase availability of shellfish resources for recreational and commercial use.
Goal 2.2. Restore habitat to increase the abundance and distribution of shellfish resources.

Objective 2.1. To keep open all shellfish resource areas now open, and to open priority resource areas that are now closed.
Objective 2.2. To increase the ability of the state Division of Marine Fisheries to carry out the sanitary survey program and provide technical assistance to municipalities to better manage shellfish resources.
Objective 2.3. To increase the capacity and commitment of municipalities to remediate pollution sources that are contributing to shellfish bed closures.
Objective 2.4. To expand the use of the conditionally approved classification for shellfish areas.
Objective 2.5. To eliminate pollution sources and disturbances contributing to the permanent loss of shellfish habitat and enhance and restore shellfish habitat.

Outlook

Warmer waters, increasing storminess, and ocean acidification all pose some risk to the goals and objectives of this action plan. These stressors range across the spectrum of severity of impact to CWA goals. The most high-risk vulnerabilities to the goals and objectives of this action plan are related to increased water temperature and ocean acidification. Some shellfish will be at a higher risk for disease and may experience developmental challenges due to acidification, making clam bed restoration more difficult. Actions related to improving water quality relating to changing patterns of stormwater, and potential increases in precipitation or extreme precipitation events are addressed in *Action Plan 3 Managing Stormwater Runoff and Promoting LID*. This action plan focuses heavily on management tools to maximize the access, availability, and abundance of recreational and commercial shellfish stock.

Risk Assessment

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
1	Runoff from more frequent and intense precipitation events will contribute to expansion in the geographic extent and duration of shellfish bed closures.	High	High	High	Division of Marine Fisheries and municipalities should increase the use of rainfall conditional closures for shellfish resources to increase available harvest days.
2	Warmer water will enhance survival of indicator bacteria leading to expansion in the geographic extent and duration of shellfish bed closures.	Medium	Moderate	Moderate	Efforts to reduce bacterial loads in other action plans must be amplified.
3	Increased water temperatures will alter seasonal growth and extent of harmful algae blooms increasing the frequency or extent of shellfish bed closures.	Medium	Low	Low	Efforts to reduce nitrogen loads in other action plans must be amplified. Shellfish restoration efforts should be sited to help complement nitrogen reduction efforts
4	Increasing summertime drought will cause changing freshwater inputs, which will affect salinity distribution in estuaries (important for some species like oysters).	Low	Low	Low	Limited geographic extent in Buzzards Bay
5	Ocean acidification will impair shellfish development, survival, and growth resulting in population declines.	High	Moderate	Moderate	Increase use of shell cultch in shellfish restoration efforts, encourage eelgrass restoration and phytoculture as blue carbon solutions. Eutrophication is the dominant cause of coastal ocean acidification, so reducing eutrophication in estuaries will limit impacts of ocean acidification.

6	Increased storm intensity will threaten aquaculture hard infrastructure, which will limit benefits to wild populations and to water quality.	Medium	Moderate	Moderate	
7	Increased storm intensity will threaten aquaculture and native shellfish stocks by bringing influxes of fresh, acidic water, and/or bacteria.	Medium	Moderate	Moderate	Impacts will be episodic and location dependent with aquaculture operations near the mouths of rivers more susceptible.

Recommended changes to action plan goals and objectives

Actions related to stormwater management, and potential increases in precipitation or extreme precipitation events are addressed in *Action Plan 3 Managing Stormwater Runoff and Promoting LID*.

New Objective: Objective 2.7. Ensure that restoration efforts consider incorporating strategies to ensure that shellfish resources remain resilient to climate effects including acidification, further degradation of water quality, and are sited to ameliorate coastal eutrophication.

Recommendations for further research

Promote research to better define the relationship between temperature and precipitation and water quality indicators and key habitat (e.g., eelgrass beds).
Basic monitoring of pH or carbonate system parameters in waters around Buzzards Bay to understand how it is changing over time.

Action Plan 3 Managing Stormwater Runoff and Promoting Low Impact Development (LID)

Goal 3.1. Prevent new or increased untreated stormwater flows to Buzzards Bay and contributing watershed areas that would adversely affect shellfishing areas, swimming beaches, water quality, and wetlands.
Goal 3.2. Correct existing stormwater runoff flows to Buzzards Bay and contributing watershed areas that are adversely affecting shellfishing areas, swimming beaches, water quality, and wetlands, or exceeding watershed total pollutant load limits.
Goal 3.3. Maintain and restore natural hydrologic conditions to provide base flow conditions to streams, wetlands, and estuaries.
Goal 3.4. To encourage LID techniques in new development and redevelopment, in order to minimize impacts from stormwater.

Objective 3.1. To adopt and implement local and state stormwater LID laws and regulations.
Objective 3.2. To implement effective stormwater pollution remediation projects that include proper design, construction, operation, and maintenance.
Objective 3.3. To provide guidance and incentives for LID that reduces and re-uses stormwater runoff and reduces the need for structural practices.
Objective 3.4. To improve compliance with federal, state, and local stormwater regulations and meet watershed total pollutant load limits.

Outlook

Sea level rise, increasing drought, increasing storminess, and warmer waters all pose some risk to the goals and objectives of this action plan. These stressors range on the spectrum of severity of impact to CWA goals. Failure of wastewater treatment plant (WWTP) operations during major storm events is the stressor of great concern to the accomplishment of this management objective. Measures should be taken to ensure WWTPs remain online during high-intensity storms. Runoff from more frequent and intense precipitation events, combined with warming waters, may lead to the perfect conditions for greater survival of pathogens and toxic algae – putting Recreational and Shellfish Uses at high risk.

Climate Change Risks Assessment

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
1	Runoff from more frequent and intense precipitation events will contribute to expansion in the geographic extent and duration of shellfish bed closures.	High	High	High	This risk is also identified in Action Plan 2.
2	Nuisance flooding of developed areas will contribute to elevated pathogen discharges to surface waters increasing the frequency or extent of shellfish bed closures.	Medium	Moderate	Moderate	
3	Increased precipitation intensity will increase the frequency of discharges from combined sewer overflows (CSO) resulting in increased extent or duration of shellfish bed closures around New Bedford.	Medium	Moderate	Moderate	Similar to Risk #1, except exclusively for New Bedford, CSO discharge volumes will increase in addition to stormwater discharges.
4	Warmer water will enhance survival of indicator bacteria in stormwater discharges, exacerbating adverse effects, and leading to expansion in the geographic extent and duration of shellfish bed closures.	Low	Low	Low	

Recommended changes to action plan goals and objectives

New Objective: Objective 3.5. Strengthen state and local performance standards, such as those for water quality volumes (the volume of stormwater that is treated), to help offset anticipated climate driven degradation.

Recommendations for further research

Fund novel cost effective approaches for diagnosing illicit connections and pollutant sources within stormwater networks to maximize water quality benefits in the face of limited government resources.

Action Plan 4 Improving Land Use Management and Promoting Smart Growth

This action plan is not expected to be impacted by climate change, except those risks associated with more intense storms and greater annual precipitation, which further illustrates the need to adopt wise land use management and smart growth techniques, particularly as they relate to minimizing impervious surfaces and better management of stormwater from development.

Goal 4.1. To improve land use management through the use of Smart Growth strategies in the Buzzards Bay watershed to maintain and improve the natural resources and ecology of Buzzards Bay.

Objective 4.1. To encourage Smart Growth techniques in less developed Buzzards Bay watershed communities to preserve open space, revitalize urban and village centers, focus development on growth centers, and protect natural resources and the environment.
Objective 4.2. To improve local zoning, subdivision, health, and wetlands regulations to manage future growth in a way that protects the environment of Buzzards Bay and its watershed.
Objective 4.3. Promote sustainable agriculture that does not adversely affect water quality.

Outlook

The application of Smart Growth techniques is not directly affected by climate stressors, but as outlined in other action plans, the adoption of policies and regulations that promote Smart Growth can also incorporate strategies to address climate vulnerabilities identified elsewhere in this report.

Climate Change Risks Assessment

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
	Sea Level Rise will force retreat from the Coast	High	Moderate	Moderate	This is highly localized but true for many sites around the Coast of Buzzard Bay

Recommended changes to action plan goals and objectives

This action plan needs to acknowledge that sea level rise is going to force development to retreat from areas as flood zones expand. How and when that will happen and what becomes of the buildings/developed landscaping/septic left behind was raised a concern. These issues must be addressed in the updated CCMP in this action plan.

Recommendations for further research

[None suggested]

Action Plan 5 Managing Onsite Wastewater Disposal Systems

Goal 5.1. Prevent public health threats and environmental degradation from on-site wastewater disposal systems.

Objective 5.1. Enforce the provisions contained in Title 5 regulations such as, siting and design, inspection and upgrades, training, maintenance, mapping, and designation of nitrogen sensitive areas, etc.
Objective 5.2. Where special local conditions exist, encourage boards of health to adopt local regulations to ensure and/or improve environmental and public health protection.
Objective 5.3. Improve management and oversight by municipalities of onsite wastewater disposal systems.
Objective 5.4. In areas where advanced nutrient removal is required, encourage community scale alternative technology systems as a preference over individual alternative systems.

Outlook

This action plan is not expected to be impacted by climate change except those risks associated with more septic systems, or increased nitrogen loading to receiving waters will be exacerbated by climate factors.

Climate Change Risks Assessment

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
1	Increased sea level rise will result in more onsite wastewater disposal system failures	Medium	Low	Low	These impacts will be greatest for systems very near to the coast. The need to upgrading systems for the purpose of nitrogen is addressed in Action Plan 1

Recommended changes to action plan goals and objectives

[None suggested]

Recommendations for further research

[None suggested]

Action Plan 6 Managing Impacts from Boating, Marinas, and Moorings

Goal 6.1. Eliminate the discharge of wastewater from all boats in Buzzards Bay.
Goal 6.2. Eliminate or minimize impacts of discharges from marina operations.
Goal 6.3. Eliminate adverse environmental impacts associated with mooring fields.

Objective 6.1. To ensure there is an adequate number of pumpout facilities in Buzzards Bay.
Objective 6.2. To promote the use of pumpout facilities by educating boaters, making facilities more accessible, and enforcing the regulations.
Objective 6.3. Achieve full compliance of marinas with the Phase II stormwater and Multi-Sector General Permit (MSGP) discharge permits.
Objective 6.4. Ensure compliance of marina power washing activities with applicable state and federal laws.
Objective 6.5. Deploy mooring systems that minimize environmental impacts to habitat and water quality.

Outlook

This action plan is not expected to be impacted by climate change except that boating impacts to receiving waters and habitat may be exacerbated by climate factors, such as more intense storms and warmer waters. Adoption of certain strategies, like conservation moorings, can have benefits in the face of increased intensity or frequency of storms.

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
1	Increased storm intensity and precipitation will result in increased discharge of bacteria from marina pump-out tanks and boat tight tanks.	High	Moderate	High	The severity of impact is highly localized.
2	Increased storm intensity and precipitation will result in increased inputs of harmful chemicals from marinas.	Medium	Moderate	Moderate	The severity of impact is highly localized and depends what materials are stored onshore.

Climate Change Risks Assessment

Recommended changes to action plan goals and objectives

[None suggested]

Recommendations for further research

[None suggested]

Action Plan 7 Protecting and Restoring Wetlands

Goal 7.1 Long-term increase of high-quality wetlands in Buzzards Bay and its surrounding watershed.

Objective 7.1. To protect existing wetlands.
Objective 7.2. To encourage restoration of degraded wetlands.
Objective 7.3. To improve enforcement of wetlands laws.
Objective 7.4. To upgrade the effectiveness of local conservation commissions to protect wetlands.
Objective 7.5. To create new wetlands habitat, especially habitat that can be used by threatened, rare and endangered coastal species and anadromous and catadromous fish.

Outlook

Sea level rise, warmer winters, increased storminess, warmer summers, and increased frequency of summer drought all pose some risk to the goals and objectives of this action plan. Some habitats, like salt marshes, are especially sensitive to climate stressors like sea level rise and storm intensity. Most risks also threaten CWA goals. Many coastal climate stressors to wetlands are also addressed in Action Plan 18, Planning for a Shifting Shoreline and Coastal Storms. Certain climate stressors, like storms and sea level rise, will increase the demand for armoring of the coast, making it more difficult for coastal wetlands to migrate and shift in response to sea level rise.

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
1	Certain climate stressors, like increasing rates of sea level rise and increased storm intensity, will increase the rate of salt marsh loss in Buzzards Bay	High	High	High	Consider restoration strategies on the most important habitat, like nesting areas of endangered roseate terns or threatened marsh sparrows.
2	Warmer water will enhance survival of certain invasive species that will degrade both freshwater and salt-water wetlands.	Medium	Low	Low	Addressed in Action Plan 11
3	Increased precipitation leading to freshwater runoff will limit potential for upslope salt marsh migration.	Low	Low	Low	The likelihood is uncertain
4	Increased precipitation and storm intensity will impact wetland restoration projects, particularly before new vegetation is established.	Medium	Moderate	Moderate	Small geographic impact.
5	Increased summer drought will lead to less successful wetland restoration projects.	Low	Low	Low	
6	Seal level rise and storms will accelerate the loss of salt marshes	High	High	High	
7	Seal level rise and storms will accelerate of vital rare and endangered coastal species habitat	High	High	High	

Climate Change Risks Assessment

Recommended changes to action plan goals and objectives

New Objective 7.6. Strategies adopted to make coastlines more resilient to climate change must be compatible with the migration of wetlands in response to sea level rise and shifting shorelines.

New Objective 7.7. Priority should be given to restore or protect wetlands or threatened species that are most vulnerable to climate impacts (e.g., roseate tern habitat; See related recommendations in Action Plan 11.).

Recommendations for further research

More research is needed to better understand how wetland species and habitat function change in the face of climate stressors. Such research should focus on the most relevant wetland habitat types in the Buzzards Bay watershed.

The slowing of the Gulf Stream is increasing sea level rise rates in Buzzards Bay. How will rapid sea level rise impact salt marshes and other ecosystems and infrastructure?

Action Plan 8 Restoring Migratory Fish Passage and Populations

Goal 8.1. Ensure that the migration of fish species between salt and fresh water is unimpeded.
Goal 8.2. To restore degraded stream habitat and stream functions to ensure the diversity and abundance of fish in Buzzards Bay streams.
Goal 8.3. To manage fishing pressures on anadromous fish populations to ensure the fish harvest and bycatch are sustainable.

Objective 8.1. Ensure adequate funding of state fisheries restoration programs.
Objective 8.2. Ensure that local, state, and federal fisheries regulators manage better the catch and bycatch of river herring and other diadromous fish to promote their recovery and population sustainability.
Objective 8.3. Improve passageways and remove impediments and obstructions to fish migration.
Objective 8.4. Ensure adequate stream flow for fish migration.

Outlook

Warmer summers, warmer water, and increasing frequency of summer drought all pose some risk to the goals and objectives of this action plan. To a degree, level of risk depends upon the species of diadromous fish. Lower summertime stream flows, combined with warming water temperature, are very likely to result in a shift in cold-water species habitats. Riverine tree planting to increase shading is one mechanism to address cold water species. Changes in flow may affect passage of adults or juvenile herring, depending upon the time of year of the impact. Removal of barriers to fish migration are more essential where stream flows are diminished.

Climate Change Risks Assessment

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
1	Certain climate stressors like earlier spring warming and summertime drought, will affect the timing of the return and juvenile departure of migratory species liking river herring.	High	High	High	The management of water control structures must adapt to the changes in water demand and changes in the timing of species migration (see related recommendation in Action Plan 11, Managing water withdrawals).
2	Increasing drought will lower water levels in streams and ponds making it difficult for anadromous fish to migrate up and down stream.	High	High	High	

Recommended changes to action plan goals and objectives

New Objective 8.5. Strengthen regulations to better manage drinking water and agriculture withdrawals, to ensure the passage of adult migratory fish in the spring and juveniles in the fall, especially during drought conditions.

Recommendations for further research

Better monitoring or new assessments of stream flow and temperature, mapping of obstructions and reproductive habitat.

Action Plan 9 Protecting Bio-Diversity and Rare and Endangered Species Habitat

Goal 9.1. Conserve and protect vital fish and wildlife habitats of Buzzards Bay and in its surrounding watershed.

Objective 9.1. Ensure that rare and endangered species areas and vernal pools continue to be mapped and this information made publicly available.
Objective 9.2. Ensure that rare and endangered species habitat is considered in the relevant permit review process.
Objective 9.3. Ensure that important biological and core habitat is protected and conserved.
Objective 9.4. Ensure that the public and government officials are aware of the importance of rare and endanger species and core bio-habitat through effective education efforts.

Outlook

Warmer summers, warmer winters, warmer water, sea level rise, changing pH, and increasing frequency of summer drought all pose some risk to the goals and objectives of this action plan. However, the level of risk highly depends upon the species or habitat type considered.

Climate Change Risks Assessment

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
1	Certain climate stressors will affect the abundance and fecundity of certain threatened, rare, and endangered species.	Medium	Low	Low	Adverse effects are highly species dependent.
2	Warmer water will lead to range shifts - with species that were previously abundant moving north and new species coming into Buzzards Bay	High	Moderate	High	Buzzards Bay is the northern edge of range of many species, so may be large shifts; food web impacts could be large due to top-down control by predators (e.g., lobsters, striped bass)
3	Increased precipitation and storm intensity will impact habitat restoration projects by inundating more places and by placing flooding and/or saltwater stress on vegetation, particularly if it is not well-established.	Medium	Moderate	Moderate	Potential climate change impacts need to be accounted for when planning restoration projects.
4	Sea level rise will result in loss of beach habitat for shorebirds such as piping plovers and terns.	High	High	High	Colonies may need to be elevated to combat sea level rise.
5	Warmer water in cold water streams will reduce habitat suitability for some species including sea run brook trout.	High	High	High	
6	Ocean acidification will impact additional species besides shellfish. Low pH, particularly in combination with hypoxia can negatively impact sensitive larval stages of other species.	Medium	Moderate	Moderate	There is great uncertainty in the assessed net risk of this problem. Impacts will be species specific. More research required to understand how important a threat this is.
7	As climate stressors limit/shift high quality habitat, there will be an increased need for connecting habitat areas to allow species to adapt/migrate.	High	High	High	

Recommended changes to action plan goals and objectives

[None suggested]

Recommendations for further research

Given increasing losses of salt marsh, and rising sea levels, a better understanding of how climate will affect marsh dependent or nesting species like the diamondback terrapins and marsh sparrow.

Wetter winters could create new vernal pools, summer droughts and permanent reduction in groundwater levels may result in wetland loss. The effect of climate change on wetland habitat area and quality needs additional study.

Expand measurements of biodiversity (currently BBC conducts does marsh vegetation, counts river herring) to be able to characterize climate change impacts.

Action Plan 10 Managing Water Withdrawals to Protect Wetlands, Habitat, and Water Supplies

Goal 10.1. Protect and preserve groundwater and surface water supplies in order to ensure a sustainable supply of high-quality drinking water.
Goal 10.2. Protect and restore the natural flows of rivers and the natural waters of ponds, lakes, and wetlands and the habitat that depend on them.
Goal 10.3. Maintain natural hydrology.
Goal 10.4. Protect and preserve estuarine and brackish surface water habitats in river mixing zones.

Objective 10.1. Encourage water use conservation and increase utilization efficiency to minimize water withdrawals, system losses, and associated impacts.
Objective 10.2. Encourage water reuse for irrigation, industrial process water, and other non-potable uses within public health constraints.
Objective 10.3. Update state regulations to reduce the potential of affecting wetlands, surface waters, and other public water supplies.
Objective 10.4. Encourage LID techniques for enhanced stormwater recharge to maximize groundwater recharge.
Objective 10.5. Manage water withdrawals and wastewater discharges from existing and new development to help maintain recharge to the aquifers.
Objective 10.6. Manage equally both public and private water withdrawals in a subwatershed, including the adoption of water use rates that encourage conservation.
Objective 10.7. Limit non-essential water use during droughts.
Objective 10.8. Develop new water supplies and improve infrastructure to improve distribution and reduce redundancy to avoid over utilization of existing wells.
Objective 10.9. Identify and protect open space for future water supplies, when needed, located as far from significant surface water resources as possible to minimize potential impacts on natural water resources.
Objective 10.10. Incorporate new information, when available, from ongoing or planned state studies on water budgets and sustainable yields into local water resources planning and regulation.
Objective 10.11. Encourage accurate tracking of water use by agricultural users and promote agricultural Best Management Practices (BMP) for water conservation.
Objective 10.12. If and when desalinization occupies a water supply role in the watershed, encourage control technologies and operational measures that minimize entrainment and impingement impacts at intakes and preserve the natural salinity structure of receiving water bodies at outlets.
Objective 10.13. Collect and maintain water use data in support of this action plan and for tracking success.

Outlook

Warmer summers and increasing frequency of summertime drought will increase demand for drinking water. Sea level rise associated with storms may affect some public water supply wells on the lower stretches of the Mattapoisett River. Generally, these risks are expected to be minor relative to other factors that drive water demand, such as new development.

Climate Change Risks Assessment

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
1	Increased summer droughts will reduce water levels in streams and ponds, and effects are exacerbated significantly where there are also water withdrawals for drinking water and irrigation water for agriculture.	High	Medium	High	Effects can be locally severe so net risk can be highest for some areas. Regulations controlling the volume of water withdrawals for drinking water and irrigation must be strengthened to adapt to climatological effects.

2	Sea level rise will result in saltwater intrusion of some drinking water supplies and increase pressure on those not impacted by saltwater intrusion.	High	Low	Medium	As coastal properties are forced to abandon private wells due to saltwater intrusion, there will be pressure to increase connections to town water supplies, increasing demand.
3	Increasing drought will reduce groundwater levels, thereby impacting drinking water supply availability.	High	Moderate	High	Net impacts are moderate generally but locally high.

Recommended changes to action plan goals and objectives

New Objective 10.14. The Interbasin Transfer Act must be modified to reflect impacts to river basins like the Mattapoisett River basin, rather than addressing only transfers in or out of the Buzzards Bay basin.

Recommendations for further research

[None suggested]

Action Plan 11 Managing Invasive and Nuisance Species

Goal 11.1. Minimize the potential introduction of new invasive and nuisance species to Buzzards Bay and its surrounding watershed.
Goal 11.2. Reduce the extent and limit the spread of existing invasive and nuisance species that are degrading habitats of Buzzards Bay and its surrounding watershed.

Objective 11.1. Adopt and enforce laws, regulations, and policies that will reduce the potential spread of invasive species.
Objective 11.2. Educate the public, farmers, nursery owners, fisherman, pet storeowners, shipping industry, and other relevant sectors about individual actions that can be taken to reduce the threat of introducing invasive and nuisance species to the environment.
Objective 11.3. Fund and promote actions and studies to control and reduce existing populations of invasive and nuisance species.
Objective 11.4. Monitor existing and new invasives to help discern introduction pathways and to identify species in early stages of introduction where there may be a slight potential for containment.

Outlook

Warmer water, warmer winters, and warmer summers all pose some risk to the goals and objectives of this action plan. Changing climatic conditions are likely to promote the spread of certain invasive species, making their control more difficult. The most likely impacts relate to competitive advantages that some warmer water introduced species will have over endemic species. Certain invasive species, such as *Phragmites australis*, may increase with sea level rise, posing an additional challenge to species management. Certain invasive or nuisance crabs may have climate-related increases in abundance (increased reproductive success or decreased predation) that may result in changes in other species or increased marsh grazing and marsh loss.

Climate Change Risks Assessment

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
1	Warmer water will enhance survival of certain invasive species that will degrade both freshwater and saltwater wetlands.	Medium	Low	Low	Create markets for crabs?

Recommended changes to action plan goals and objectives

[None suggested]

Recommendations for further research

Study the role of invasive crabs on salt marsh loss.

Action Plan 12 Protecting Open Space

Goal 12.1. Preserve the ecological integrity of Buzzards Bay and its watershed by increasing the amount of permanently protected open space.

Objective 12.1. Improve and protect coastal and inland surface water quality through land protection.
Objective 12.2. Protect biodiversity in the watershed.
Objective 12.3. Protect the region's groundwater supplies.
Objective 12.4. Improve the land conservation community's ability to protect open space.

Outlook

This action plan is not expected to be impacted by climate change except that additional consideration should be given to the acquisition of properties that allow for the inland migration of coastal wetlands.

Climate Change Risks Assessment

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
1	Need for coastal retreat of roads and other infrastructure will place development pressure on nearby undeveloped lands for the relocation of infrastructure.	Medium	Moderate	Moderate	

Recommended changes to action plan goals and objectives

[None suggested]

Recommendations for further research

[None suggested]

Action Plan 13 Protecting and Restoring Ponds and Streams

Goal 13.1. Ensure that beneficial water uses will not be lost, nor ecosystems adversely affected, by pollution discharges, nuisance species, or alterations of flow to fresh surface waters in the Buzzards Bay watershed.
Goal 13.2. Restore any beneficial water uses and ecosystem functions lost in watershed freshwater systems caused by pollution discharges, nuisance species, or alterations of flow and volume.

Objective 13.1. Help adopt TMDLs for all freshwaters.
Objective 13.2. Help ensure that plans are developed and implemented to meet recommended TMDLs.
Objective 13.3. Help restore impaired wetlands habitat.
Objective 13.4. Protect open space that enhances and protects lakes, ponds, and streams.

Outlook

Warmer water, increasing annual rainfalls coupled with increased frequency of summertime drought, warmer winters, increasing storminess, warmer summers, and sea level rise all pose some risk to the goals and objectives of this action plan. These risks vary in likelihood of occurrence and expected severity of impact. The most likely impacts relate to shifts in water levels, the distribution of species and changes to water chemistry. Other high-risk vulnerabilities include a decrease in freshwater flows, warming waters, increasing hypoxia, saltwater intrusion further upriver during summer droughts. These changes could result in severe impacts at selected sites, resulting in failure to meet Aquatic Life Use designations on the state's Integrated List in affected waterbodies. Decreased flows and warmer waters may also lead to Recreational Use impairments at selected sites due increased bacteria or harmful algae. Other action plans address climate related impacts to protecting and restoring ponds and streams.

Climate Change Risks Assessment

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
1	Increasing drought will reduce groundwater levels impacting pond and stream water level.	High	Moderate	High	Moderate generally but locally High

Recommended changes to action plan goals and objectives

Need to add additional discussion about climate related impacts.

Recommendations for further research

At selected sites, particularly those with obstructions to fish passage like dams, assess or model how stream form (dimension, pattern, profile) or dams might become more vulnerable to catastrophic failures under new climate regimes.

Need to model and understand the potential stream summertime low flow conditions of the future.

Action Plan 14 Reducing Beach Debris, Marine Floatables, and Litter in Wetlands

Goal 14.1. To ensure that Buzzards Bay beaches, coastal waters, and inland wetlands habitat are clear of harmful and degrading levels of marine debris.

Objective 14.1. Ensure an adequate number and capacity of waste disposal barrels be provided at public beaches and public and private marinas, and boat haul-outs.
Objective 14.2. Stormwater discharge BMPs should include strategies to reduce or eliminate discharges of debris and floatables.
Objective 14.3. Encourage fishermen to not dispose of fishing lines, nets, cables, and trash at sea or on shore.
Objective 14.4. Educate the public and businesses on the importance of reducing litter and marine debris discharges and involve them in the potential solutions.
Objective 14.5. Ensure that state and local officials work in concert to reduce litter on public lands, beach debris, and marine floatables.
Objective 14.6. Identify and map important debris location sites, natural collection points, and potential remediation strategies.

Outlook

This action plan is not expected to be impacted by climate change except in those areas where debris and litter may shift with rising sea level or increasing storminess.

Climate Change Risks Assessment

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
1	Increased storm frequency and intensity will wash more litter from watersheds into coastal waters and wetlands.	High	Low	Moderate	More frequent litter removal from beaches and streets would limit impact of increased flows.
2	Increased storm frequency and intensity will cause more damage to boats and coastal structures creating more debris along the coast.	High	Low	Moderate	More frequent litter removal from beaches and streets would limit impact of increased debris washed ashore.

Recommended changes to action plan goals and objectives

[None suggested]

Recommendations for further research

Analysis of wind data - has there been a shift in dominant wind direction due to climate change? How will wind speeds change?

Action Plan 15 Managing Coastal Watersheet, Tidelands, and the Waterfront

Goal 15.1. To manage the uses and activities in the waters and on the tidelands of Buzzards Bay in an integrated manner using sound assessments of natural resources, habitat, and water quality, to ensure sustainable recreational and commercial activities while protecting and improving ecosystem health and values.
Goal 15.2. Ensure that the effects of dredging activities are minimized on water quality, physical processes, marine productivity, and public health, and that the beneficial use of dredged sediments is maximized.

Objective 15.1. Develop and improve upon geographic databases identifying habitat, natural resources, seabed characteristics, and contamination or impairment hotspots of lands under the ocean to establish a strong technical basis for embayment watersheet planning and management.
Objective 15.2. Promote the development and implementation of municipal embayment management plans to manage the watersheet, protect water quality, vital natural resources, and tideland habitat, and increase shoreline resilience to storms and rising sea level, while allowing sustainable uses.
Objective 15.3. Ensure that dredging methods and timing be conducted to minimize adverse impacts, and where appropriate, transfer sensitive resources out of areas to be dredged.
Objective 15.4. To maximize the beneficial uses of dredged material by creating opportunities by pre-designating or pre-permitting receiving areas (e.g., beach nourishment zones) to expedite permitting, and through increased funding.

Outlook

To a large degree, the climate related issues relevant to this action plan are appreciably addressed in Action Plan 18, Planning for a Shifting Shoreline and Coastal Storms.

Climate Change Risks Assessment

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
1	The myriad effects of climate change on ecosystem health and values will mean that assessments will become quickly out of date because of rapid changes.	High	Moderate	High	Adaptive management and regular communication with researchers will be needed to manage this risk.
2	Sea level rise will increase demand for clean material to maintain beaches and potentially raise salt marshes.	Medium	Low	Low	Opportunities for the beneficial use of dredged sediments must continue to be maximized.

Recommended changes to action plan goals and objectives

[None suggested]

Recommendations for further research

[None suggested]

Action Plan 16 Reducing Toxic Pollution

Goal 16.1. Protect public health and the bay ecosystem from the effects of toxic contamination.

Objective 16.1. To reduce the amount of toxic contamination entering Buzzards Bay and water bodies listed under the 303(d) program.
Objective 16.2. To eliminate hazardous discharges of toxic contaminants from point sources into the bay.
Objective 16.3. To reduce the discharge of toxic contaminants and contaminants of emerging concern into wastewater systems (both septic and sewer).
Objective 16.4. To reduce hazardous discharges from nonpoint sources of toxic contaminants into the bay.
Objective 16.5. To meet all state, federal, and local action levels for water and seafood.
Objective 16.6. To improve local, state, and federal regulation and control of seafood and sediment quality to protect human health and the environment.

Outlook

Sea level rise, warmer water, warmer summers, warmer winters, and increased storminess all pose some risk to the goals and objectives of this action plan. However, these stressors are generally expected to be low-to-moderate on the spectrum of impact to CWA goals. One of the main concerns is the increased conveyance of toxic compounds from urban areas via stormwater networks. Storm damage to Superfund containment areas (contaminated sediment reservoirs) in New Bedford Harbor may pose an additional risk. Sea level rise and rising groundwater elevations nearshore may potentially hamper clean-up at certain hazardous waste sites.

Climate Change Risks Assessment

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
1	Warmer temperatures will extend growing season and lead to additional crop planting and additional fertilizer and pesticide inputs.	High	Moderate	High	Severity and net risk are highly estuary-dependent. Some farmers in the region are already planting additional crop because of extended warm season. Also addressed in Action Plan 1.
2	Increased storm intensity could remobilize polychlorinated biphenyls (PCBs) in/around New Bedford Harbor that are under sediment caps.	Low	Moderate	Low	
3	Increased intensity or frequency of rainfall will increase toxic contaminant discharges in stormwater.	Low	Low	Low	

Recommended changes to action plan goals and objectives

[None suggested]

Recommendations for further research

[None suggested]

Action Plan 17 Preventing Oil Pollution

Goal 17.1. Reduce the amount of petroleum hydrocarbons released to Buzzards Bay.
Goal 17.2. Prevent the occurrence of oil spills in Buzzards Bay, both large and small.
Goal 17.3. Minimize the environmental effects from oil inputs to Buzzards Bay.

Objective 17.1. To promote a regional strategy for preventing oil spills and hydrocarbon discharges.
Objective 17.2. To promote a coordinated and effective regional strategy for responding to large oil spills.
Objective 17.3. To implement a source-reduction plan for chronic inputs of hydrocarbons into Buzzards Bay.
Objective 17.4. To provide adequate facilities for the collection of waste oil from cars and boats.
Objective 17.5. To take enforcement actions against the illegal discharge of oil.

Outlook

Increasing storminess and sea level rise pose some threats to the goals and objectives of this action plan. These vulnerabilities represent a range of risks in terms of likelihood of occurrence and consequence of impact to CWA goals. High-risk vulnerabilities primarily relate to marine transportation and navigability risks due to potential accidents, collisions, and grounding caused by increased frequency and intensity of storms. At some sites, low-clearance bridges may be impacted due to sea level rise. Increased smaller spills from boats and marinas due to storms is another risk.

Climate Change Risks Assessment

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
1	Increased frequency of storms will result in more vessel groundings and increased spills.	Low	Low	Low	Better navigational systems that characterize existing conditions around the bays, like the Physical Oceanographic Real Time System (PORTS), should be implemented in Buzzards Bay

Recommended changes to action plan goals and objectives

[None suggested]

Recommendations for further research

[None suggested]

Action Plan 18 Planning for a Shifting Shoreline and Coastal Storms

Goal 18.1. Protect public health and safety from problems associated with coastal hazards including rising sea level, shifting shorelines, and damage from storms and storm surge.
Goal 18.2. Reduce the public financial burden caused by the destruction of or damage to coastal property.
Goal 18.3. Plan for shifting shorelines and the inland migration of buffering wetlands and shifting sand formations, and the species that utilize these habitats.

Objective 18.1. To incorporate sea level rise, increased frequency and intensity of coastal flooding, and shoreline change phenomena into all relevant planning and management programs.
Objective 18.2. To develop a comprehensive strategy for handling existing structures in areas that will be affected by future shoreline changes and other coastal hazards.
Objective 18.3. To adopt regulatory and non-regulatory measures for guiding growth and development in areas that will be influenced by coastal flooding and new shorelines.
Objective 18.4. To encourage continued restructuring of the national flood insurance program to discourage development in flood prone areas.
Objective 18.5. To adopt emergency response plans to reflect additional needs and constraints caused by reduced access and increased flooding potential of developed coastlines.

Outlook

This action plan already acknowledges that sea level rise is a major threat to coastal wetlands. Warmer winters, increased storminess, warmer summers, and increased frequency of summer drought pose additional risks to the goals and objectives of this action plan. These risks also threaten CWA goals. These drivers will increase the demand for armoring of the coast, making it more difficult for coastal wetlands to migrate and shift in response to sea level rise. Salt marsh loss is expected to increase because of the inability of salt marshes to accrete peat at a fast enough pace to keep up with sea level rise, or to migrate landward due to coastal armoring or development.

Climate Change Risks Assessment

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
1	Certain climate stressors, like increasing rates of sea level rise and increased storm intensity, will increase the rate of salt marsh loss.	High	High	High	Consider restoration strategies on the most important habitat, like nesting areas of endangered roseate terns or threatened marsh sparrows.
2	Warmer water will enhance survival of certain invasive species that will degrade both freshwater and saltwater wetlands.	Medium	Low	Low	Addressed in Action Plan 11
3	Sea level rise will lead to armoring roads and culverts, which will negatively impact coastal ecosystems by interrupting the natural flow of water and sediment.	High	High	High	Medium generally but locally High. Projects must evaluate the impacts on wetlands and coastal areas and mitigate them.

Recommended changes to action plan goals and objectives

This action plan does not explicitly address loss or threats to wetlands from climate change or other stressors, particularly salt marsh loss, and this emphasis needs to be added to the CCMP update.

This action plan should more explicitly promote the adoption of living shoreline practices.

Recommendations for further research

More research is needed into the efficacy of management practices to prevent salt marsh loss, including the use of sediment deposition and runneling.

Document marsh elevations and model future loss to prioritize active and passive management approaches.

Evaluate techniques for the creation of new salt marshes.

Action Plan 19 Protecting Public Health at Swimming Beaches

Goal 19.1. Reduce or eliminate pollution sources contributing to beach closures.
Goal 19.2. Manage beach use to reduce human exposure and health risks based on site-specific conditions.

- Objective 19.1. Reduce contaminated stormwater discharges to beach areas.
- Objective 19.2. Increase public awareness about areas prone to contamination or conditions that may lead to elevated contaminant levels at beaches.
- Objective 19.3. Prohibit pet use of beaches and encourage pet waste collection in stormwater drainage areas.
- Objective 19.4. Develop and implement more rapid assays to document existing conditions, and where necessary implement preemptive rainfall closures.

Outlook

Warmer summers and particularly warmer water temperatures coupled with more intense storms may result in more swimming beach closures because of higher bacteria concentrations related to greater pollutant discharges and increased bacteria survival in water turbid waters.

Climate Change Risks Assessment

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
1	Increased storminess will result in increased frequency and duration of beach closures	Low	low	Low	There is insufficient data or reports to suggest this has happened.

Recommended changes to action plan goals and objectives

This action plan should include a discussion about potential climate impacts, including the possibility of increasing frequency in the appearance of harmful jellyfish.

Recommendations for further research

[None suggested]

Action Plan 20 Monitoring Management Action, Status, and Trends

Goal 20.1. To document environmental trends of water quality and living resources in order to assess the effectiveness of management actions taken or identify the need for new actions.
Goal 20.2. Identify research and monitoring needs to understand more clearly the causes of impairments, reduce uncertainties about health risks, and better define conditions in Buzzards Bay.

- Objective 20.1. Collect and monitor programmatic actions to document implementation of CCMP recommended actions.
- Objective 20.2. Ensure that regulatory agencies define essential monitoring requirements and collect data necessary to evaluate program and project success.
- Objective 20.3. Ensure that funding is available to implement essential monitoring programs.
- Objective 20.4. Revise and adapt monitoring programs to meet changing needs and information gaps.
- Objective 20.5. Disseminate data and syntheses of information to scientists, managers, and the public.
- Objective 20.6. Encourage scientists and agencies to evaluate emerging contaminants and other stressors to the environment.

Outlook

This action plan is not expected to be impacted by climate change except that certain monitoring programs may need to be adjusted to track climate stressors, and certain new monitoring programs should be implemented (e.g., marsh monitoring).

Climate Change Risks Assessment

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
1					

Recommended changes to action plan goals and objectives

Explicitly call out salt marsh monitoring as a needed element.

Recommendations for further research

[None suggested]

Action Plan 21 Enhancing Public Education and Participation

Goal 21.1. To expand the public's knowledge of the natural resources and water quality of Buzzards Bay and surrounding watershed and the threats they face.
Goal 21.2. To increase public participation in actions that support the goals, objectives, and recommendations in the CCMP.
- Objective 21.1. To better convey concepts of watersheds and the flow of water from precipitation along the land surface and in the ground.
- Objective 21.2. To better convey an understanding of pollution sources and pathways in the environment.
- Objective 21.3. To improve the public understanding of human and natural effects on plant and animal populations and ecosystems.

Outlook

This action plan is not expected to be impacted by climate change except that public education about climate related impacts becomes another topic area to be addressed in outreach efforts.

Climate Change Risks Assessment

#	Climate risk (stressor and outcome)	Likelihood by 2050	Severity of impact	Rank of Net Risk	Adaptation Strategy(ies) or Comments
1					

Recommended changes to action plan goals and objectives

[None suggested]

Recommendations for further research

[None suggested]

Steps 5 and 6: Risk Evaluation and Establishing Context for an Action Plan

This assessment evaluated vulnerabilities already addressed by action plans, vulnerabilities which may be mitigatable but are not addressed by existing action plans, but could be included in a future CCMP update, and vulnerabilities where more research may be required. In the preceding Action Plan assessment, many climate risks were identified that will affect meeting the goals and objectives of action plans in the CCMP, were identified through this exercise. For some Action plan goals and objectives, such as public education, no climate risk was identified. However even for this Action Plan, it could also be argued that climate education can compete for the public's attention with other messaging such as educating the public about the impacts of nitrogen pollution to coastal waters. Many identified risks were perceived as seemingly inevitable, and beyond the capacity of the NEP to prevent to prevent them. The implications of these outcomes are summarized below.

Step 7: Deciding a Course

This step is used to identify priority actions the NEP will take to either mitigate or adapt to risks, through the alteration or addition of CCMP actions. Generally, there are four approaches the NEP can take to respond to any given risk (Mlsna 2019):

- Mitigate: Mitigating a risk involves taking actions to reduce the likelihood and/or consequence of the threat to your goals.
- Transfer: “Transfer” is a technical risk management term for having another organization take responsibility for reducing the risk; your risk is mitigated by another party.
- Accept: Accepting a risk means that organization will continue with business as usual and run the risk, dealing with the impact if/when it does occur. You might choose to accept a risk for some time, and work towards mitigation later.
- Avoid: Typically, avoiding a risk involves eliminating its root cause. However, since the NEP itself cannot stop climate change from occurring, and cannot relocate its planning area, avoiding a risk in this context requires a shift in objectives and/or planned action items so that you are no longer exposed to the risk. Avoiding a risk does not mean the impact to the resource or to your place goes away – this is an administrative handling of risk in which you move away from the objective/goal and will no longer be putting resources toward it. This means you may be pulling back from work that you thought was important.

Some suggested actions to mitigate risks were provided in the previous Action Plan assessment section. During the climate vulnerability assessment, participants also suggested reorganizing or combining certain action plans in the updated CCMP. Because of this anticipated reorganization, the final identified approaches above will be defined during the updating of the CCMP, where each action plan will be assigned one or more of the above approaches. In preparing the 2023 CCMP update, the NEP will use the decision-making chart in Fig. 6.

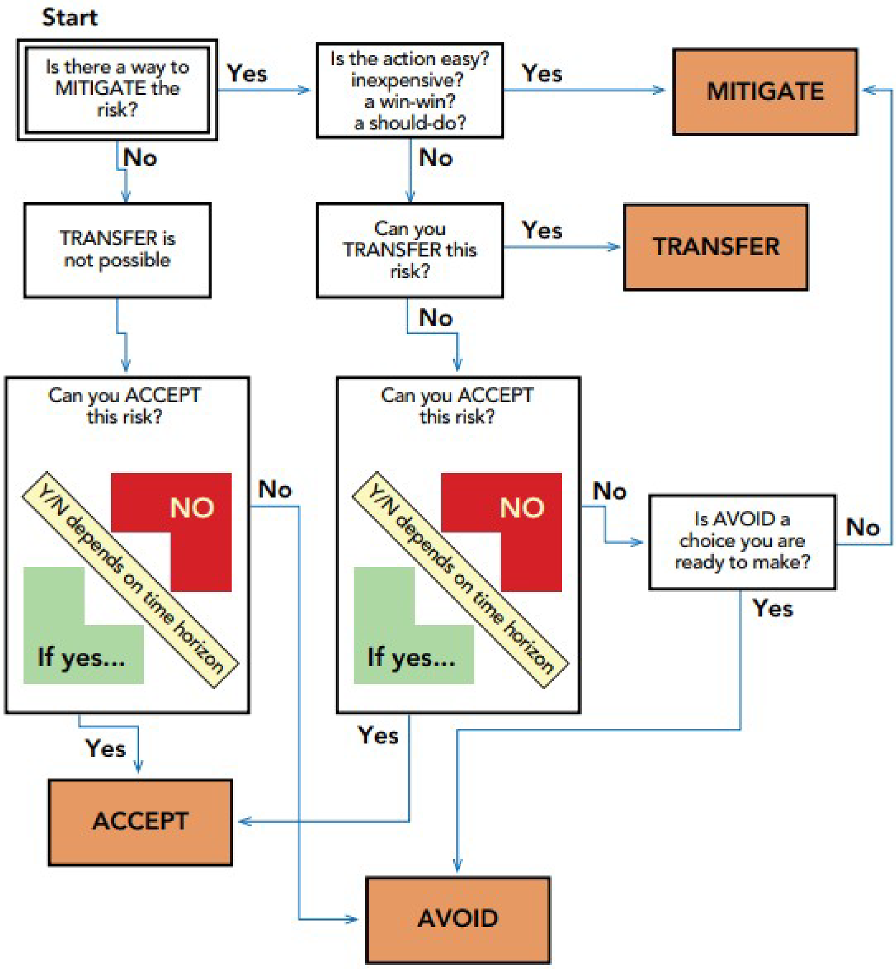

Fig. 6. Decision tree of potential approaches in response to Climate Change taken from the EPA Workbook (Mlsna 2019; U.S. EPA 2014).

Step 8: Finding and Selecting Adaptation/Mitigation Actions

The EPA Climate Ready Estuaries guidance document Synthesis of Adaptation Options for Coastal Areas, and similar documents were used as a template to assess risks in each action plan. As suggested in the EPA guidance, priority for action should be given to strategies that may address more than one risk. Several such examples were identified in this assessment. For example, climate related increased annual precipitation and increased precipitation during storms will increase stormwater discharges that will affect water quality and living resource goals in the Managing Nitrogen Sensitive Embayments, Protecting and Enhancing Shellfish Resources, and Managing Stormwater Runoff and Promoting Low Impact Development Action Plans. In this case, the climate impact can be mitigated by more stringent performance standards by increasing the volume of first flush, and updating statistics that define for 2-, 5-, 10-, and 100-year storms volumes used for sizing stormwater treatment systems. Similarly, increased water temperatures will exacerbate low oxygen concentrations caused by coastal eutrophication from watershed nitrogen loading. While the NEP cannot prevent expect water temperature increases in Buzzards Bay, and increased margin of safety can be incorporated into watershed nitrogen total maximum daily loads to offset low oxygen caused by increased water temperature alone. The impact on CCMP goals from other climate stressors like sea level will be addressed through avoidance (landward retreat) or acceptance of risk. In the planned CCMP update, NEP staff and partners will discuss a range of feasible actions (regulatory, economic, and political) to adapt to or mitigate each identified risk in this assessment. Any potential actions will also be reviewed for robustness and the strength of scientific evidence. The Buzzards Bay NEP recognizes that given the uncertainty about future climate, adaptive management approaches are essential.

Summary and Conclusion

This climate vulnerability assessment identified many climate risks that will affect meeting the goals and objectives of action plans in the CCMP. Climate stressors like increased temperature and increased precipitation will have the greatest impact on Action Plans related to water quality like nitrogen management and those related to the control of bacteria discharge from stormwater that affect shellfish bed and beach closures. The expected increased pollution discharges and synergistic effects like warmer waters depress oxygen concentrations that are already depressed from excessive algal growth. These water quality changes also facilitate bacteria survivals. Some of these climate impacts (like those associated with increased conveyance of nitrogen and bacteria, can be mitigated by more stringent reductions in pollution control standards to offset the new stressors. The effects of other stressors, like ocean acidification, may have different effects, much harder to control, like adversely affecting reproduction, growth, and biomass of shellfish populations. Sea level rise cannot be directly mitigated, so options may include protection, accommodation, coastal advance, and retreat. In these instances, decisions to accept loss will be defined by property owner acceptances of risk in the face of government programs that encourage risky development practices through financial incentives. Many of the identified risks were perceived by participants as inevitable, and beyond the capacity of the NEP to prevent. Thus, the management efforts in the CCMP must focus on climate adaptation approaches if mitigation is impossible. In this respect, the NEP could help communities and partners implement strategies that are most effective to adapt to these impacts. Other impacts may be through state and federal policies and grant programs. These concepts must be incorporated into each action plan in the updated CCMP.

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TECHNICAL REPORT

Appendix B

Climate Change Vulnerability Assessment and Adaptation Planning Study for Water Quality Infrastructure in New Bedford, Fairhaven and Acushnet

Prepared by SeaPlan for
Buzzards Bay National Estuary Program
June 30, 2014

Abstract

The City of New Bedford and the neighboring Towns of Acushnet and Fairhaven are particularly vulnerable to the impacts of sea level rise (SLR), especially in the event of a hurricane barrier failure in a storm. The projected interaction between SLR, increased storm intensity, and heavier precipitation is expected to impact the area's public and private property including associated water quality infrastructure and at-risk populations. A SeaPlan led team, which included RPS ASA and Fuss & O'Neill, modeled hypothetical worst case inundation scenarios using a combination of hurricane parameters and SLR scenarios, and used the model results to conduct a vulnerability analysis of water quality infrastructure, public property and populations. We also quantified economic and structural damages from storms, and formulated recommendations for adapting water quality infrastructure to prepare for storm events. The results of the vulnerability analysis showed that hurricane barriers around New Bedford Harbor began to be compromised by Category 2 hurricanes with 4-foot SLR and Category 3 hurricanes at current mean higher high water (MHHW). At a Category 3 storm with 4-foot SLR, maximum inundation depths in the area would reach 32 feet. This scenario would also result in inundation at the site of 100% of Designated Port Areas, 36% of publically-owned structures, 26 pump stations, and one wastewater treatment facility. It would also affect over 30,000 residents of environmental justice communities. Damage quantification analyses estimated $3.5 billion in projected economic damages to buildings and substantial damage to 1,399 buildings. Municipalities can use a water quality infrastructure adaptation project adaptation matrix developed in the report to prioritize projects which will protect critical water quality infrastructure from storm-related damages. Recommendations include adding on-site generators, checking for buoyancy, and flood-proofing doors, electrical systems and air intakes at vulnerable structures. The data generated during this study will further the municipal, state, and federal government's understanding of public infrastructure vulnerability and help municipalities plan for future storm events.

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Cover Images: "Damaged House in Massachusetts", "Road Closed in New Bedford" and New Bedford Hurricane Barrier" by US Army Corps of Engineers; "Hurricane Irene" by NOAA; and map by SeaPlan

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Contents

Executive Summary

With the threat of climate change impacts such as sea level rise (SLR), and potentially more severe storms and precipitation events, coastal communities need to consider adaptation practices to protect populations and vital infrastructure. To address this need, the Buzzards Bay National Estuary Program (NEP) contracted SeaPlan to assess potential climate change vulnerability and mitigation strategies for water quality infrastructure in the three communities surrounding New Bedford Harbor under various SLR and storm surge inundation scenarios. The City of New Bedford and the Towns of Acushnet and Fairhaven share the harbor and are home to 50% of the Buzzards Bay watershed population, so it is important to assess to what degree these populations are at risk, and to identify climate change adaptation practices that are most critical for the the three municipalities.

SeaPlan, along with project partners RPS Applied Science Associated (RPS ASA) and Fuss & O'Neill, conducted inundation modeling using the National Oceanic and Atmospheric Administration's (NOAA) Sea, Lake and Overland Surge from Hurricanes (SLOSH) model to produce more than 60,000 storm surge predictions representing various combinations of SLR and hurricane parameters. These parameters included radius of maximum winds, forward speed, track direction, landfall location, and barometric pressure. We aggregated the storm surge results into 20 inundation depth grids, each representing worst case inundation for a particular hurricane category and SLR scenario. We then used the inundation data to determine inundation vulnerability of priority infrastructure, public property, and populations, using MassGIS and other local databases, and to estimate potential damages and economic losses using the Federal Emergency Management Agency's (FEMA) Hazus model. A panel of experts, including water quality infrastructure engineers and planners, analyzed a subset of the modeled data to evaluate the vulnerabilities and formulate recommendations for water quality infrastructure. Throughout the project, stakeholder engagement was an essential component in order to integrate ideas and values of local municipalities. The results and data products from the project were compiled into two online data visualization tools. The mapping tool uses the ArcGIS Online Story Map application to visually compare flooding scenarios and identify vulnerable infrastructure, while the risk communication tool compares estimates of economic losses between hurricane scenarios.

The results of the vulnerability analysis showed that hurricane barriers around New Bedford Harbor began to be compromised by Category 2 hurricanes with four feet of SLR and Category 3 hurricanes at current mean higher high water (MHHW). Rising baseline sea levels exacerbated inundation depths, extents, and projected damages in all hurricane scenarios. A range of storm parameters were modeled from low intensity (Category 1 with no SLR) through catastrophic (Extreme Category 4 with 4-foot SLR). The following summary describes results of the vulnerability analysis through a Category 3 with 4-foot SLR only, as higher intensity storms have never been recorded in the area. The relative risk of these or worse catastrophic storms making landfall in the area in the future would require additional analyses. Expected impacts from the modeled hurricane Category 3 SLR scenarios for the entire study area (New Bedford, Fairhaven and Acushnet) include:

- Maximum inundation depths of 11 to 32 feet above sea level
- 65 to 100 percent of Designated Port Area will be within inundation zones
- 4 to 36 percent of publically-owned structures
- Inundation at the locations of 6 to 39 percent of state-owned buildings
- Economic damages to buildings (which include replacement costs) ranging from $559 million to $3.5 billion
- Substantial structural damage might occur to 1,399 buildings with a Category 3 hurricane with 4-foot SLR
- Between 9,315 and 34,223 residents of environmental justice communities will be affected in the Category 3 scenarios

The report identifies the following water quality infrastructure features as high risk, based on their locations in the Category 3 floodplain at baseline conditions (no SLR):

- 1 pump station in Acushnet,
- 10 pump stations in Fairhaven,
- 4 pump stations and 1 wastewater treatment facility in New Bedford.

Additionally, 24 combined sewage overflows (CSO) are located in the City of New Bedford, and many of these will be significantly adversely affected by SLR.

Based on the modeling results and on typical standards for the design of wastewater infrastructure, the project team recommends that municipalities plan for at least a Category 3 storm occurring at current MHHW and that they take actions to evaluate and protect water quality infrastructure against damage at those predicted water levels. Based on available data from each municipality, we developed 24 site-specific adaptation actions that the municipalities could undertake to protect wastewater infrastructure from structural damages and to ensure functionality during inundation events and to be prepared for SLR. Examples of projects include adding on-site generators, checking structures for buoyancy, and flood-proofing doors, electrical systems and air intakes. The potential total study area construction costs for these projects could range from $1,240,000 - $5,200,000; however, that does not include costs for the necessary additional planning, modeling, and requisite engineering design that would be necessary to ground-truth and refine these recommendations.

To help the towns prioritize adaptation projects, the report includes a prioritization matrix, which calculated a priority ranking score based on project cost, inundation risk, and the relative system-wide importance of each facility. The following projects received the highest priority rankings based on this prioritization tool:

- Conduct a hydraulic modeling study of New Bedford's CSO system to assess the system's ability to store water during various hurricane scenarios (cost unknown)
- Add a floodproof door and extend vents on the Slocum St. pump station in Acushnet. Potential cost range is $10,000 - $25,000.
- Check South St. pump station in Fairhaven for buoyancy; potentially add floodproof door and remote controls. Potential cost range is $10,000 - $250,000.
- Floodproof doors, raise electrical service, and assess gas service at E. Rodney French Blvd. and Cove Rd. pump stations in New Bedford; Potential cost range is $25,000 - $250,000 for each pump station.

These recommendations are based on relatively coarse planning-level analysis, and should be viewed as starting points. It is recommended that all future actions be further refined based on site-specific investigations and any new information available to municipal decision-makers. Additional recommendations and considerations for each municipality can be found in the prioritization matrix of this report.

Through this study, the municipalities of New Bedford, Acushnet, and Fairhaven have taken important steps toward understanding and evaluating the potential impacts and vulnerabilities to climate change. This report provides important information essential for planning and prioritizing climate adaptation actions and identifying issues requiring more study. The information from this report can be used to prioritize specific actions to reduce those impacts and to target future more detailed vulnerability assessments.

If more detailed modeling is required for future predictions and analyses, the municipalities might consider leveraging the results of this project to hurricane parameters using the Finite-Volume Coastal Ocean Model (FVCOM) or other fine-scale modeling approaches which incorporate wave exposure, flood duration, and erosion. With respect to adaptation practices, it is important that each community continue to evaluate risk of public buildings and water quality infrastructure using the latest available information and implement cost effective measures to minimize threats to the critical infrastructure upon which their residents depend.

Project Background and Overview

New Bedford Harbor, which is shared by the City of New Bedford and the Towns of Acushnet and Fairhaven, is protected by a hurricane barrier that was completed by the US Army Corps of Engineers in 1966 (USACE 1997). The barrier and dikes protect a heavily urbanized and industrial area, an environmental justice community, a nationally important fishing fleet, and a center for the seafood processing industry. About 50% of the Buzzards Bay watershed population lives in these three communities.

Beginning in 2012, the Buzzards Bay National Estuary Program (NEP) and Massachusetts Office of Coastal Zone Management (MA CZM) have jointly conducted a draft evaluation of sea level rise (SLR) impacts, using LiDAR data, to New Bedford Harbor. These studies revealed apparent low areas on the hurricane barrier, which may increase the vulnerability of otherwise protected areas. The inconsistencies between NGVD elevations and NAVD88 LiDAR data, as well as possible errors in the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) have made it challenging to evaluate the vulnerability of some critical public infrastructure (Costa et al. 2013). This work generated particular concern about sea water intrusion into the combined sewer overflows (CSOs) in New Bedford and other water quality infrastructure vulnerabilities (Webler et al. 2012). Given these concerns, Buzzards Bay NEP recognized a need for a more rigorous evaluation of how SLR might affect storm impacts in the greater New Bedford area.

To address this need, the Buzzards Bay NEP and MA CZM contracted SeaPlan to model hypothetical storm surges, quantify associated damages, identify vulnerable structures and populations, develop data products and tools, and create an informed series of recommendations for enacting short and long term adaptation actions. SeaPlan is a Boston-based non-profit science and policy group which focuses on fostering decision making and planning through best available science and stakeholder engagement. The team also included modeling and data visualization tool development from RPS ASA, and water quality and engineering expertise from Fuss & O'Neill. The over-arching goals of the project were to:

- Improve the understanding of local officials in New Bedford, Fairhaven, and Acushnet about the vulnerabilities of public infrastructure (especially wastewater and stormwater) to future SLR and potential increased frequency and intensity of storms through the use of easily-accessible and interpretable data products; and
- Identify priority adaptation strategies to guide municipalities in implementing future changes in infrastructure maintenance planning and lead to a reduction in long-term vulnerabilities of public and municipal infrastructure

This technical report details the methodology, results, and conclusions from this study. The interactive mapping tool and the risk visualization tool found at seaplan.buzzardsbay.org summarize the results of this study and can serve as decision making tools for municipal leaders and other stakeholders.

Methodology

The study was comprised of the following five project components:

1. Inundation modeling
2. Vulnerability analysis and damage quantification
3. Water quality engineering analysis and recommendation development
4. Stakeholder engagement
5. Data visualization tools

Inundation modeling using the National Oceanic and Atmospheric Administration's (NOAA) Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model resulted in over 60,000 scenarios run with SLOSH. The results were aggregated to develop 20 "summary depth grids" representing maximum inundation for each combination of hurricane category and SLR scenario. The team used these depth grids to produce maps and tables which summarized vulnerable infrastructure and populations, and to estimate economic and structural damage using the Federal Emergency Management Agency's (FEMA) Hazus model. Results of the vulnerability analysis informed the water quality engineering analysis, which resulted in a series of recommendations for CSOs, pump stations and wastewater treatment facilities. A series of stakeholder engagement meetings and workshops informed our modeling approach and subsequent analyses which highlighted key priorities for municipal officials, as well as state and federal agencies. The development of online data visualization tools was a key component of our outreach strategy. The following sections describe the methodology for each component of the project.

Inundation Modeling

The team used the SLOSH model (Jelesnianski et al. 1992) to forecast hypothetical storm surges for New Bedford, Fairhaven and Acushnet under current and future conditions. SLOSH was developed by the NOAA/National Weather Service Meteorological Development Laboratory and is used operationally by NOAA's National Hurricane Center. SLOSH includes a surface wind model and can simulate overtopping of barrier systems, levees, and roads, flow through barrier gaps, and inland inundation. The US Army Corps of Engineers (USACE) used SLOSH as part of its Southern Massachusetts Hurricane Evacuation Study (USACE 1997) which was updated in 2013.[1]

A comparison of several storm surge planning tools can be found in blue call-out box on the next page. Although SLOSH lacks some of the physics of more robust circulation models, a major advantage is that it requires very little computational time, meaning that for a given area of concern, an ensemble of SLOSH simulations (i.e., thousands of runs) can be performed to examine the effect of slight perturbations in storm track, speed, and size on storm surge.

[1] Updated maps from this study can be found at http://www.mass.gov/eopss/agencies/mema/hurricane-inundation-maps.html

Model Inputs

The stakeholder engagement activities described in later paragraphs informed the model parameters used in the analysis. Participants at the kick-off and agenda development meetings vetted the project team's recommendations for project-specific model inputs and methodology. The three main components of SLOSH model inputs are the SLOSH basin, which provides the computational grid for the area of interest, a matrix of hurricane parameters, and the base water level. The hurricane parameters include pressure deficit, radius of maximum winds, landfall location, forward speed, and track direction. The model uses the hurricane parameters defined for each model scenario to calculate water in each model grid cell at each model time step.

We used the Providence/Boston (PV2) basin (Figure 1), which is used operationally by the NOAA National Hurricane Center. The grid's center point is between Providence and Boston. The highest resolution of the grid is in Narragansett Bay, where the resolution is 0.2 NM. Of the basins available for the region, the PV2 basin is the most recent and offers the highest resolution (0.5 NM at the New Bedford Hurricane Barrier). The vertical elevations in the Providence/Boston basin digital elevation model (DEM) are relative to NAVD88.

The matrix of storm parameters used in SLOSH was developed from the catalog of storms used by NOAA to generate the composite Maximum Envelope of Water (MEOW) and Maximum of MEOWs (MOM) products produced for each hurricane category for the PV2 basin. To account for the uncertain impacts of climate change on hurricane intensity, the project team recommended expanding the ranges of pressure deficit, forward speed, and radius of maximum winds parameters.

We used feedback from the kick-off meeting, described in future sections, to prepare a draft input matrix, and then performed a sensitivity analysis to determine the parameters that were most influential causing high water levels in the area of interest. The analysis revealed that the largest pressure deficit and fastest forward speeds caused the largest storm surges. It also showed additional sampling of the radius of maximum winds and track direction should be included in the matrix. The team added these additional parameters to the input matrix, which is summarized in Table 1. Figure 2 depicts the landfall locations used in the model.

COMPARISON OF STORM SURGE PLANNING TOOLS

There are several models and tools that are used to predict storm surge inundation depths and extents. While this does not contain an exhaustive list of these tools, it outlines several approaches which are applicable in the region. Municipal, state, and federal planners are often familiar with FEMA's FIRMs, which depict the 1% risk area (100-year storm) or a 0.2% risk area (500-year storm) of inundation vulnerability. Base Flood Elevations (BFEs) within the floodplains indicate the inundation depth resulting from these storms. FIRMs are used to determine flood insurance rates and requirements, and also to establish regulations and standards for development within a floodplain. BFEs are calculated using storm surge stillwater elevations, wave heights, and other wave parameters (FEMA 2007).

Like the model used to create FEMA's Flood Insurance Rate Maps (FIRMs), the NOAA Sea Lake, and Overland Surges from Hurricanes (SLOSH) model is used to identify areas that are vulnerable to inundation from storm surges. While FIRM BFEs are calculated using storm surge stillwater elevations, wave heights and other wave parameters, SLOSH uses stillwater elevations along with a matrix of hypothetical hurricane parameters to generate inundation extents. Wave heights are not included in the model. In the Buzzards Bay area, the 1% FIRM area corresponds roughly to Category 2 hurricanes modeled by SLOSH, while the .2% FIRM area roughly corresponds to a SLOSH Category 3 hurricane.

The Finite Volume Coastal Ocean Model (FVCOM) currently in development at the School of Marine Science and Technology at the University of Massachusetts Dartmouth is another example of a modeling tool that can be used to model storm surges. This fine-scale model uses an unstructured grid which is beneficial in modeling complex coastal features, and also features the ability to incorporate wind-wave interactions (Chen et al. 2003; Qi et al. 2009).

Table 1. Final matrix of hurricane parameters used as SLOSH model inputs. Values marked with an asterisk were added to the matrix based on feedback from municipal officials at the kick-off meeting. Bold values were added based on the results of the sensitivity analysis.

Parameter	Values	# Variations
Landfall Location	Evenly spaced along the shoreline	12
Pressure Deficit (ΔP)	20, 40, 60, 80, 90* mb	5
Radius of Maximum Winds (R)	**20***,30, **40**, 45, **50**, **55*** NM	6
Forward Speed (T)	20, 30, 40, 50, 60, **70*** mph	6
Track Direction (Θ)	N, NNE, NNW, NW, **NtW***, **NWtW**, **NtE***	7
	Matrix Total Cases	**15,120 per water level** **60,480 total**

The base water level input to SLOSH is typically defined as a tidal elevation. In order to address the purpose of this study, we used four base water levels: current conditions and three SLR scenarios. In this case, we used a tidal elevation alone and in combination with 1, 2, and 4 feet of SLR for each set of hurricane parameters. Current conditions were defined using mean higher high water (MHHW). MHHW is the average of the higher high water height of each tidal day and thus represents areas that are, on average, wet once per day. Although there are two NOAA CO-OPS stations (Station 8447712 at New Bedford, Clarks Point, MA and Station 8447584, New Bedford Bridge station) in the study area, neither provide offsets between tidal datums and NAVD88 (as required by the SLOSH model when using the PV2 basin). Therefore, the MHHW water level referenced to NAVD88 at NOAA CO-OPS Station 8452660 at Newport, RI is transformed to the NOAA CO-OPS New Bedford Bridge station (8447584) using a the 1.05 multiplicative relationship calculated by NOAA using a series of simultaneous observations between the two stations. The locations of the NOAA CO-OPS stations are presented in Figure 3 and the four water levels that SLOSH was initialized with are provided in Table 2.

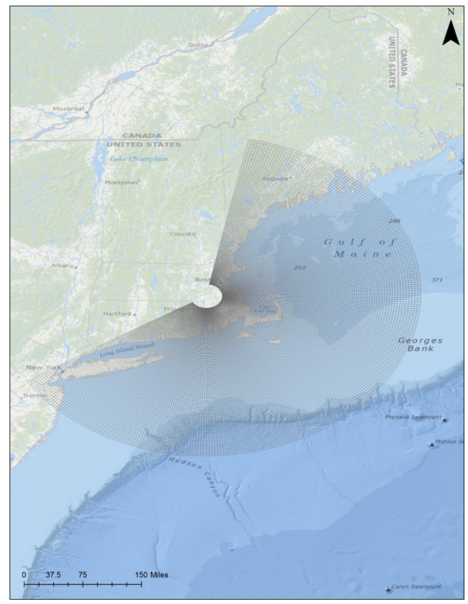

Figure 1. Boston Providence depth grid used as SLOSH model input

Depth Grid Processing

Running all combinations of hurricane parameters in the input matrix (Table 1) under the four base water level scenarios resulted in a total of 60,480 storm tide grids (15,120 per water level). To summarize the model outputs, the team aggregated the results by hurricane category (Categories 1-4 and extreme 4, based on pressure deficit parameters of 20, 40, 60, 80, and 90 mb) and base water level scenarios (0, 1, 2, and 4-foot SLR) to create 20 summary grids based on the MOM approach used by NOAA. The MOM approach takes the maximum storm tide value for each grid cell from a group of model results. Thus, the resultant grid does not represent the storm tide specific to one particular event (or set of storm parameters), but provides the worst-case water level elevation for each location (grid cell). The results of this aggregation approach are 20 summary grids showing the worst case water level in each SLOSH grid cell for all combinations of base water levels and hurricane category.

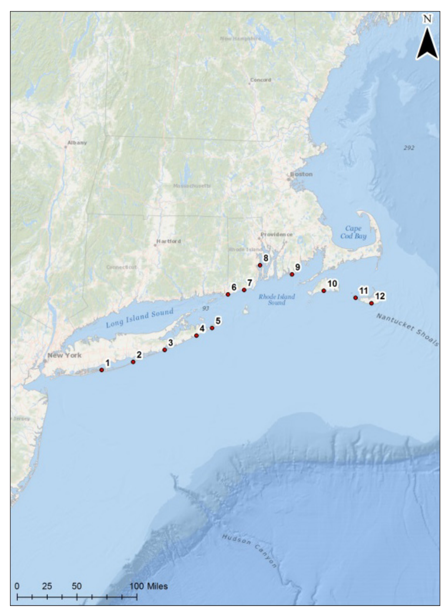

Figure 2. Landfall locations used as SLOSH model input

The team downscaled the SLOSH results onto a much higher resolution DEM, using two LiDAR datasets, including the one developed by Buzzards Bay NEP and MA CZM for their New Bedford Harbor Study, as well as a United States Geological Survey (USGS) National Elevation Dataset (NED). We then assessed flooding extent and depth using a series of ArcGIS-based scripts which account for spatial variation inherent in storm surge model output and which remove areas of hydraulically disconnected flooding.

Figure 3. NOAA monitoring stations used for base water level inputs in SLOSH model

Table 2. Base water level inputs used in SLOSH Model. The tidal elevation was defined as mean higher high water (MHHW) for each water level scenario. MHHW is the average of the higher high water height of each tidal day and thus represents areas that are, on average, wet once per day. Location names and associated numbers refer to tide prediction stations.

Tidal Elevation	Newport, RI (8452660)	New Bedford, MA (8447584) Offset = Newport*1.05	New Bedford, MA (8447584) with SLR		
	Feet Relative to NAVD88		1 ft	2 ft	4 ft
MHHW	1.81	1.9005	2.9005	3.9005	5.9005

To account for small features, such as swing gates on the hurricane barriers which are not represented as open in the LiDAR datasets but which control flooding in the harbor when closed during storms, we manually post-processed the depth grids. In those cases where the flooding did not extend over the top of or around the barrier, we clipped the depth grids to remove inundation behind the barrier. We also removed areas of the depth grid which depicted static flooding from SLR in scenarios that did not breach the hurricane barrier. Finally, we clipped the results using an aggregated shoreline product created from the LiDAR data and a NOAA high resolution shoreline dataset. The final depth grid maps can be found in Appendix A.

For visualization purposes in summary maps and in the online mapping tool, depth grids were converted to polygons and simplified to depict inundation extents only.

Vulnerability assessment and damage quantification Methodology

Data Inventory

The team began the vulnerability assessment by inventorying, categorizing, and assessing relevant spatial datasets available from MassGIS, Buzzards Bay NEP, and other local data sources. After reviewing the list with meeting participants and municipal officials, the team developed a final list of datasets to be included in the vulnerability analysis and resulting spatial data products and tools, and modified the datasets as needed. A summary of the data, data sources, and modifications can be found in Table 3. More detailed metadata can be found in the downloadable geodatabase[2] associated with the project available at http://climatechange.buzzardsbay.org/seaplan-study.html.

Table 3. Data processing summary

Dataset	Source	Project-specific Modifications
CSOs and Stormwater Pipes	Buzzards Bay NEP (Discharge Points dataset)	• Merge datasets from New Bedford, Fairhaven and Acushnet • Filter out roadcuts
Water Quality Infrastructure (wastewater treatment plants and pump stations)	Public property assessor's data via Buzzards Bay NEP; data from municipal officials	• Select wastewater infrastructure from municipal assessor's data using attribute values • Create water quality features not present in assessor's data using location information from municipal officials and Google Earth imagery
Public Property Structures	Public property assessor's data via Buzzards Bay NEP	• Select public property structures from municipal assessor's data using attribute values
Built Public Parcels	Public property assessor's data via Buzzards Bay NEP	• Select public property structures from municipal assessor's data using attribute values
Government Buildings	Public property assessor's data via Buzzards Bay NEP	• Select public property structures from municipal assessor's data using attribute values
State-owned Buildings	MA Division of Capital Asset Management & Maintenance/MAssets	• Select buildings within study area
Designated Port Areas	Public property assessor's data via Buzzards Bay NEP; MA CZM	• Select DPA structures from municipal assessor's data using list of DPAs from MA CZM
Environmental Justice Communities	US Census via MassGIS	• Select environmental justice communities within study area

[2] A geodatabase is a data storage framework used by ESRI ®ArcMap ™ to manage spatial datasets used in the program.

Data Processing

We imported these datasets and the SLOSH output grids into ESRI ®ArcMap ™ v. 10.2. Using the Extract Multi Values to Points geoprocessing tool in the Spatial Analyst toolbox, we assigned a depth value from each SLOSH grid to each point feature. In the case of polygon features, we assigned a mean depth to each polygon feature using zonal statistics tools and a spatial join.

We also used LiDAR data to identify low points on the New Bedford hurricane barrier using a shapefile of points along the crest of the barrier with 5m spacing. For each point, we created a profile and queried the elevation within +/- 5m of the digitized structure crest to account for uncertainty of the precise location of the crest in the digitized structure and any offset between the imagery and the LiDAR. We then highlighted points on the structures that had maximum elevations that were lower than 1.5 standard deviations from the mean elevation to identify barrier low points.

Hazus

We used the Federal Emergency Management Agency's (FEMA) Hazus model to quantify and visualize damages from each inundation scenario. Hazus is a GIS-based program that models damages and loss from hazards such as floods. Hazus is capable of quantifying the physical, economic, and social impacts of various flood scenarios and SLR time horizons. Hazus includes base asset and population information for the entire United States and is easily applied to any community in the country. Using the flood inundation layers generated by additional SLOSH modeling, the team applied Hazus to each of the 20 summary inundation scenarios.

We ran each inundation scenario individually, first by defining the study region using Census Block data included in Hazus and municipal boundary data from MassGIS. The SLOSH depth grid defined the floodplain, and the team chose assets of interest from the default Hazus database to run the damage analysis. Hazus calculated damages and loss to general building stock, essential facilities (medical care, police stations, fire stations, emergency centers, schools), transportation systems, utility systems, and also calculated the amount of debris and direct social losses associated with each flood scenario.

A major caveat associated with the Hazus analysis is that the default data included in the program is aggregated on a national level using data from the 2000 Census, and as such, may be out of date or on a coarser scale than locally-sourced datasets. Although the option exists within Hazus to incorporate user-supplied data which may be more accurate, precise, or descriptive than the default data, preparing appropriate data for Hazus was beyond the scope of this project. As such, it is important to interpret the results with caution, treating them as conservative estimates. The project team recommends that the results be used to compare the scale of damages among hurricane scenarios, rather than to make firm projections about damages.

[3] Available from http://climate.buzzardsbay.org/floodplain-expansion-results.html

Water quality engineering analysis and recommendation development Methodology

The project team developed recommendations for wastewater treatment facilities and pump stations based on two inundation scenarios. Because of the large quantity of data that resulted from the inundation modeling, we prioritized our recommendations based on inundation depths for these facilities for two modeled inundation scenarios. We chose these evaluation scenarios based on typical standards of engineering design specifications. Typical wastewater design recommendations are to protect wastewater infrastructure against the 500-year flood. FEMA guidance is as follows:

Under Executive Order 11988, Floodplain Management, Federal agencies funding and/or permitting critical facilities are required to avoid the 0.2% (500-year) floodplain or protect the facilities to the 0.2% chance flood level.

Following the standard of protecting critical facilities against damages from a 500-year storm, the team chose the scenarios based on the 2009 FEMA floodplain projections for a 500-year storm.[3] The inundation scenario from the team's modeling approach that most closely resembled the FEMA 500-year storm floodplain was the modeled Category 3, baseline (no SLR) water level scenario. The team used this scenario, as well as the modeled Category 3, 4-foot SLR scenario to evaluate vulnerability for each wastewater treatment facility pump stations, and to make recommendations based on each feature's vulnerability.

Our analysis was based on the information that was made available during the task through our data inventory, through interviews and documents provided by municipal officials, and remote visual inspection of some facilities through online digital imagery, but did not include site visits. Much of the data necessary to fully characterize in detail infrastructure associated with each CSO, wastewater treatment facility, and pump station are stored as paper copies in various locations, and as such, the costs and level of effort necessary to locate, catalog, and digitize this information exceeded the scope of this project. At this level of analysis, this report focuses on defining problem areas and identifies tangible action items communities can undertake to better understand and address vulnerabilities. This should be considered only a cursory engineering review that does not replace a more detailed site specific inspection and evaluation that will be required to be conducted in a future phase of this project.

We obtained data on CSOs from two sources. The "Discharge Points" GIS dataset, available through the Buzzards Bay NEP website, contains the locations of some of the City of New Bedford's CSOs. The engineering firm CDM Smith and the City of New Bedford also provided information on CSO tide gates and regulators (Table 4); however these data were not spatially explicit, and could not be directly linked to the available spatial data. Although the team assigned inundation depths to the CSO spatial dataset as part of the vulnerability analysis, the engine ering analysis determined that more information would be needed to assess site-specific vulnerability of individual CSOs based on the locations of each CSO in the floodplain, as CSOs are less likely to be affected by individual storms than by sustained inundation due to SLR. Recommendations for future studies are based on modeling work that would assess the system as a whole under various SLR scenarios, rather than on the vulnerability of individual features.

We used SLOSH model results to assign vulnerability ratings to wastewater treatment plants and pump stations. Facilities that are in the floodplain for both Category 3 scenarios received a vulnerability rating of 3 (high risk), those in the floodplain only during the Category 3 storm with 4-foot SLR received a risk rating of 2 (medium risk), and those that weren't in the floodplain in either scenario received a risk rating of 1 (low risk). Additionally, we used Google Earth imagery to visually

Table 4. Summary of CSO regulator elevation data provided by the City of New Bedford and CDM Smith

Regulator Number and Location	Receiving Water Body	Structure Invert	Weir/Outlet Height	Weir/Overflow Elevation	NAVD 88
022A - Sawyer St. and No. Front St.	Acushnet River	4.47	3.6	8.07	9.79
022C - Tallman St. - West of Belleville Ave.	Acushnet River	9.5	0.17	9.67	11.39
022D - Purchase St. and County St.	Acushnet River	35.45	1.5	36.95	38.67
022G - Holly St. and Belleville Ave.	Acushnet River	2.03	0.9	2.93	4.65
023A - Coffin Ave. and Riverside Ave.	Acushnet River	-3.07	1.27	-1.8	-0.08
024A - Hathaway St. and Riverside Ave.	Acushnet River	-3.2	1	-2.2	-0.48
026A - Truro St. and River Rd.	Acushnet River	0.2	1.08	1.28	3
027A - Mill St.	Acushnet River	1.5	0.88	2.38	4.1
027B - Ohio St. and Acushnet Ave.	Acushnet River	15.5	2.25	17.75	19.47
027E - Grenier St. and Belleville Ave. - East	Acushnet River	10.1	1.33	11.43	13.15
030A - Potomska St. and Second St.	Acushnet River	0.74	0.75	1.49	3.21
030B - South St. and Second St.	Acushnet River	0.72	2.2	2.92	4.64
031A - Grinnell St. and Second St.	Acushnet River	0.76	0.87	1.63	3.35
031B - Second St. - North of Grinnell St.	Acushnet River	1.5	1	2.5	4.22
031C - Howland St. and Second St.	Acushnet River	0.9	1.13	2.03	3.75
031D - Bonney St. and Grinnell St.	Acushnet River	21.06	1.85	22.91	24.63
031E - Howland St. P.S.	Acushnet River	-4.38	9	4.62	6.34
032A - Russell St. and Second St.	Acushnet River	3.86	1	4.86	6.58
032B - Madison St. and Second St.	Acushnet River	6.8	1.33	8.13	9.85
032C - Walnut St. and Acushnet Ave.	Acushnet River	17.05	0.9	17.95	19.67
032D - Griffin St. and Second St.	Acushnet River	Unk.	Unk.	Unk.	Unk.
034A - Union St. and Acushnet Ave.	Acushnet River	28.13	1.15	29.28	31
035A - Hillman St. and Foster St.	Acushnet River	63.45	1	64.45	66.17
035B - Pleasant St. and Maxfield St.	Acushnet River	48.7	0.5	49.2	50.92
020A - Wamsutta St. at Rt. 18	Acushnet River	3.91	0.83	4.74	6.46
020B - Logan St. and Acushnet Ave.	Acushnet River	5.9	1.29	7.19	8.91
036A - Willis St. and Purchase St.	Acushnet River	26.5	2	28.5	30.22
036B - Pearl St. and Purchase St.	Acushnet River	21.28	0.45	21.73	23.45
037A - Pope St. and Purchase St.	Acushnet River	17.92	5.45	23.37	25.09
040A - Coggeshall St. P.S.	Acushnet River	-8.98	11.28	2.3	4.02
041A - Belleville Ave. and Bellville Rd	Acushnet River	2.8	0.1	2.9	4.62
041B - Belleville Ave. P.S.	Acushnet River	-1.22	2.05	0.83	2.55
021A - Washburn St. and No. Front St.	Acushnet River	4.65	0.98	5.63	7.35
022F - Purchase St. and Deane St.	Acushnet River	41.02	2	43.02	44.74
022H - Nauset St. at NERI Connection	Acushnet River	42.54	2.3	44.84	46.56
022E - Sawyer St. and County St.	Acushnet River	33.18	0.77	33.95	35.67

Table 8. Continued

Regulator Number and Location	Receiving Water Body	Structure Invert	Weir/Outlet Height	Weir/Overflow Elevation	NAVD 88
027C - Belleville Ave. and Mill St.	Acushnet River	15.2	0.1	15.3	17.02
027D - Grenier St. and Belleville Ave. - West	Acushnet River	8.92	0.58	9.5	11.22
035C - Maxfield St. and Acushnet Ave.	Acushnet River	-4.77	1.5	-3.27	-1.55
003A - Padanaram St. and Cove Rd.	Clarks Cove	-3.1	4.7	1.6	3.32
003B - Padanaram St. and Norwell St.	Clarks Cove	3.12	1.35	4.47	6.19
004C - Dike Station	Clarks Cove	-9.66	0	-9.66	-7.94
005A - Dudley St. and West Rodney	Clarks Cove	-0.9	3.75	2.85	4.57
006A - Lucas St. and West Rodney	Clarks Cove	2.41	0.67	3.08	4.8
006B - Oaklawn St. and West Rodney	Clarks Cove	2.22	0.67	2.89	4.61
006C - Capitol St. and West Rodney	Clarks Cove	1.53	2	3.53	5.25
006D - Lucas St. and West Rodney	Clarks Cove	-1.77	3.5	1.73	3.45
007A - Capitol St. and West Rodney	Clarks Cove	2.7	3.21	5.91	7.63
008A - Calumet St. and West Rodney	Clarks Cove	1.58	0.7	2.28	4
009A - Aquidneck St. and West Rodney	Clarks Cove	3.93	2.6	6.53	8.25
010A - Bellevue St. and West Rodney	Clarks Cove	1	1.14	2.14	3.86
004A - Rockdale Ave. and Cove Rd.	Clarks Cove	-6.1	6.37	0.27	1.99
004B - Orchard St. and Cove Rd.	Clarks Cove	-3.9	1.9	-2	-0.28
004D - Orchard St. and Rivet St.	Clarks Cove	2.2	1.5	3.7	5.42
004E - Bonney St. and Rivet St.	Clarks Cove	0.59	3.7	4.29	6.01
004F - Bonney St. and Rivet St.	Clarks Cove	0.59	0	0.59	2.31
004G - Crapo St. and Rivet St.	Clarks Cove	1.48	2.7	4.18	5.9
004H - Bonney St. and Cove Rd.	Clarks Cove	-3.1	1.6	-1.5	0.22
004I - David St. and West Rodney	Clarks Cove	0	4.8	4.8	6.52
012A - Ricketson St. and East Rodney	Outer Harbor	-0.61	0.5	-0.11	1.61
012B - Bellevue St. and East Rodney	Outer Harbor	-0.44	0.29	-0.15	1.57
013A - Aquidneck St. and East Rodney	Outer Harbor	0.5	0.6	1.1	2.82
015A - Butler St. and East Rodney	Outer Harbor	-4.07	2.57	-1.5	0.22
016A - Frederick St. and East Rodney	Outer Harbor	0.8	0.6	1.4	3.12
017A - Rodney St. and East Rodney	Outer Harbor	-1.42	1.51	0.09	1.81
017C - David St. and East Rodney	Outer Harbor	-3.38	0.33	-3.05	-1.33
017D - Ruth St. and East Rodney	Outer Harbor	-2.33	0.5	-1.83	-0.11
018A - Cove St. and East Rodney	Outer Harbor	-1.78	0.5	-1.28	0.44
018B - Cove St. and Cleveland	Outer Harbor	-1.65	0.67	-0.98	0.74
020C - Merrimac St PS	Acushnet River	Unk.	Unk.	Unk.	Unk.
Note: All elevations refer to City of New Bedford Datum					

evaluate pump stations for structural features that put them at higher or lower risk of damage from inundation and made adaptation recommendations accordingly. The City of New Bedford and the Town of Fairhaven provided supplementary details on pump stations which provided the basis for more in-depth recommendations for those features.

We also ranked the cost of adaptation measures (1 = high, 2 = medium, 3 = low), and ranked the relative impact of risk to the community in the event of damage to the structure. Projects with a projected cost of less than $100,000 were considered low cost, those with projected costs of over $250,000 were considered high cost, and those that fell between $100,000 and $250,000 were considered medium cost. If the projected costs were expressed as a range of values, the rank was assigned based on the higher value. Low cost projects would receive a higher ranking and would therefore contribute to a higher prioritization score because they would be more achievable within the constraints municipal budget. We accounted for relative importance of individual pump stations by giving an additional ranking value of 2 to pump stations in Fairhaven that pump water from upstream pump stations. If these structures malfunction, they will affect the functionality of the rest of the pump stations in the system; therefore, they require extra consideration. We multiplied the rankings such that each facility received a numerical score, with higher scores indicating facilities and projects that should be prioritized by the town. A dash in the priority ranking field denotes vulnerable structures for which there was insufficient information to provide a recommendation and/or cost estimate. No prioritization scores were assigned in these cases. The team also developed a summary of proposed adaptation actions for each municipality, based on the results section of this report.

Stakeholder engagement

Throughout the project, the team held in-person meetings and workshops to present project overviews and updates, to ask for input from municipal and state officials on priority areas of focus, and to vet recommendations and project approaches with key stakeholders. Representatives from the Buzzards Bay NEP, Coastal Zone Management, and from the Department of Public Works in each municipality served as a project advisory team. A summary of the meeting dates, locations and objectives can be found in Table 5. Detailed meeting agendas and summaries can be found in Appendix B.

Data Visualization Tool Development

Using priority datasets and results from the SLOSH and Hazus models, the team created two data visualization tools as part of its outreach approach for the project. To create an interactive online map viewer, we uploaded simplified polygons depicting the hurricane inundation extents resulting from SLOSH, as well as priority datasets used in the vulnerability maps, into an ArcGIS Online Story Map application. To visualize the economic losses associated with various hurricane scenarios, we summarized economic loss data generated using the Hazus model into a custom risk visualization tool which provides a snapshot of estimated damages from various hurricane scenarios.

Table 5. Summary of meetings and objectives.

Meeting	Date	Location	Objectives
Kick-off Meeting	12/16/2013	New Bedford Wastewater Treatment Facility	• Present study scope to municipal and state planning agencies • Present interim data inventory to meeting participants • Hold a listening session to obtain feedback and input on project scope and data inventory • Strategize for filling any data gaps
Workshop Agenda Development Meeting	2/4/2014	Fairhaven Wastewater Treatment Facility	• Present project update, identifying lingering data gaps and next steps • Plan interactive half-day workshop for April
Interactive Half-Day Workshop	4/17/2014	Acushnet Council on Aging	• Provide a project overview • Present major findings of vulnerability assessment, the Hazus damage assessment, and preliminary recommendations • Present draft versions of data visualization tools, including the web viewer and the risk visualization tool • Receive feedback from workshop participants on refining results, recommendations, and tools
Presentation of Draft Findings	6/12/2014	New Bedford Wastewater Treatment Facility	• Provide a summary of the project's key findings • Obtain feedback on final data products, reports, and tools

Results

The following sections detail results from the SLOSH inundation modeling, the vulnerability analysis, and the engineering analysis and recommendation development. We also describe results from the stakeholder engagement activities, as well as a description of data visualization tools. In general, results of the SLOSH modeling and subsequent analysis showed that impacts from Category 1 and 2 storms through a 2-foot SLR scenario were likely to be minimal. We predict that impacts will increase substantially as SLR approaches 4 feet for a Category 2 storm. At this point, storm surge-inducted inundation begins to occur around the New Bedford Hurricane Barrier, though the barrier is not actually overtopped. In general, impacts increase steadily with hurricane category and are exacerbated by projected increased SLR scenarios. Based on initial discussions with municipal officials, the team modeled inundation scenarios and resulting damages based on hurricane categories 1 through 4, despite the fact that a hurricane exceeding a Category 3 has not made landfall in New England in recorded history. Extreme hurricane scenarios were modeled for informational purposes only and should be interpreted as theoretical. For comparative purposes, Table 6 provides an overview summary of historical New England storms and their associated categories and impacts.

Table 6: New England Hurricanes of the 20th and 21st centuries and their impacts

Date	Comments	Peak Intensity	Intensity at Landfall	Estimated Intensity in Buzzards Bay	Maximum Storm Surge in New England, if known (ft)	Elevation at New Bedford Hurricane Barrier, if known (NGDV-ft)	Estimated Regional Economic Damage ($1,000,000)
9/21/1938	Hurricane of '38	Category 5	Category 3	Category 2-3	20	12.5	$400
9/14/1944	Great Atlantic Hurricane of '44	Category 4	Category 3	Category 2-3		8.1	$100
9/11/1950	Hurricane Dog	Category 5	No landfall				$3
8/31/1954	Hurricane Carol	Category 3	Category 3	Category 1-2	12	11.9	$460
9/11/1954	Hurricane Edna	Category 3	Category 3		6		$40
8/18/1955	Hurricane Diane	Category 3	Tropical Storm	Tropical Storm			$832
9/12/1960	Hurricane Donna	Category 5	Category 2	Category 1-2	13	6.3	$40
9/27/1985	Hurricane Gloria	Category 4	Category 1	Category 1	6.8	5.2	$900
8/19/1991	Hurricane Bob	Category 3	Category 2	Category 1	15	7.6	$2,500
8/28/2011	Hurricane Irene	Category 3	Tropical Storm	Tropical Storm	8	5.6	$15,000
10/29/2012	Hurricane Sandy	Category 3	Extratropical Cyclone	Tropical/Extratropical Hybrid	8	6.8	$50,000

Sources: http://www.mass.gov/eopss/agencies/mema/ready-massachusetts/new-england-hurricanes-of-note.html (list derived from this), additional information from NOAA http://www.nhc.noaa.gov/outreach/history/#new and the US Army Corps of Engineers

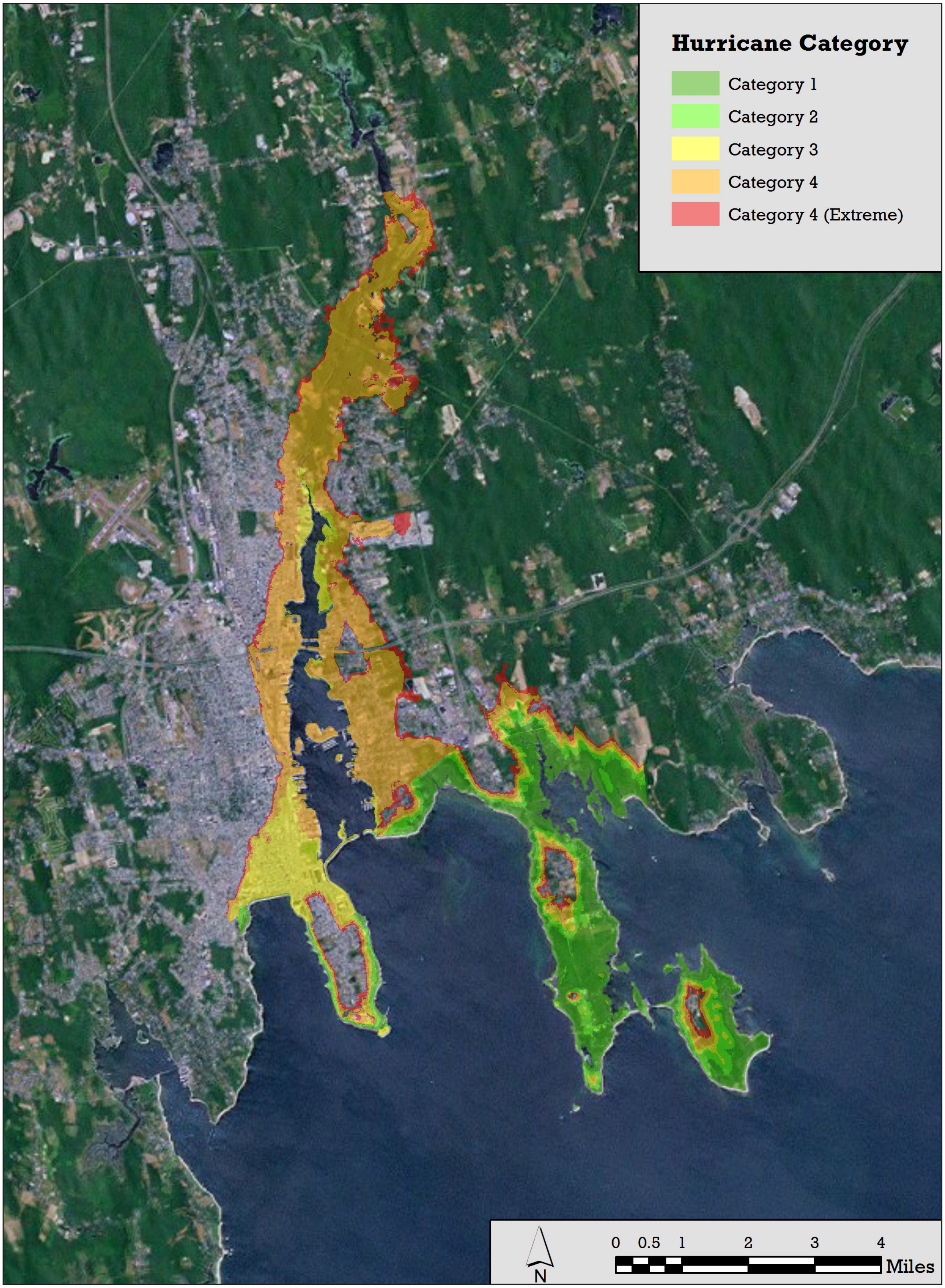

Figure 4. Summary inundation extents for hurricane scenarios modeled using baseline (no SLR) water levels.

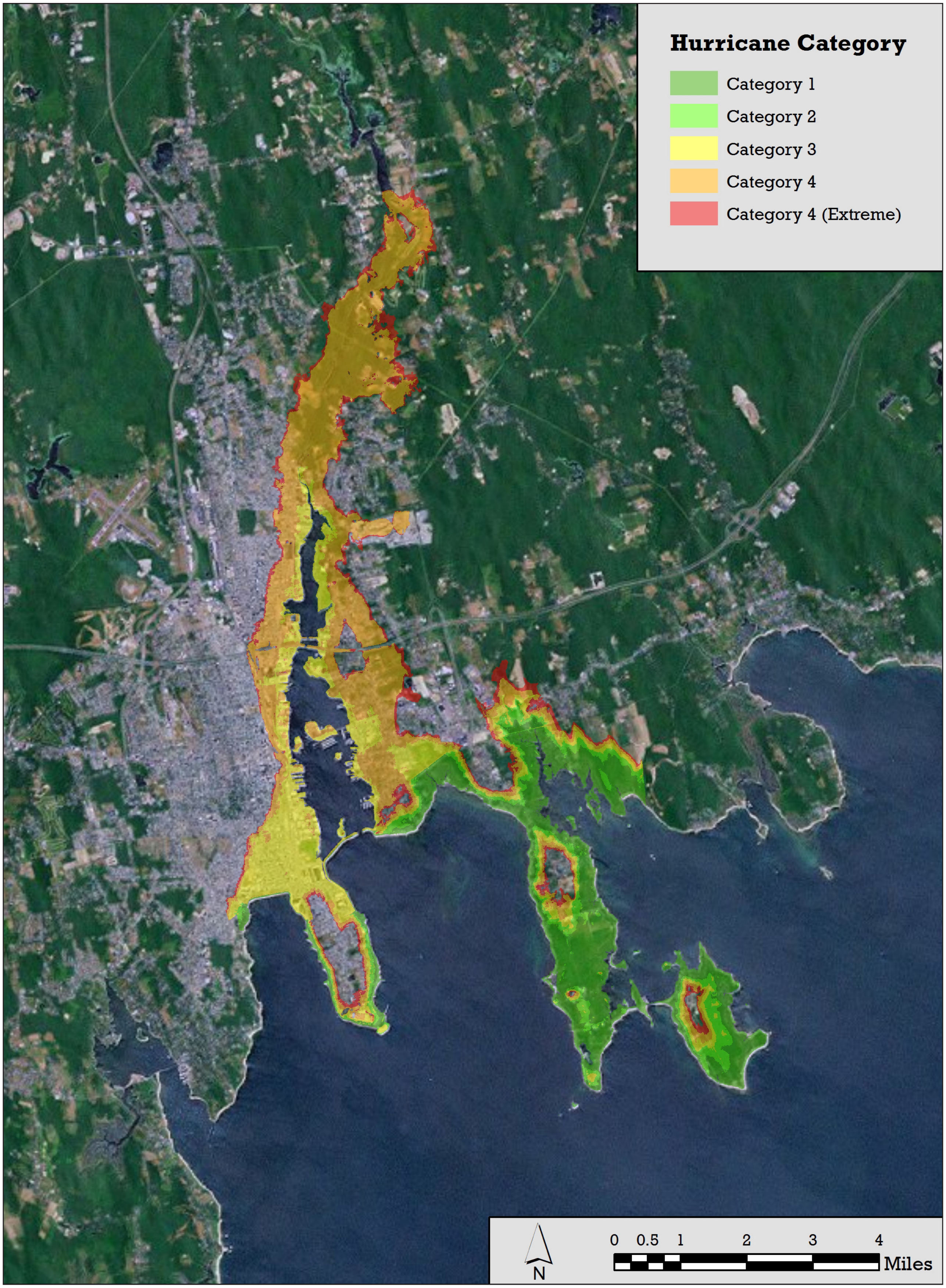

Figure 5. Summary inundation extents for hurricane scenarios modeled using 1-foot SLR water levels

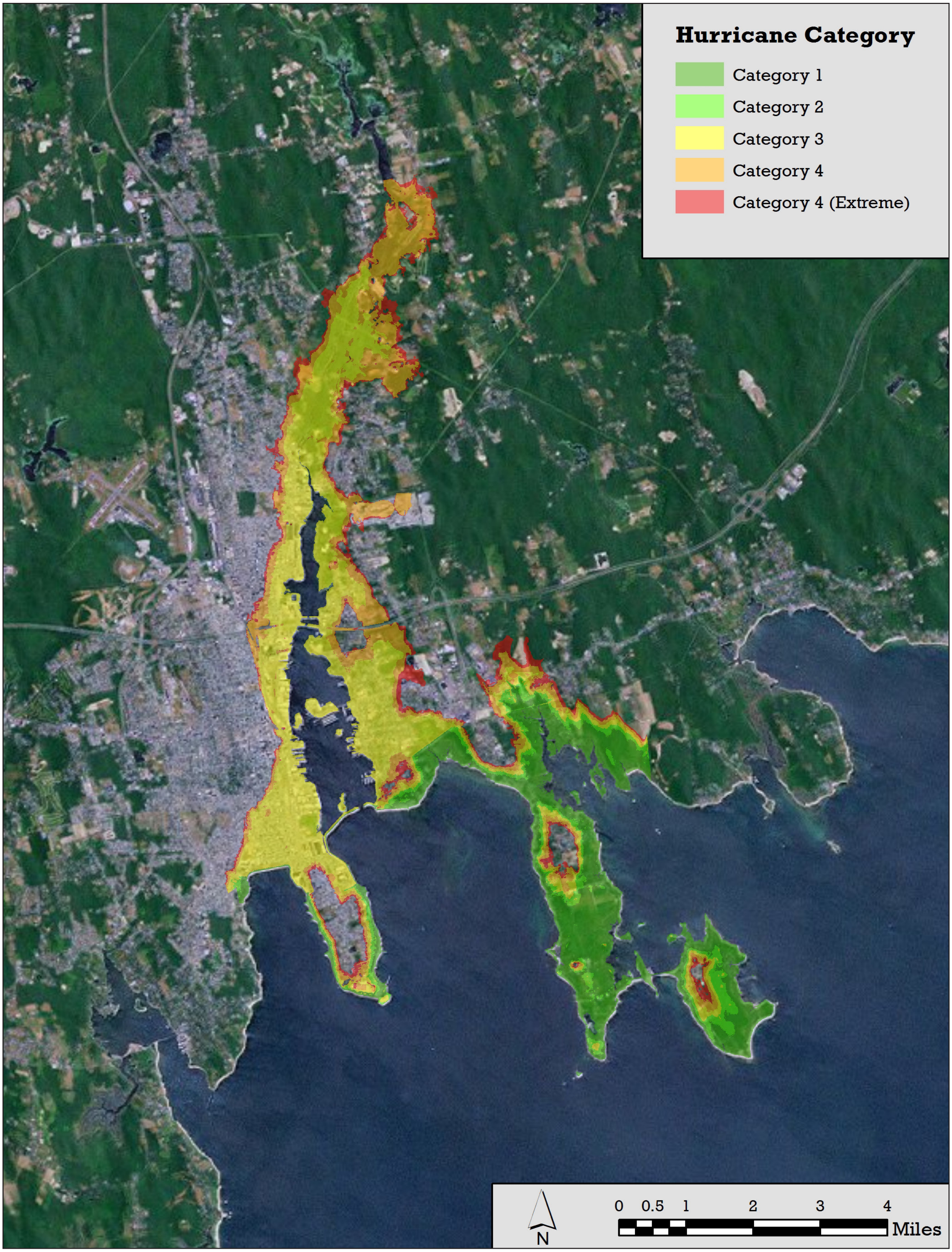

Figure 6. Summary inundation extents for hurricane scenarios modeled using 2-foot SLR water levels

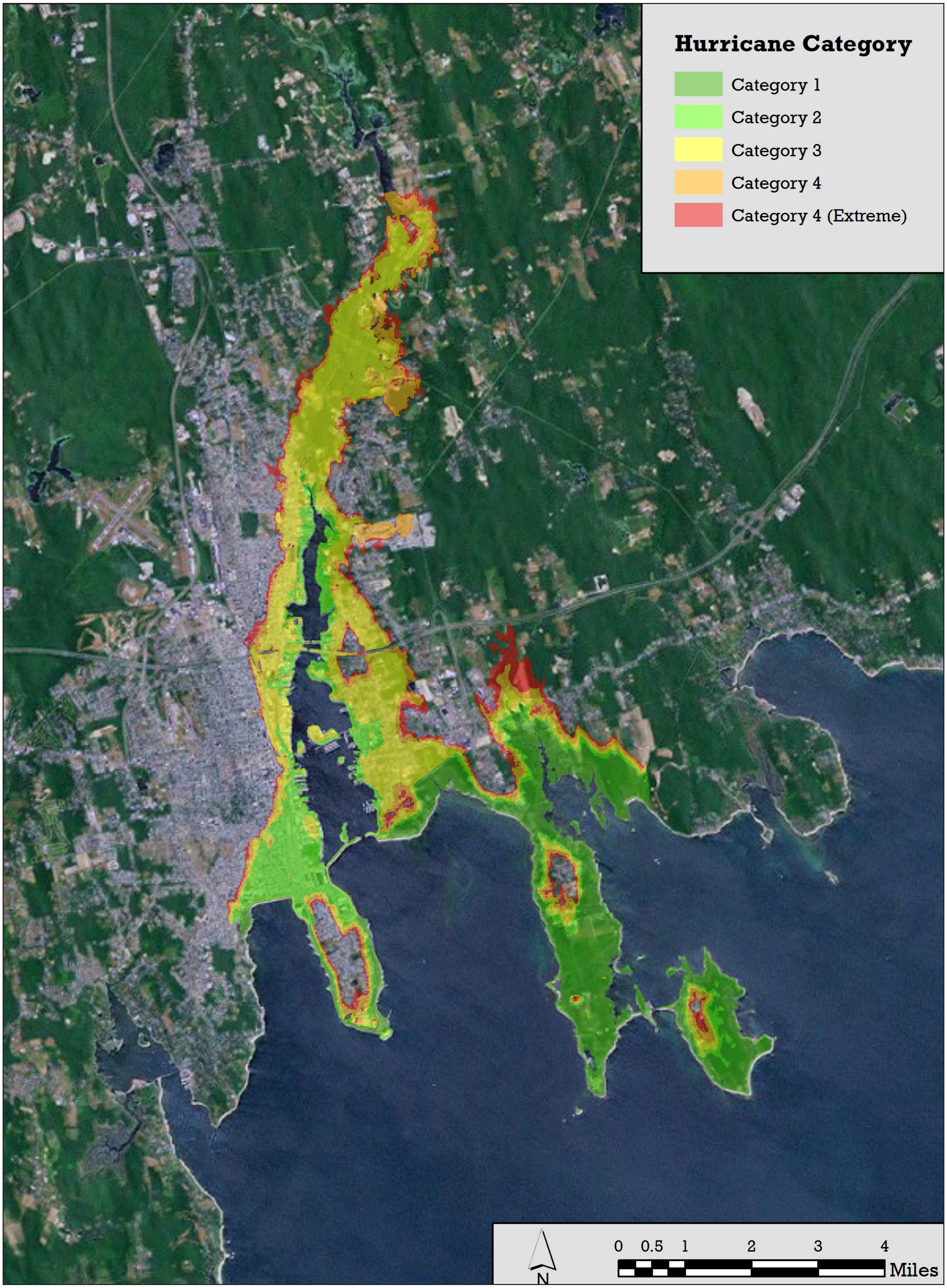

Figure 7. Summary inundation extents for hurricane scenarios modeled using 4-foot SLR water levels

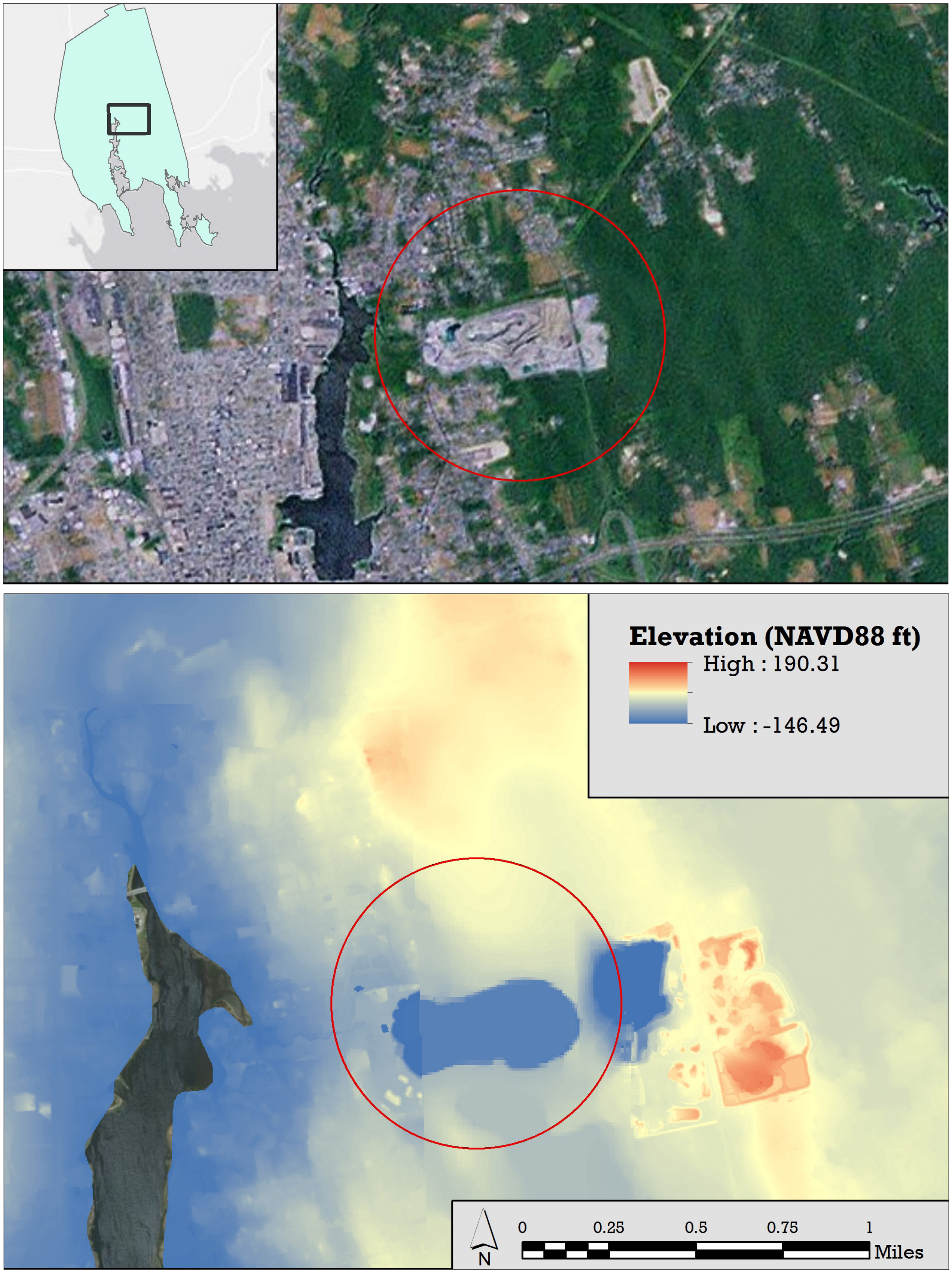

Figure 8. Tilcon Quarry and DEM showing negative (below sea level) elevations at that location

Inundation modeling

The SLOSH model resulted in 20 summary depth grids depicting worst case inundation depths at each location (grid cell). As described above, these depth grids represent worst case flooding for each storm category (5) at each base water level (4) [5 x 4 = 20 scenarios]. Maps of each of the depth grids can be found in Appendix A. Figures 4 – 7 depict simplified versions of the depth grids. These figures show how increasing hurricane intensities increase inundation extents at each of the input water levels. These figures provide the basis for the interactive online map viewer.

Maximum flood depths in the study area range from 11 feet in the Category 1, no SLR scenario to 43 feet in the most severe scenario (Extreme Category 4 with 4-foot SLR). Even higher maximum flooding depths were predicted in Tilcon Quarry in Acushnet, which is an area inland from the east bank of New Bedford Harbor (Figure 8). This area has large negative (below sea level) elevations, and thus has higher maximum inundation depths than those along the harbor. The maximum flood depths reported in this section and in the maps reflect the maximum flood depths above sea level modeled along New Bedford Harbor, and do not account for the higher flood depths reported in the quarry.

In the worst case scenario, the surge elevation increases as it moves up the New Bedford Harbor from approximately 30 feet at the mouth of the Harbor just inside the hurricane barrier to 43 feet just north of the Acushnet border. The worst case storms move approximately north and make landfall west of the site, meaning that hurricane winds and storm translational speed are additive. The combination of forward speed and wind pushes water directly north causing a high surge along the main coast of Buzzards Bay, which is then focused as the surge is funneled into the harbor, amplifying the elevation as it moves up the harbor. This most extreme case also has the most extreme amplification of the surge as it progresses up the harbor. The effect is must less pronounced in the Category 1 case, where the difference is only 0.98 ft.

The summary depth grids resulting from SLOSH modeling indicate that the hurricane barriers become ineffective at preventing inundation beginning with Category 2, 4-foot SLR hurricane scenarios, with inundation depths and extents increasing as hurricane scenarios and baseline water levels increase. A summary of inundation scenario impacts on hurricane barriers can be found in Table 7.

Table 7. Summary of hurricane impacts: Scenarios resulting in inundation around and over hurricane barriers

Storm Scenario	New Bedford Barrier	Clarks Cove Dike	Fairhaven Dike
Cat 2, 4-ft SLR	Inundates around barrier	Inundates around dike	No impact
Cat 3, 0' SLR	Inundates around barrier	Inundates around dike	No impact
Cat 3, 1-ft SLR	Inundates around barrier	Inundates around dike	Inundates around and over dike
Cat 3, 2-ft SLR	Inundates around and over barrier	Inundates around barrier; begins to inundate over barrier	Inundates around and over dike
Cat 3, 4-ft SLR Cat 4, all SLR scenarios	Inundates around and over barrier	Inundates around and over barrier	Inundates around and over dike

The analysis demonstrated that the factors which produced the highest water levels in the SLOSH inundation results were:

1. Storm landfall in eastern CT and Rhode Island
2. Angle of approach (ϴ) between 168° and 180° from North (storm headed NtW to N)
3. Radius of maximum wind (Rw) 40 to 50 NM
4. Highest forward speed (60 or 70 mph)

Depth grids can be downloaded in a geodatabase from climate.buzzardsbay.org/seaplan-study.html.

Vulnerability Assessment Results

The LiDAR data revealed low points in the hurricane barrier at several locations. The maximum elevations ranged from 19.09 - 22.24 feet. Figures 9 – 11 show elevations along the New Bedford hurricane barrier, as well as the Fairhaven and Clarks Cove dikes. Points that are more than 1.5 standard deviations away from the mean are highlighted in yellow to show low points along the barrier system. These low points could potentially contribute to hurricane barrier failure in major storms, although on the maps of the Clarks Cove and Fairhaven dikes, low points are likely the results of anomalies in the LiDAR data.

The team used the values from the summary depth grids to assign worst case scenario inundation depths to features which were identified by the project advisory team as priority interest to the municipalities. As depths were assigned to the locations as defined by the spatial data derived in the data inventory, which, in most cases, are center points, it is not possible to assume uniform flood depth for each feature. Rather, the listed depth for each scenario should be interpreted as the maximum inundation depth at the location of the center point of each feature.

INFRASTRUCTURE, PROPERTY AND POPULATION DATA FEATURES INCLUDED IN THE VULNERABILITY ANALYSIS

Detailed tabular data of inundation depths and for each hurricane scenario for the following features can be found in Appendix C:

- CSOs and storm drains
- Wastewater treatment plants and pump stations
- Designated port areas
- Built public structures
- Government buildings
- State-owned structures
- Environmental justice communities

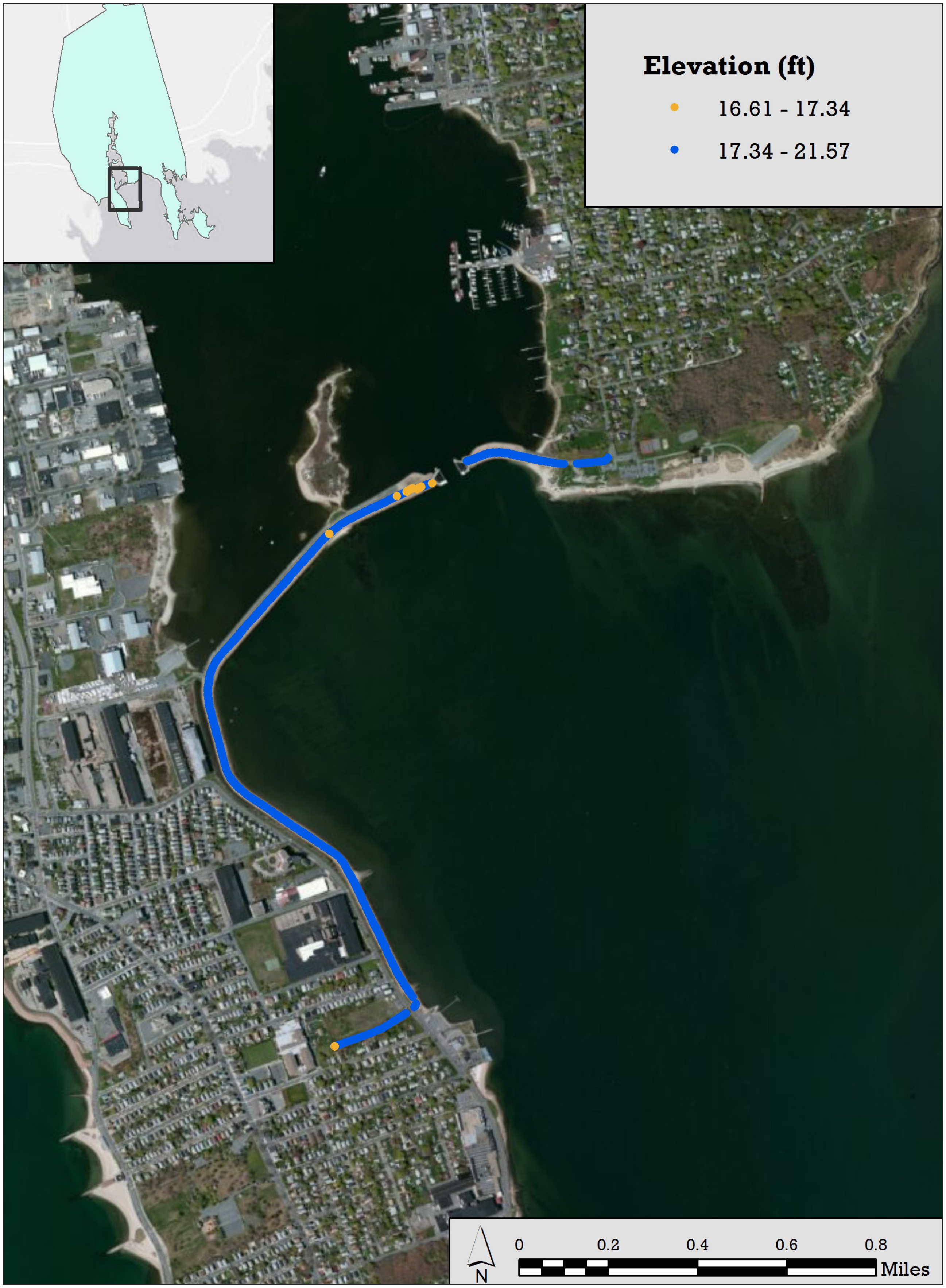

Figure 9. New Bedford Hurricane Barrier elevations.

Figure 10. Clarks Cove Dike elevations.

Figure 11. Fairhaven Dike elevations.

Figures 12 – 17 show inundation depths at the locations of specific infrastructure features. These features include:

- New Bedford Wastewater Treatment Plant
- Fairhaven Wastewater Treatment Plant
- Slocum Street Pump Station in Acushnet
- Clarks Cove CSO (located at Aquidneck Rd and West Rodney French Blvd)
- New Bedford Harbor CSO (located at Merrimac Street and Herman Melville Blvd)
- Pope's Island Marina

These features were identified by municipalities and the project advisory team as either priority concerns or representative examples of vulnerable areas. While more information is needed to assess the vulnerability of CSOs, as noted above, municipal representatives suggested that we depict the inundation depths at the locations of these CSO to illustrate the vulnerability of water quality infrastructure in these two representative locations. Similarly, we chose to represent the inundation depths of the Pope's Island Marina to illustrate the potential vulnerability of New Bedford Harbor infrastructure, businesses, and populations during the various storm scenarios.

Reference maps for visualizing the vulnerability of each structure can be found in Figures 18 – 24. Features are symbolized by color based on the number of scenarios at which the feature is vulnerable to flooding. If the feature is vulnerable in 1-5 storm scenarios, it is given a risk ranking of low and colored green. If the feature is vulnerable in 6-10 storm scenarios, it is given a risk ranking of moderate and colored yellow. If the feature is vulnerable in 11-15 storm scenarios, it is given a risk ranking of high and colored orange. If the feature is vulnerable in 16 – 20 storm scenarios, it is given a risk ranking of very high and colored red. If the feature is not vulnerable in any of the modeled scenarios, it is colored blue.

The interactive mapping tool found at seaplan.buzzardsbay.org provides a visual summary of the inundation mapping by allowing the user to visualize water infrastructure, public buildings and populations that are at flooded locations during each scenario.

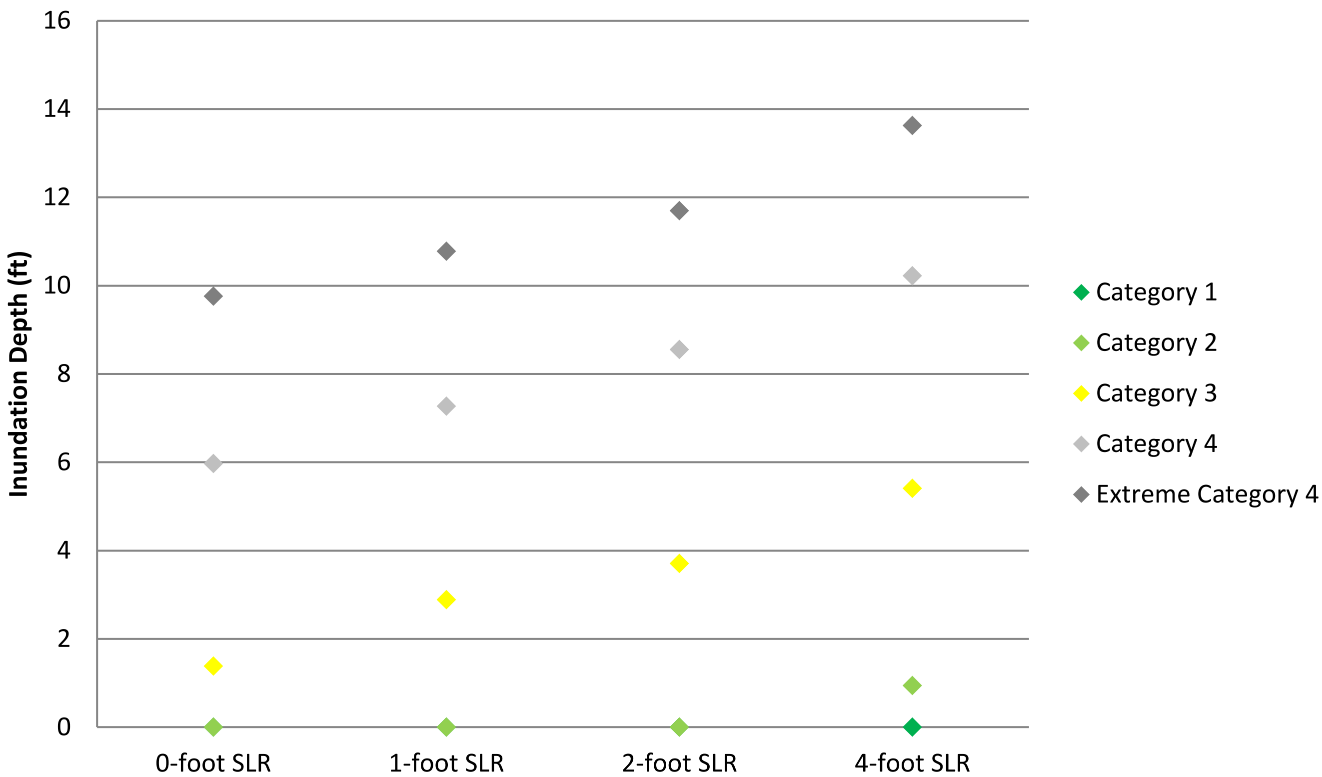

Figure 12. Inundation Depths at New Bedford Wastewater Treatment Facility.

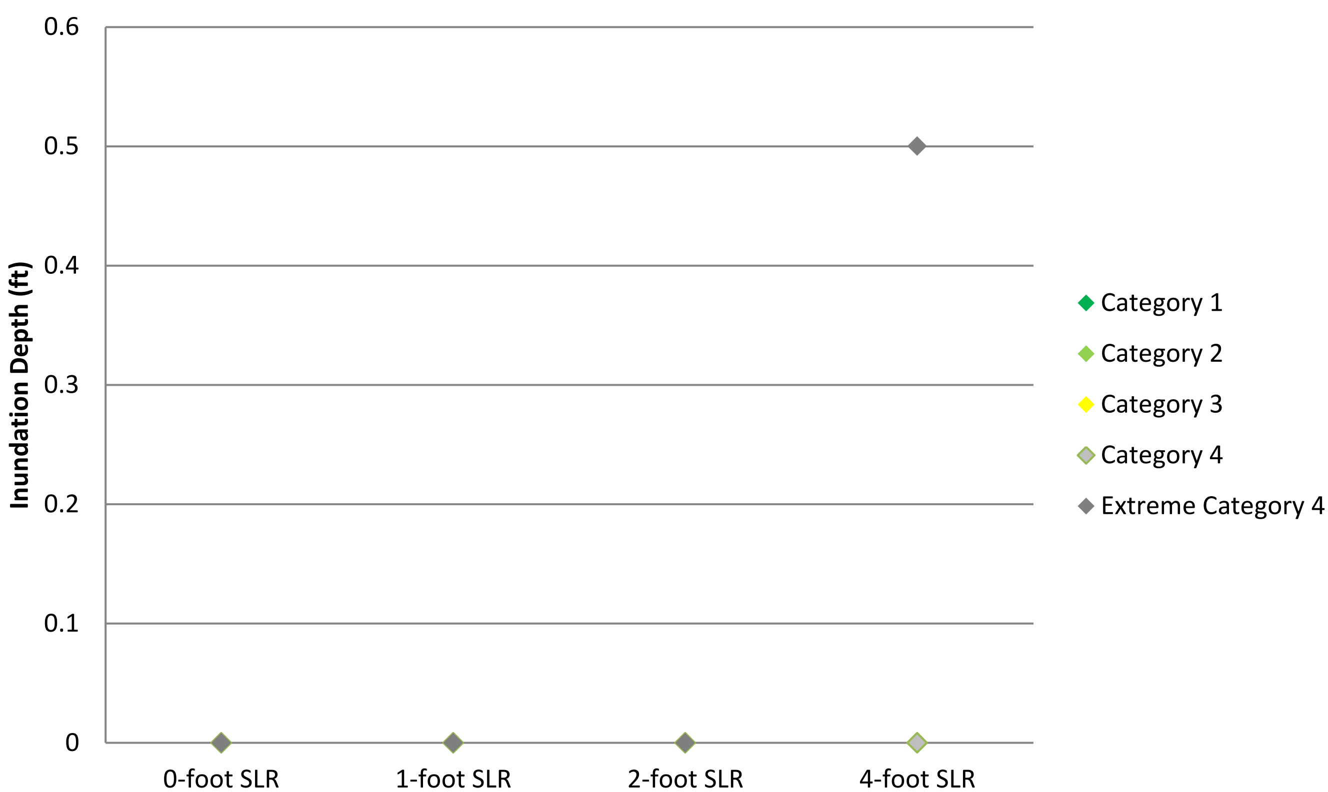

Figure 13. Inundation Depths at Fairhaven Wastewater Treatment Facility.

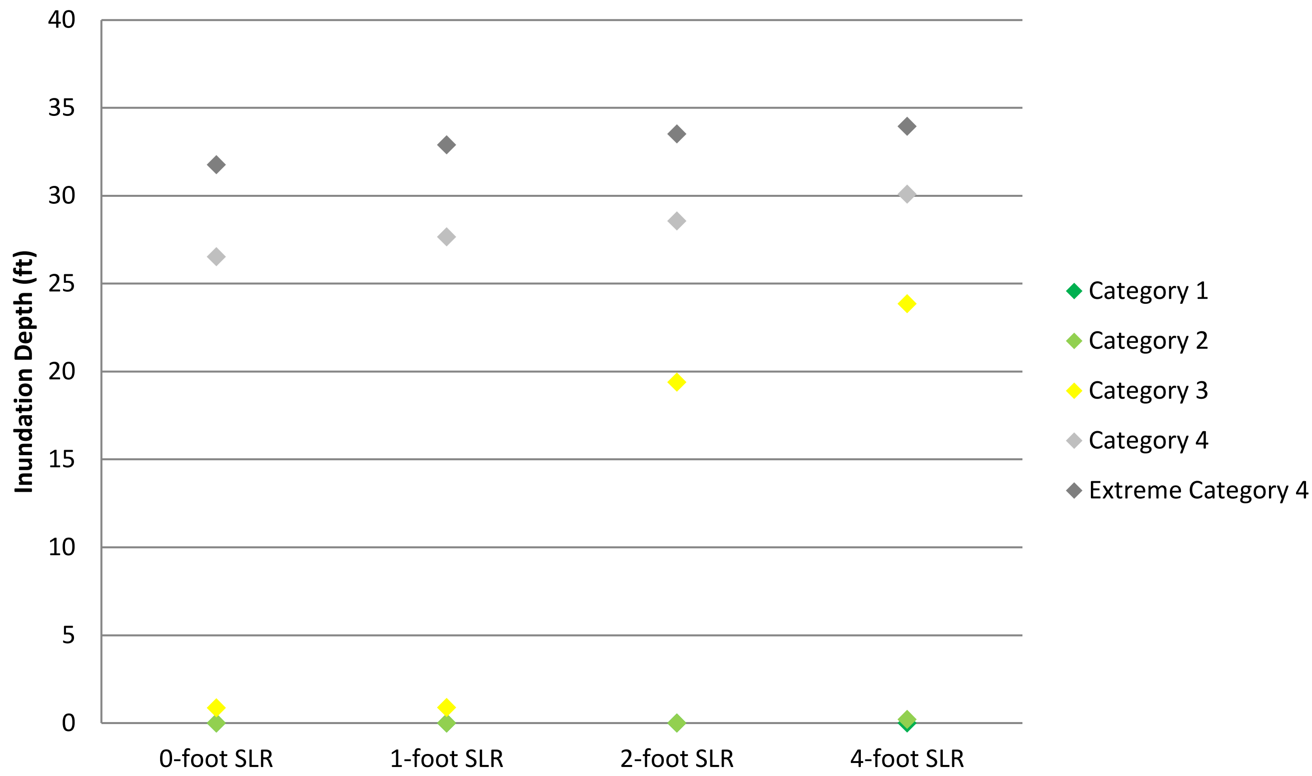

Figure 14. Inundation Depths at Slocum Street Pump Station, Acushnet.

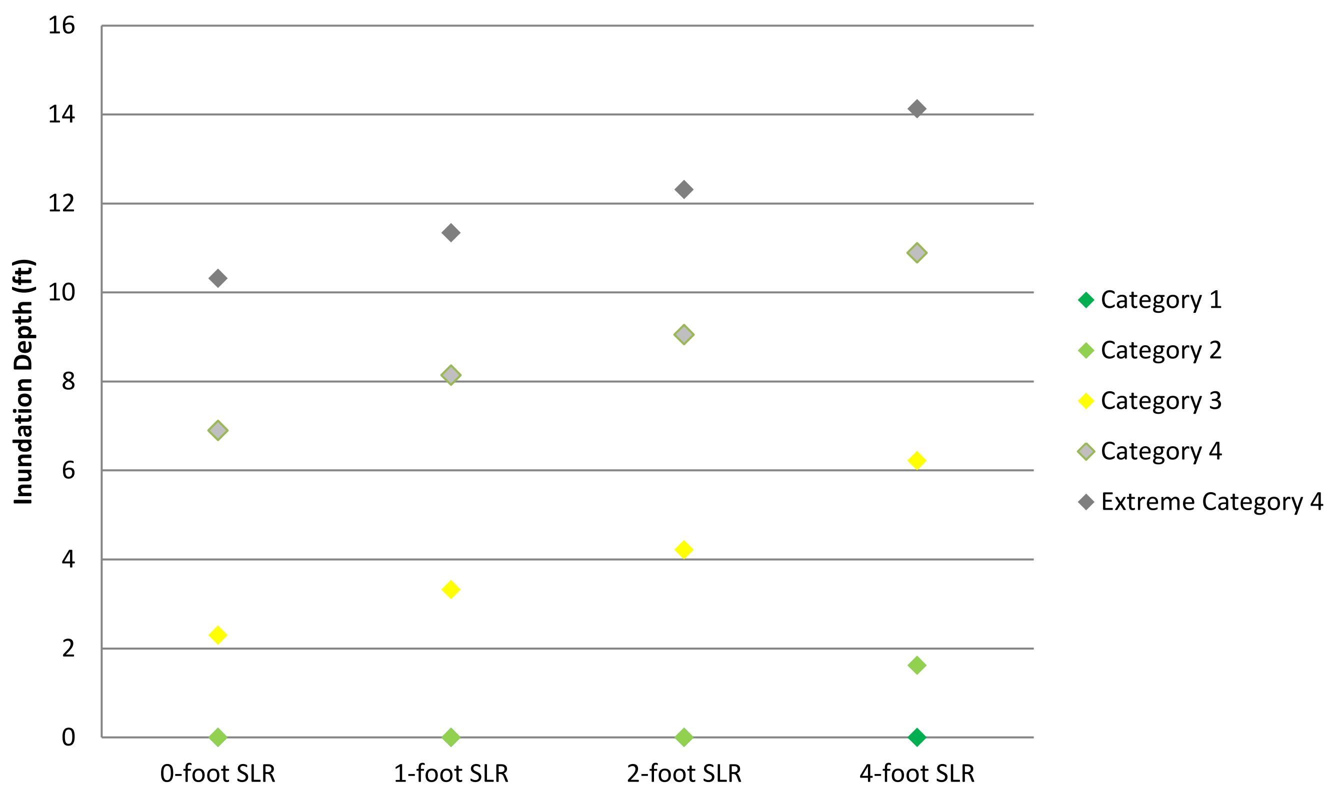

Figure 15. Inundation Depths at Clarks Cove CSO (W. Rodney French Blvd. between Seymour St. and Bayview St.). More information is needed to assess the vulnerability of individual CSOs; however, this figure illustrates the potential vulnerability of water quality infrastructure in this representative location.

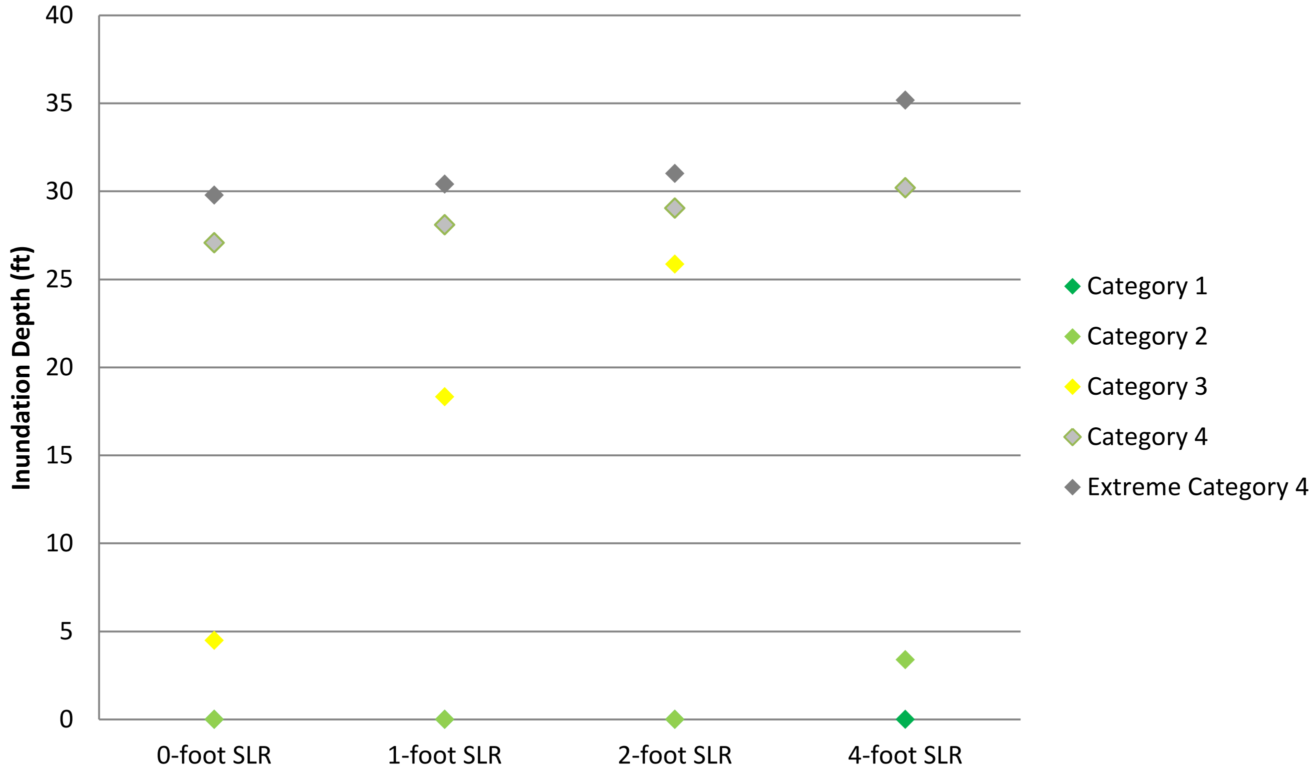

Figure 16. Inundation Depths at New Bedford Harbor CSO (corner of Purchase St. and Wamsutta St.). More information is needed to assess the vulnerability of individual CSOs; however, this figure illustrates the potential vulnerability of water quality infrastructure in this representative location.

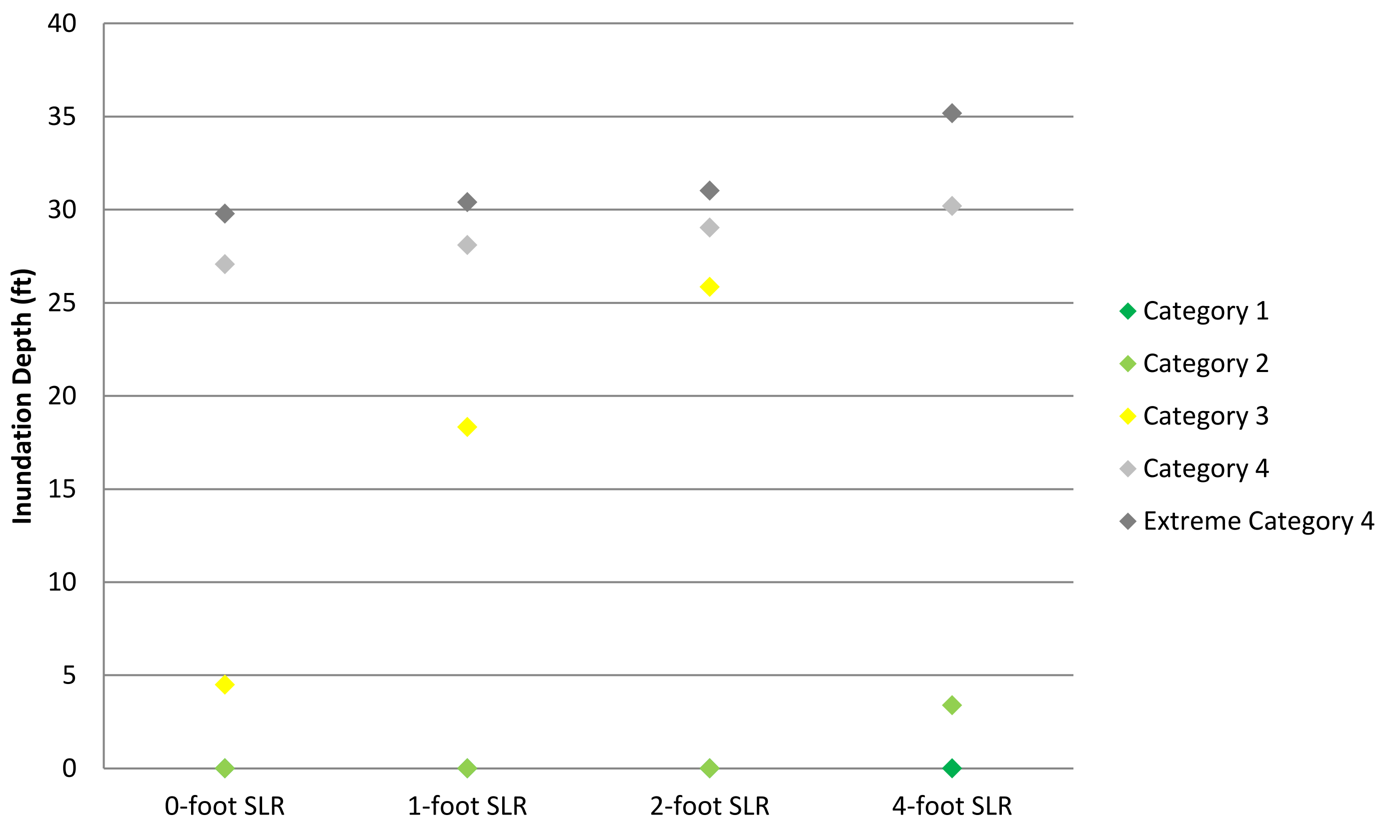

Figure 17. Inundation Depths at Popes Island Marina Pump Station.

Hazus

We ran the Hazus model 20 times, one for each inundation scenario generated by SLOSH, using a different SLOSH output grid on each run. Each model run resulted in tabular data, spatial data, and summary reports which detailed structural and economic damages to buildings, infrastructure, and populations. While this report focuses on structural and economic impacts to buildings, the summary reports found in Appendix D also provide estimates of impacts on transportation features, emergency facilities, debris impacts and populations.

In general, substantial physical and economic damage to buildings and infrastructure in the study area occurred with hurricane categories 3 and above, and damages in each hurricane category were exacerbated by rising sea levels; however the model did predict some damages even in less severe scenarios. In a Category 1 storm with 1-foot SLR, two buildings would be substantially damaged. The total replacement value, or building exposure estimate for this scenario is $1.9 billion. This estimate includes not only the cost of the buildings themselves (substantially damaged or otherwise), but also the engineering cost to replace or repair a damaged building. By contrast, the predicted building damages for the most extreme scenario, (Extreme Category 4 with 4-foot SLR), includes 3,830 substantially damaged buildings with a building exposure estimate of $4.1 billion (Figures 25 and 26).

We did not extend Hazus analysis to a property-specific level for wastewater treatment facilities as the project team was not confident that the default data used in the model would accurately account for the complexities of predicting damages to the underground structures of these facilities.

Hazus output reports which summarize physical and economic damage estimates from each hurricane scenario can be found in Appendix D. Spatial datasets which summarize economic loss and structural damage from all scenarios can be downloaded in the project geodatabase available at climate.buzzardsbay.org/seaplan-study.html. The online risk visualization tool also functions as a summary of Hazus results by visualizing damage estimates by town and by hurricane parameter. The economic loss data in the viewer and in the downloadable geodatabase is a measurement of direct economic loss, which includes capital stock losses (building loss, contents loss, and inventory loss), and

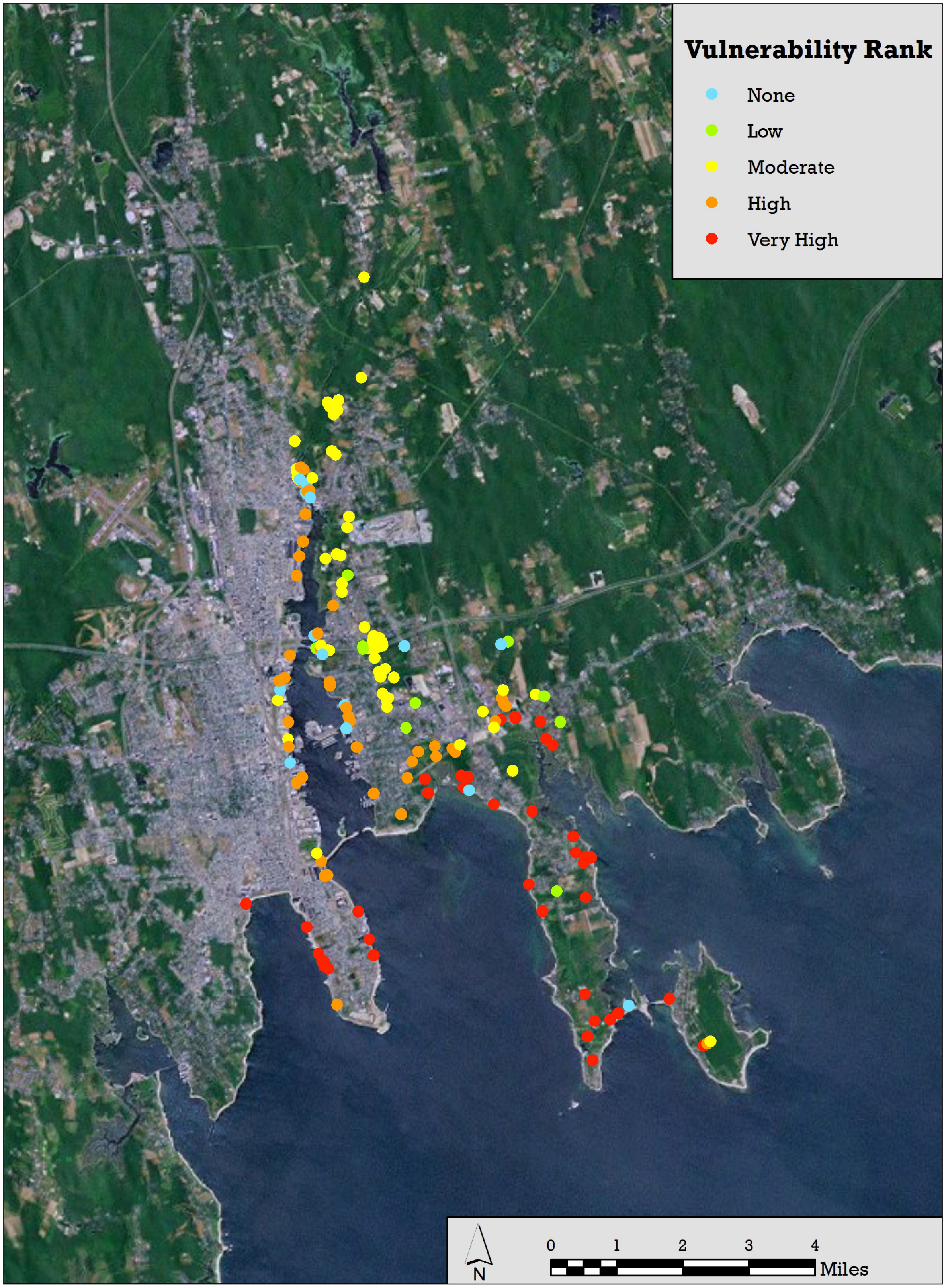

Figure 18. **Water quality infrastructure features (pump stations and treatment plants)** by vulnerability rank.

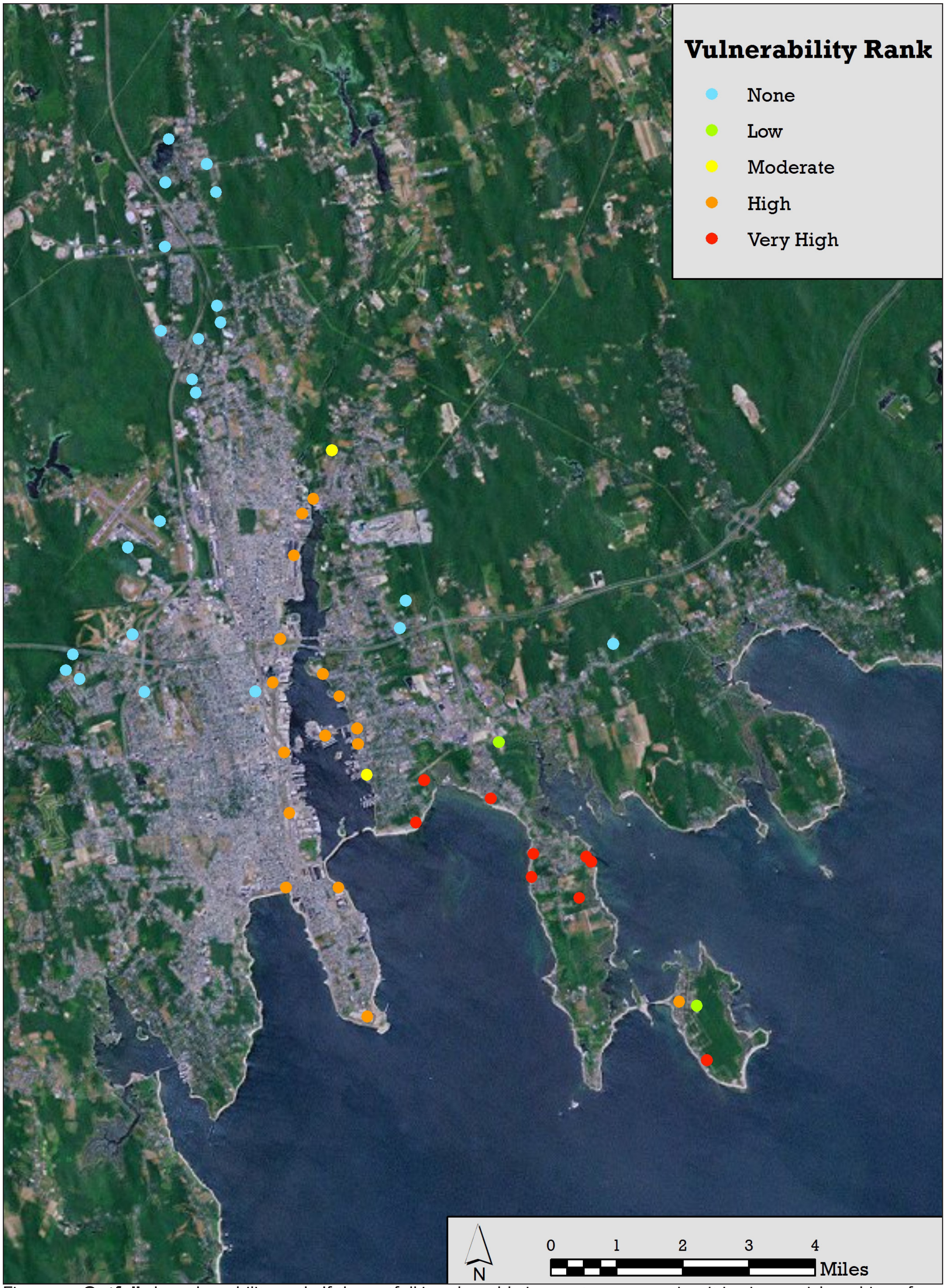

Figure 19. **Outfalls** by vulnerability rank. If the outfall is vulnerable in 1-5 storm scenarios, it is given a risk ranking of low and colored green. If the outfall is vulnerable in 6-10 storm scenarios, it is given a risk ranking of moderate and colored yellow.

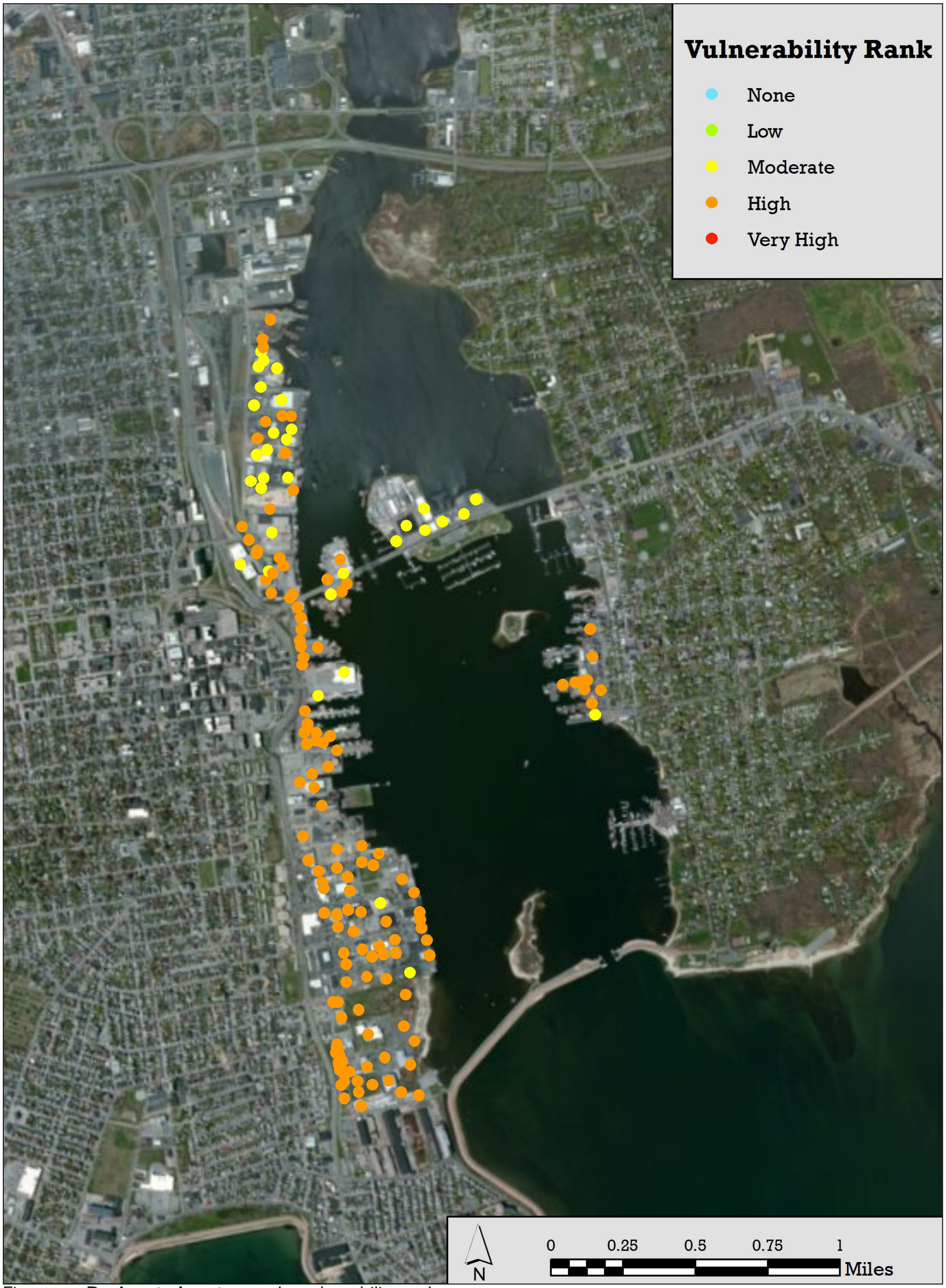

Figure 20. **Designated port areas** by vulnerability rank.

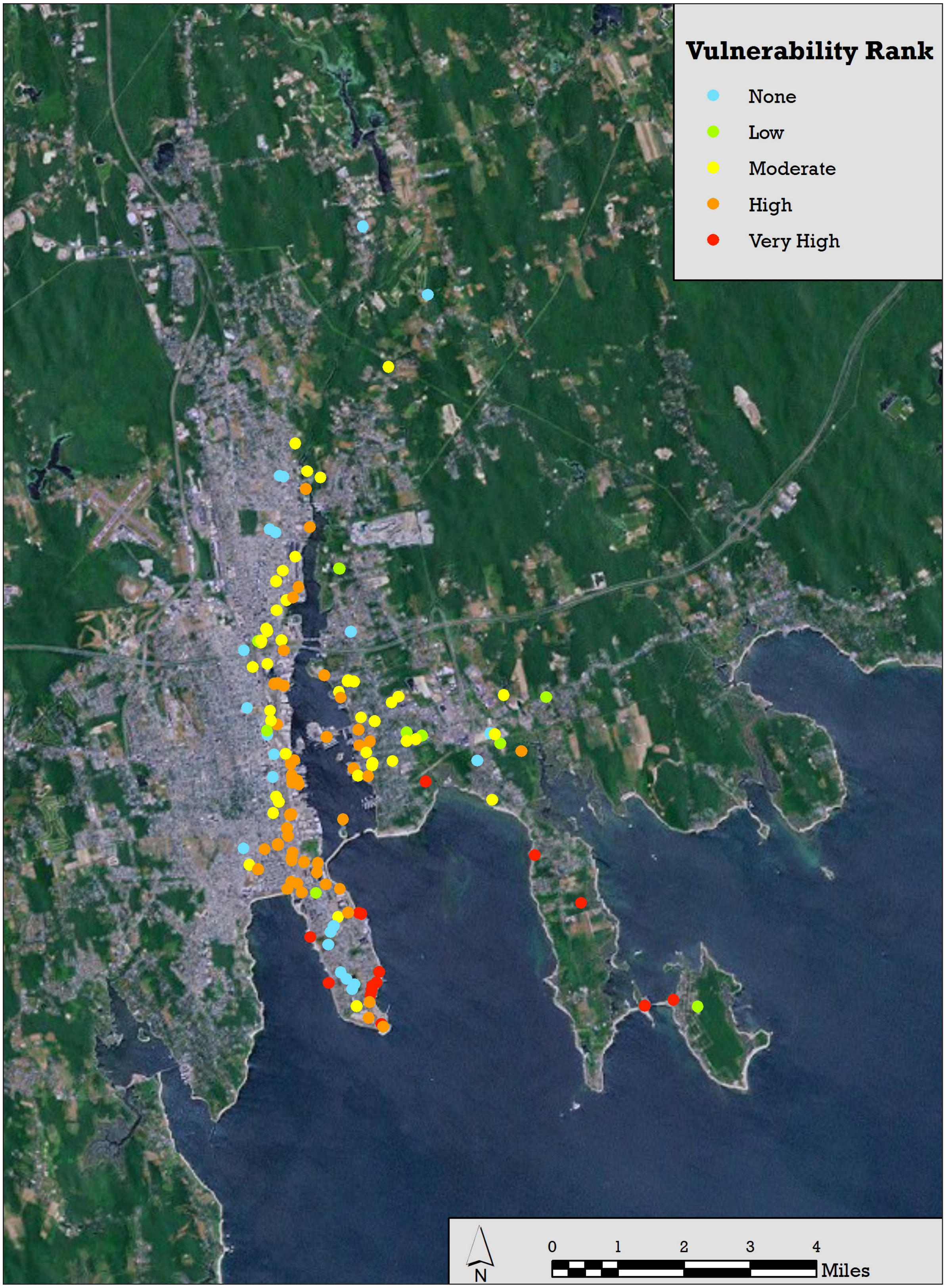

Figure 21. **Built public structures** by vulnerability rank.

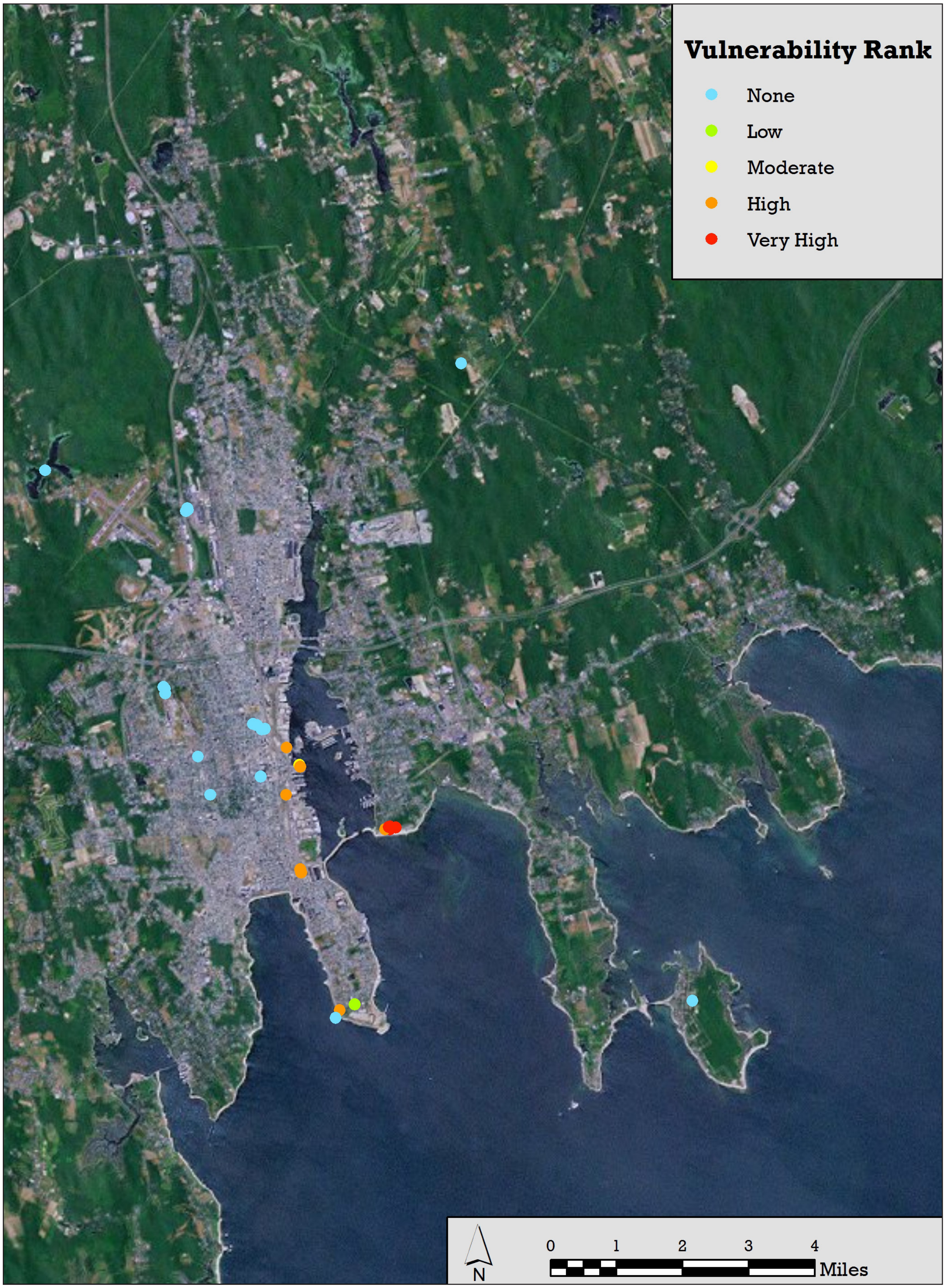

Figure 22. **State-owned buildings** by vulnerability rank.

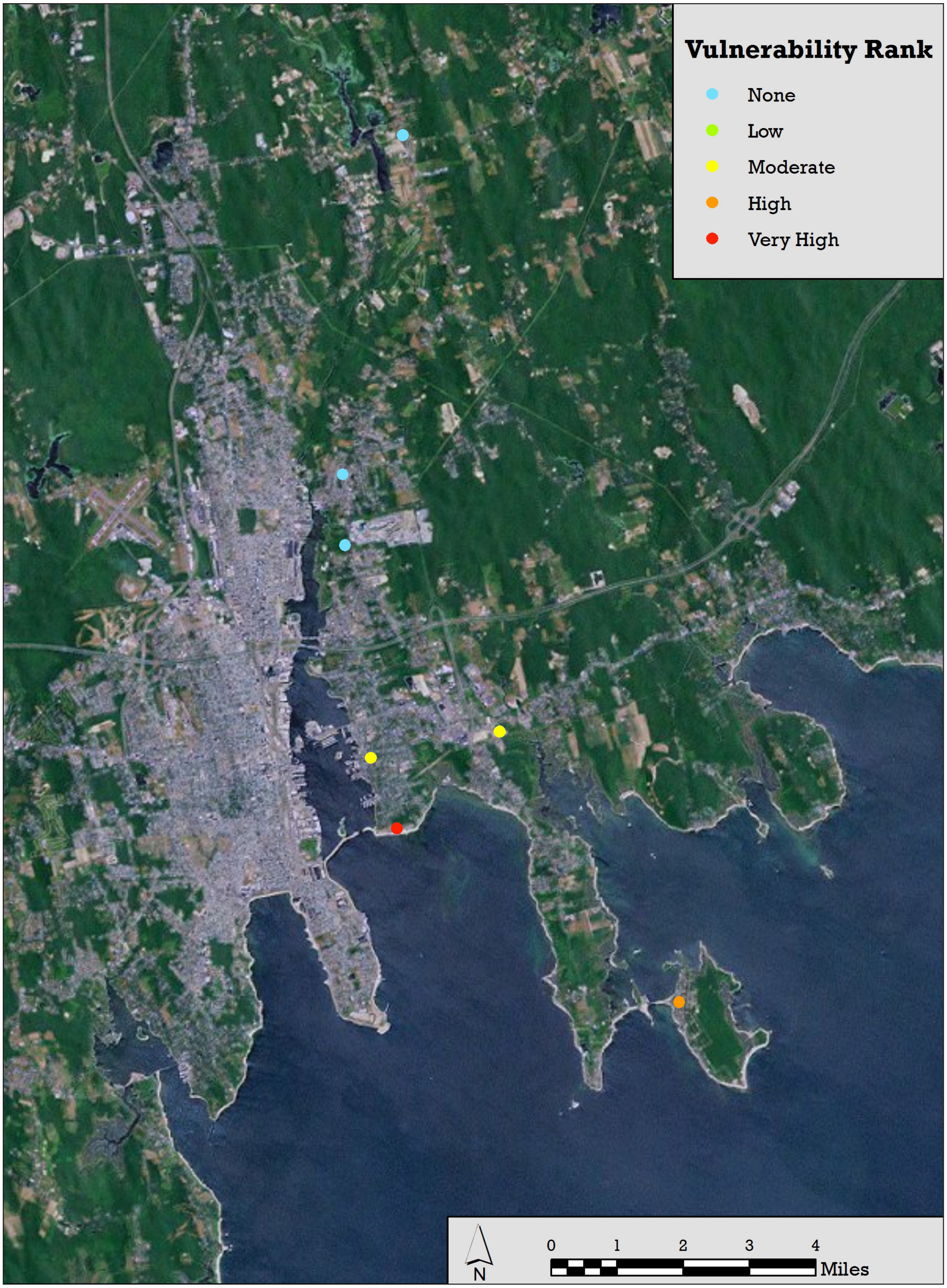

Figure 23. **Government buildings** by vulnerability rank.

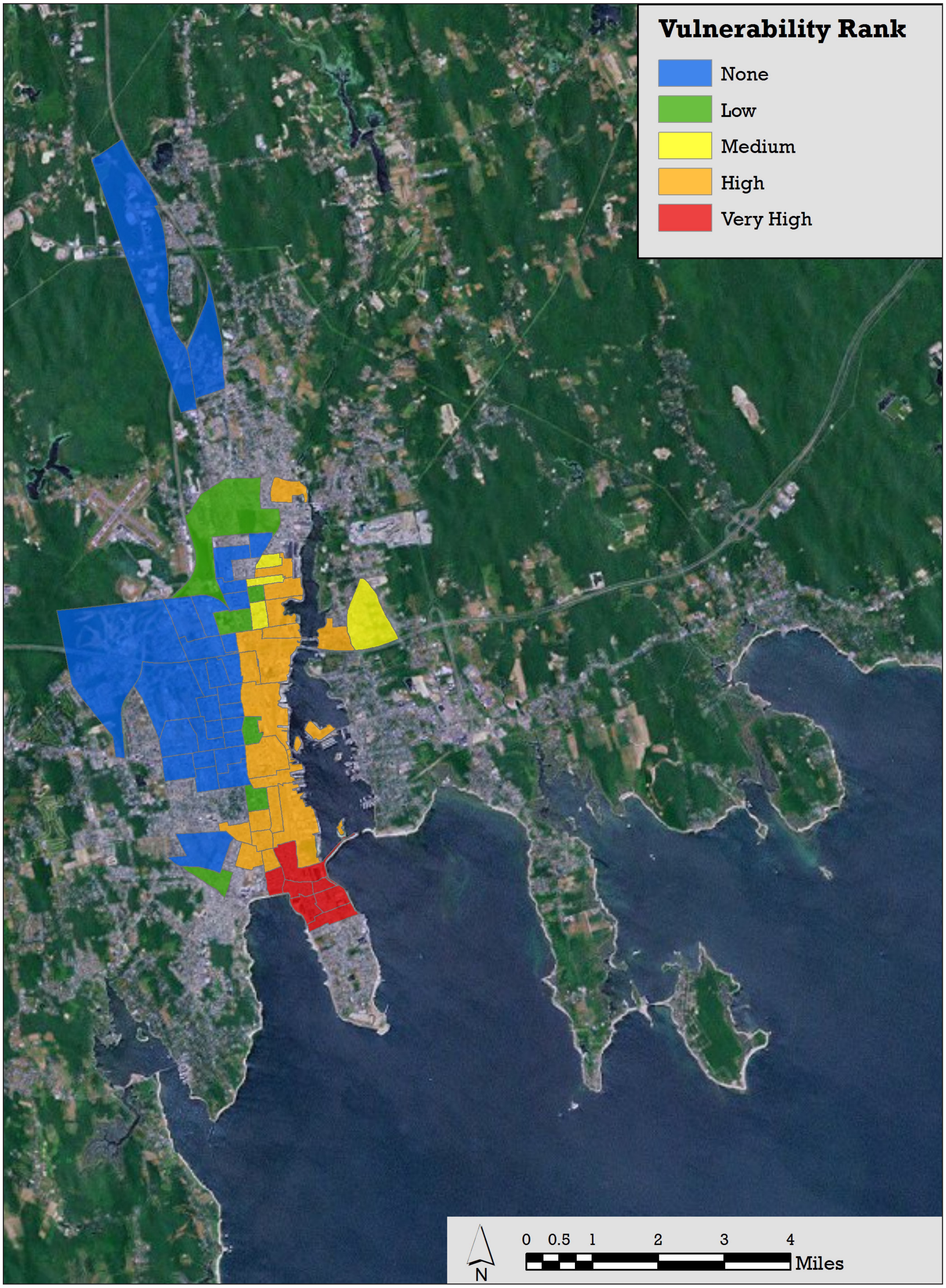

Figure 24. **Environmental justice communities** by vulnerability rank.

income losses (relocation loss, capital losses, wage loss and rental income loss). It does not include estimated repair and replacement costs. Costs of repair and replacement costs are factored into the estimates of building exposure, which are reported in other sections of this document. Building exposure data is not aggregated the level of Census Block level in Hazus, which is why no downloadable spatial datasets were developed using these estimates.

Water quality engineering analysis and recommendation development Results

The inundation depths at the locations of priority water quality infrastructure features (CSOs, pump stations and wastewater treatment facilities) informed the development of recommendations for the municipalities in the study area to begin to address vulnerabilities. Recommendations were developed based on the available data from each municipality; however, the considerations used to develop these recommendations were consistent for each municipality. Below, we describe the general considerations, approaches, and recommendations for CSOs, pump stations and treatment plants for the entire study region. We then provide specific recommendations for each water quality infrastructure feature and municipality in the prioritization matrix (Table 8), which provides details about risks, costs, and other considerations at specific structures and assigns a relative value ranking top priority adaptation projects for the municipalities to consider. In order to provide information that is most helpful to individual municipalities, we also developed separate recommendation summaries specific to each municipality. These summaries contain a simplified version of the prioritization matrix and can be found in Appendix E.

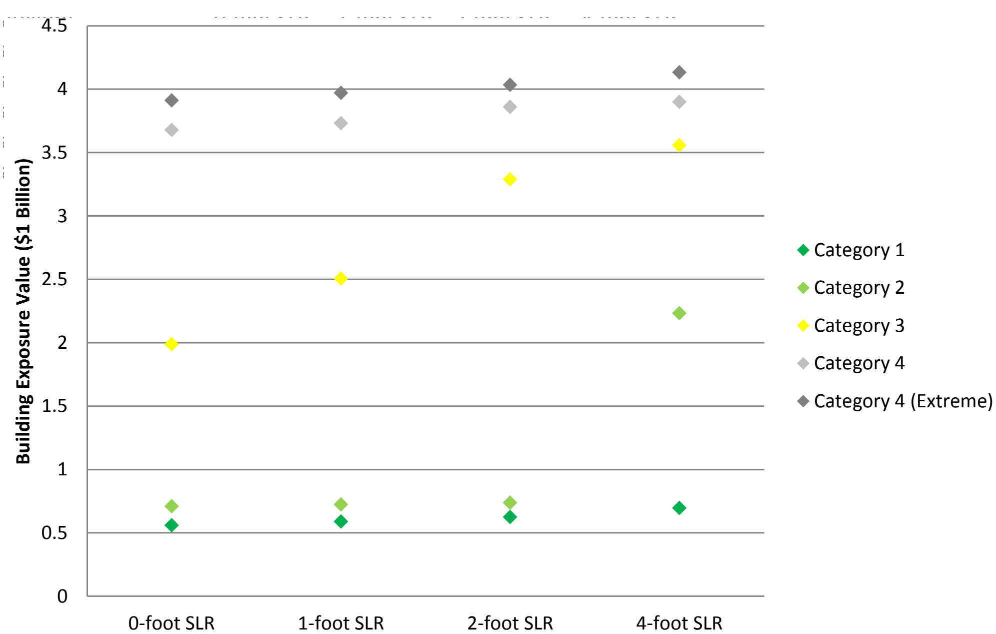

Figure 25. Summary of estimated building exposure values from the Hazus model. This estimate includes not only the cost of the buildings themselves (substantially damaged or otherwise), but also the engineering cost to replace or repair a damaged building.

CSOs

The City of New Bedford has 24 active, permitted CSOs. CSO discharges are controlled by regulators, many of which are already below MSL (mean sea level) and MHW (mean high water) (Figure 27). This means that there are likely to be additional regulators, sets of controls and/or storage available that would prevent the system from flooding during normal operation. Additionally, 15 of these outfalls have a tide gate that would preserve system storage. The project team understands that several regulators currently flood with water from the river and/or bay during storms and other extreme tide events resulting in in situ river/bay water draining to the treatment plant. This inflow into the system unnecessarily impacts the system hydraulic loads and likely negatively impacts the waste water treatment system performance. SLR will only exacerbate these flooding issues. However, it is not currently possible to quantify the extent of these impacts beyond understanding that increased SLR will add backflow to the existing CSO outfalls and reduce their hydraulic performance.

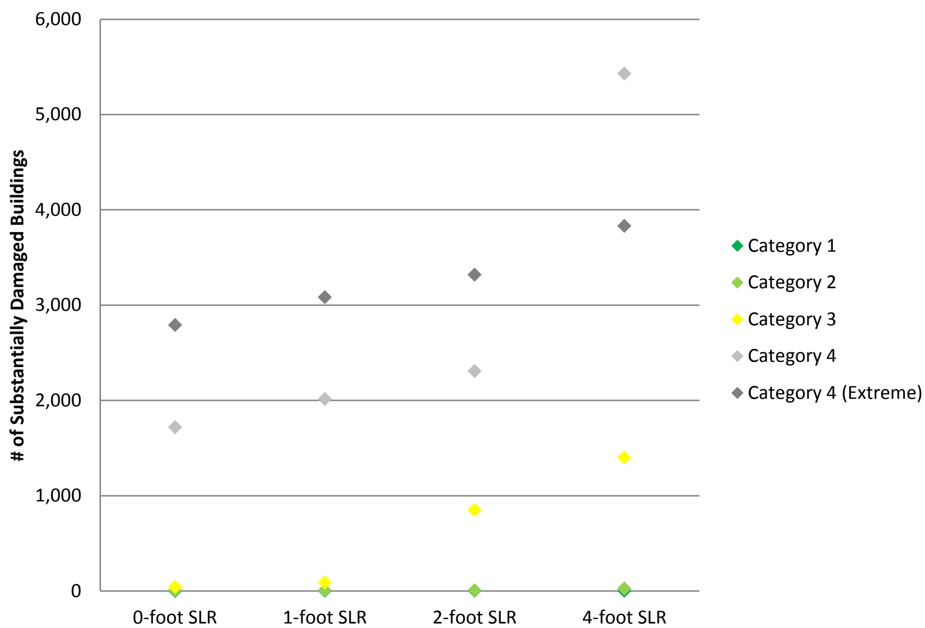

Figure 26. Summary of estimated structural damages to buildings using Hazus model.

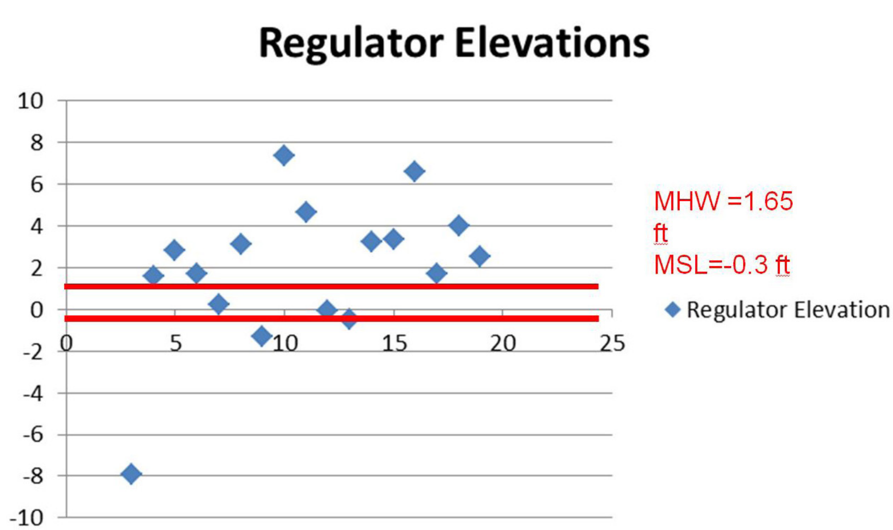

Figure 27. CSO Regulator Elevations. Regulator elevations (ft) are shown on the y-axis. Red lines on the chart depict mean high water (MHW) and mean sea level (MSL) at baseline (no SLR) scenarios.

In the short-term, the team recommends that the City of New Bedford pursue smaller adjustments and repairs to CSOs, where possible; however, more information is needed as to whether increased water levels at discharge locations would prevent regulators from functioning properly. As such, we suggest that assessing the impacts of storm surges will require hydraulic modeling of the system, which answers questions about the storage capacity of the system and its ability to drain. In general, the hydraulic modeling would need to assess the ability of the system to temporarily store water during target evaluation storms and then release that water as tides recede for SLR scenarios. In terms of priority study activities, we recommend that CSO hydraulics should be modeled for those CSOs where regulator weir elevations are below SLR elevations for specific SLR scenarios (Table 4). This study modeled flooding from hurricane events, however, in the long term, if there is more than 1 – 2 feet of SLR, there will be limited abilities to make any changes to individual CSOs that will prevent overflows. Under these projected SLR scenarios, dramatic and costly changes will have to be made to sewer infrastructure to prevent saltwater intrusion and to eliminate CSOs due to seawater intrusion into the system. Once these sea levels are reached, it will be necessary to devote substantial resources to increase overall sewer capacity.

Pump stations

The infrastructure housed at pump stations, including motors, electrical service and electronic controls, generators, buried compressors and fuel tanks, and manholes can all influence a pump station's ability to operate during flooding events. There are 15 pump stations, in the floodplain of a Category 3 hurricane with no SLR. This includes 1 in Acushnet, 4 in New Bedford, and 10 in Fairhaven. When 4-foot SLR is added to the scenario, there are an additional 11 additional pump stations in the flood plain. This includes 1 additional pump station in Acushnet, 5 in New Bedford, and 5 in Fairhaven. Generally the pump stations are above ground on level ground near the shoreline and are very exposed. A few are below ground. Figure 28 summarizes the inundation depths at each pump station for these scenarios.

Adaptation actions should prioritize structures that fall within the Category 3 floodplain at current water levels, and focus secondarily on those which are at risk during Category 3 storms with 4-foot SLR. Individual assessments of each structure should be performed to determine the following:

- Whether the structure has already been floodproofed
- To confirm elevations of possible points of entry for water (e.g. vents, door sills, windows)
- The vulnerability of critical infrastructure within each pump station
- What would be required to floodproof
- Whether the facility is currently able to operate during flood conditions (e.g. equipped with generator, ability to remotely operate)

Once potential risks to a facility are understood, potential mitigation measures should be identified and more accurate opinions of costs can be developed to retrofit existing facilities. From an initial evaluation of the pump station locations under these scenarios, we have found that access to many structures will not be possible except by boat

Table 8. Prioritization Matrix. This table shows the water quality infrastructure evaluated for water quality engineering adaptations. Facilities that are in the floodplain for both Category 3 (0-ft SLR and 4-ft SLR scenarios received a vulnerability rating of 3 (high risk, highlighted in red), those in the floodplain only during the Category 3 storm with 4-foot SLR received a risk rating of 2 (medium risk, highlighted in orange), and those that weren't in the floodplain in either scenario received a risk rating of 1 (low risk, highlighted in green). Adaptation costs are ranked 1 (high), 2 (medium) and 3 (low). Some additional features are assigned a facility importance ranking of 2 to pump stations in Fairhaven that reflects their overall importance to system function. These ranks are multiplied to get the priority ranking score. Proposed projects with higher scores should be considered high priority for the municipality.

Structure Location	Municipality	500 year flood depth with baseline water levels	500 year flood with 4' SLR	Inundation Risk	Preliminary Recommendations	Facility Importance Rank	Project Cost	Comments	Priority Ranking
Combined Sewer Overflows (CSOs)									
Various	New Bedford	N/A	N/A	Unknown	Hydraulic modeling of CSO system to assess storage capacity of system and ability to drain during various SLR scenarios, especially for those CSOs where regulator weir elevations are below SLR elevations for evaluation scenarios.		1	There is not currently enough data to assess the extent of the impacts of the modeled storm scenarios on CSOs. in the long term, if there is more than 1 – 2 feet of SLR, there will be limited abilities to make any changes to individual CSOs that will prevent overflows. Under these projected SLR scenarios, dramatic and costly changes will have to be made to sewer infrastructure to prevent saltwater intrusion and to eliminate CSOs due to seawater intrusion into the system.	-
Pump Stations									
Blueberry Drive	Acushnet	0.00	0.00	1	None			Above ground structure with brick construction. Door sill is close to ground	1
Allen Street	Acushnet	0.00	4.74	2	Consider berm or wall with weir boards for access. Need for generator is unknown. Potential cost range is $25,000 to $75,000		3	Above ground structure type unknown, likely pre-manufactured housing for pump station. If so, likely cannot be floodproofed and earthen berm will be required.	6
Slocum Street	Acushnet	0.85	23.84	3	Add floodproof door and extend vents. Potential cost range is $10,000 to $25,000. on site generator will be expensive and not included in these costs. Controlling water levels above roof line likely not feasible.		3	Below ground structure. Vents likely could be flooded with SLR scenario.	9
Rivard Street	Fairhaven	0.00	0.00	1					1
Marguerite Street	Fairhaven	0.00	0.00	1				Above ground structure type unknown.	1
Pine Grove Road	Fairhaven	0.00	0.00	1				Below ground structure. Vents likely could be flooded with SLR scenario.	1
Rocky Point Road**	Fairhaven	7.44	11.25	3				No information available	3
Abbey Street**	Fairhaven	12.50	16.75	3	None			Has on-site generator	3
Boulder Park**	Fairhaven	13.20	17.33	3	Needs elevation			No data available	3
Taber Street*	Fairhaven	0.00	20.73	2	Potentially require floodproof door. Potential cost range is $10,000 to $250,000.		2	Above ground structure with brick construction. Door sill is close to ground.	4
Pilgrim Avenue*	Fairhaven	0.00	20.65	2	Potentially require flood proof door as well as generator and remote controls. Structure should be checked for buoyancy. Potential cost range is $10,000 to $250,000.		2	Above ground brick structure, first floor within 2-3 ft of ground. Generator on site.	4
Bridge Street*	Fairhaven	0.00	18.05	2	Potentially require floodproof door as well as generator and remote controls. Structure should be checked for buoyancy. Potential cost range is $10,000 to $250,000.		2	"Above ground brick structure, first floor within 2-3 ft of ground. This is no longer a pump station; used for odor control only. "	4
Middle Street*	Fairhaven	0.00	18.82	2	This is a drainage (not sewer) pump station and therefore should be assessed to determine how essential it is to operate during coastal floods. Potential cost range is $10,000 to $50,000.		3	Above ground structure. Door sill is 1 to 2 feet above ground.	6
Causeway Road**	Fairhaven	3.93	7.66	3	Structure would require complete reconstruction. Potential cost range is $200,000 to $500,000	2	1	Above ground wood structure. Door sill is just above ground. Generator on site. Pumps water from upstream pump stations	6
Camel Street**	Fairhaven	8.04	11.66	3	Below ground pump station. Flood door for vault required and on site generator should be considered. Potential cost range is $50,000 - $250,000		2	Town has indicated that a portable generator is used during storms; however, access to site would be limited during projected inundation scenarios.	6
Manhattan Avenue**	Fairhaven	8.71	12.49	3	Minimum likely requirement is floodproofing doors. Potential cost range is $10,000 to $250,000		2	Above ground structure with pump station on site. Doors are elevated 15 feet.	6
Bernese Street**	Fairhaven	8.73	12.59	3	None	2		Generator on-site with elevated doors. Pumps water from updstream pump stations.	6
Shore Drive**	Fairhaven	12.18	15.98	3	Floodproof access hatch and provide on-site generator. Potential cost range is $100,000 - $250,000		2	Below grade pump station with no generator	6
Waybridge Road**	Fairhaven	12.59	16.40	3	On-site generator recommended. Potential cost range is $10,000 to $250,000		2	Aboveground pump station with elevated first floor which is 10-12" above grade. Town has indicated that a portable generator is used during storms; however, access to site would be limited during projected inundation scenarios.	6
Seaview Avenue**	Fairhaven	12.81	16.59	3	On-site generator with above ground structure recommended. Potential cost range is $10,000 to $250,000		2		6
South Street	Fairhaven	0.00	11.74	2	Potentially require floodproof door as well as generator and remote controls. Structure should be checked for buoyancy. Potential cost range is $10,000 to $250,000.	2	2	Above ground structure with brick construction. Door sill is close to ground. Pumps water from upstream pump stations.	8
Arsene Street	Fairhaven	0.00	0.00	1	None				1
Rowe Street	New Bedford	0.00	0.00	1	None				1
Peckham Road	New Bedford	0.00	0.00	1	None				1
Sassaquin Avenue	New Bedford	0.00	0.00	1	None				1
Pequot Street	New Bedford	0.00	0.00	1	None				1
Phillips Road	New Bedford	0.00	0.00	1	None				1
Marlborough Street	New Bedford	0.00	0.00	1	None				1
Forbes Street	New Bedford	0.00	0.00	1	None				1

* Town has indicated that these pump stations, which are behind the hurricane barrier, may be older structures therefore more vulnerable in the event of flooding at that location.

** This facility reportedly is not operated during flooding events. As a result, adaptations to allow pump station to operate during the flood events are likely not required. However, adaptations to these structures may still be required in order to protect key infrastructure in the facilities (e.g. motors and electrical service) and allow the facilities to be able to operate after the storm.

Structure Location	Municipality	500 year flood depth with baseline water levels	500 year flood with 4' SLR	Inundation Risk	Preliminary Recommendations	Facility Importance Rank	Project Cost	Comments	Priority Ranking
Hanover Street	New Bedford	0.00	0.00	1	None				1
Welby Road	New Bedford	0.00	0.00	1	None				1
Church Street	New Bedford	0.00	0.00	1	None				1
Joyce Street	New Bedford	0.00	0.00	1	None				1
Aviation Way	New Bedford	0.00	0.00	1	None				1
Shawmut Avenue	New Bedford	0.00	0.00	1	None				1
Valley View Drive	New Bedford	0.00	0.00	1	None				1
Joy Street	New Bedford	0.00	0.00	1	None				1
Hathaway Road	New Bedford	0.00	0.00	1	None				1
Apple Tree Lane	New Bedford	0.00	0.00	1	None				1
Merrimac Street	New Bedford	0.00	0.00	1	None				1
Coggeshall Street	New Bedford	0.00	16.66	2	Floodproofing of doors, windows and vaults will be required. Existing vents will need to be raised. Electrical infrastructure such as services, generators and transformers will either need to be raised or protected with floodwall system with flashboards for access. Structure and vaults should be checked for buoyancy. Controlling water levels above roof line likely not feasible. Potential cost range is $150,000 to $350,000.		1	Above ground brick structure with brick construction. Door sill is about 0.8' above ground. Window sills are about 4.7' above ground. Several concrete vaults with hatches or accessways exist below grade that likely provide pathway for flooding inside of building. A vent to one of the vaults also has a low point at about the same elevation of the window sills. Two other vents also exist at a lower elevation. Building electrical service is below inundation levels. A transformer adjacent to the site and generator is on right at grade.	2
Howard Avenue	New Bedford	0.53	23.44	3	"Require floodproof doors and windows including accessways to below grade vaults. Above ground tank will have to be anchored and vaults checked for buoyancy. Generator should be provided for site. Controlling water levels above roof line likely not feasible. Potential cost range is $150,000 to $350,000. "		1	"Above ground structure with brick construction. Two stainless steel doors have sills at grade. Window sills are as low as 2.7' above ground. Below grade vaults exist with hatches or grates providing access to the vaults. Above ground storage tank exists at grade. Generator transfer switch and connection are located about 3.2' above grade. A below grade electrical vault also exists on this site. Above ground structure with brick construction. Two stainless steel doors have sills at grade. Window sills are as low as 2.7' above ground. Below grade vaults exist with hatches or grates providing access to the vaults. Above ground storage tank exists at grade. "	3
Belleville Avenue	New Bedford	0.00	17.73	2	Require floodproof doors for entries and loading dock as well as floodproofing electrical vault and air intakes. Also, incoming sewer manholes will need to have covers bolted and gasketed. Potential cost range is $25,000 to $200,000.		2	Above ground brick structure. Door and loading dock landing is about 3.3' above ground. Air intake or exhaust is about 3' above ground. Below grade electrical vault will be vulnerable to flooding. Equipped with SCADA and telemetry so can be remote operated. Generator is located on site.	4
MacArthur Drive	New Bedford	0.00	13.27	2	Potentially require floodproof door, generator and floodproofing of vaults that could be points of entry. Potential buoyancy of building should also be assessed. Controlling water levels above roof line likely not feasible. Potential cost range is $100,000 to $250,000.		2	Above ground brick structure.First floor is at about 3.1' above ground at entry door landing. Several buried concrete vaults are adjacent or nearby the structure. Contents of those vaults are not known but likely points of entry into pump station. The vaults may be inlet works, wet wells or electrical vaults.Site is not equipped with a generator and pigtail connection is at door sill elevation. Some electrical service enters building from ground. Facility will be equipped with SCADA and telemetry to allow remote operation.	4
Wamsutta Street	New Bedford	0.00	23.53	2	Potentially require floodproof doors as well as floodproofing at-grade entryway and building penetrations. Generator will also need to be protected likely with wall system. Potential buoyancy of building should also be assessed. Controlling water levels above roof line likely not feasible Potential cost range is $75,000 to $250,000.		2	Above ground structure with brick construction. Door sill is close to ground. No generator, likely pigtail.	4
Popes Island	New Bedford	0.00	16.69	2	Access hatch to pump station will need to be floodproofed. Electrical service and control panels will need to be raised and floodproofed. Ability to operate pump station remotely will need to be confirmed. Generator should also be provided that will need to be protected as well. Potential cost range is $100,000 to $250,000		2	Below ground pump station. Electrical service and control panels are at about 2.8' above grade. Vent is about 4.25' above grade. No generator	4
South Water Street	New Bedford	6.82	15.12	3	Potentially require floodproof door and floodproof windows. Generator and electrical service will likely need to be raised or protected. Little information available for this site to identify other needs. Potential cost range is $100,000 to $250,000.		2	Above ground structure. Door sill is just above ground. Generator is reportedly located on site.	6
East Rodney French Boulevard	New Bedford	11.39	15.74	3	Floodproof doors and windows. Vents will need to be protected with cutoff wall. Electrical service will need to be raised and gas service needs to be evaluated. Controlling water levels above roof line likely not feasible. Potential cost range is $25,000 to $150,000.		2	"One door sill and vent are located 3.6' above grade. One door sill is 1.8' above grade. Ground elevations vary at both doors. Electrical service meter box located 2.3' above grade. Electrical junction boxes appear to be as low as 0.8' above grade. Intake/exhaust vents for generator are about 1.8' above grade. Gas service is at grade for backup generator. "	6
Cove Road	New Bedford	11.89	15.12	3	Floodproof existing doors. Electrical service should be raised and floodproofed with transformer protected as well. Generator vent should be protected with cut off wall. Gas service needs to be assessed. Controlling water levels above roof line likely not feasible. Potential cost range is $50,000 to $250,000.		2	"Protected by existing levee; The ability to enhance the existing flood control system around this structure should be assessed as part of any consideration to providing further flood protection for this structure. First floor 4' above grade with two stainless steel doors providing access. Electrical box is located 3' above grade. Transformer is located at grade. Gas service is also located at grade. Generator intake/exhaust vents is located 4.4' above grade. Odor control system is located outdoors but is not critical to system operation and would not be required to be protected. Generator is on site in building. Odor control system is located outdoors but is not critical to system operation and would not be required to be protected. Generator is on site in building."	6
Wastewater Treatment Facilities									
South Rodney French Boulevard	New Bedford	1.38	5.40	3	None			Protected by existing levee; The ability to enhance the existing flood control system around these structure should be assessed as part of any consideration to providing further flood protection for this structure.	-
Arsene Street	Fairhaven	0	0	1	None			Generator above ground brick, inside building	1
West Island	Fairhaven	0	0	1	None				1

during the inundation scenarios evaluated.

The Cove Road pump station in New Bedford is protected by an existing levee, although, there is the potential for inundation around this levee in the evaluated scenarios. The ability to enhance the existing flood control system around this structure should be assessed as part of any consideration to providing further flood protection for this structure. Use of short earthen levees or other flood protection structures will likely not be feasible for most of the other vulnerable facilities. The sites are too small to provide the space required for new structures and still allow equipment to access the facilities.

Structural floodproofing will likely be the only option available for these sites. The need for floodproofing may be minimal for some of these sites where pump stations are elevated.Several pump stations are below grade. These likely will be a greater challenge to floodproof.

Wastewater treatment plants

The Category 3 storms at both baseline water levels and 4-foot SLR levels show over ground flooding at the New Bedford Wastewater Treatment Facility. Future studies should assess the storm scenarios that this treatment facility should be protected from and should focus on thorough evaluations of the flood control system and critical infrastructure for those scenarios. Ideally, flood controls should keep the entire site dry for the specified inundation scenario.

The New Bedford facility is protected by an existing revetment; however, this does not appear to provide sufficient

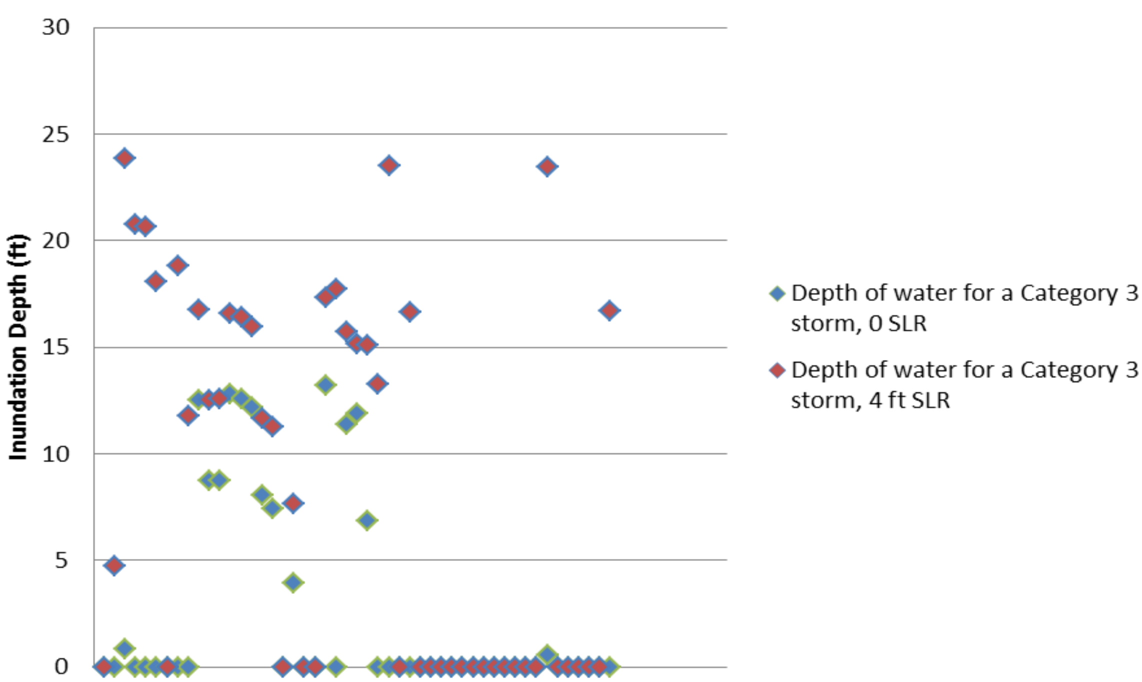

Figure 28. Inundation depths for pump stations. Depths reflect the inundation above sea level at the location of each pump station

protection from inundation around the treatment plant in hurricane scenarios more severe than Category 2 with 4-foot SLR. The ability to enhance the existing flood control system around these structures should be assessed as part of any consideration to providing further flood protection for this structure. Neither of the wastewater treatment facilities located in Fairhaven are at risk for flooding in either of these scenarios.

A site-specific assessment should be conducted to assess vulnerability to flooding. This would include a site visit to determine point of entry and where flood waters could damage equipment/structures and a survey to identify actual elevations of critical points to compare with target flood elevations. Once potential risks to the facility are understood, potential mitigation measures should be identified and more accurate opinions of costs can be developed to retrofit existing facilities.

Stakeholder engagement

Kick-off Meeting

On December 16, 2013, the kickoff meeting and listening session took place at the New Bedford Wastewater Treatment Facility and included the project team, as well as representatives from Buzzards Bay NEP, MA CZM, municipal departments of public works, and other interested parties. The project team presented an overview of the project and proposed approach. This was followed by a listening session in which meeting attendees provided feedback on data availability, priority concerns on water quality infrastructure, and hurricane parameters that should be involved in the SLOSH matrix. Major results from the meeting included: an updated list of datasets to include in the analysis, including designated port areas, public property with assessed values, and state-owned facilities; a plan to prioritize water quality infrastructure, especially CSOs, in the report recommendations; an approval of draft model parameters to be used in SLOSH; and a modified timeline for the remainder of the project.

Workshop Agenda Development

On February 4, 2014, a workshop planning meeting took place at the Fairhaven Wastewater Treatment Facility and included project team members from SeaPlan and RPS ASA, as well as representatives from Buzzards Bay NEP, MA CZM, municipal departments of public works, and other interested parties. At this meeting, the team presented a project update, and planned the interactive workshop. The outcomes of this meeting included an approval of the SLOSH input matrix, overview of the workshop agenda, ideas for workshop dates, and locations, and a consensus on the workshop audience and list of invitees.

Interactive Half-day Workshop

The half-day workshop for an audience of municipal staff and municipal appointed boards and commissions, waterfront users, state and federal agency took place at the Acushnet Council on Aging on April 17, 2014. The meeting included a presentation of the major findings of the vulnerability assessment, the Hazus damage assessment, a demonstration of draft data visualization tools, and preliminary recommendations in both a formal PowerPoint presentation and via the wall maps. The meeting was then divided into three interactive breakout sessions: Data Visualization Tools, Analysis and Results, and Recommendations in which meeting participants had a chance to explore tools and results in greater detail, ask in-depth questions, provide feedback specific to the session's theme. Major outcomes of the workshop included ideas for refining cartographic representations in the online interactive map viewer, a discussion of how the project outcomes will affect future land-use planning, economic analysis, and emergency management, and a plan to acquire more detailed data on water quality infrastructure from municipal representatives.

Presentation of Draft Findings

The final meeting took place on June 12, 2014, and focused on presenting the draft findings and the draft report, as well as final versions of the interactive online tools. Meeting attendees included representatives from each municipality, as well as any additional interested representatives from MA CZM, MEMA, and the EPA. During this meeting, participants had the opportunity to provide comments on the draft results and recommendations outlined in the draft technical report available on the project website. The consulting team had an opportunity to clarify and reconcile comments received prior to the meeting. Outcomes of this meeting included plans to refine recommendations related to New Bedford CSOs and some Fairhaven pump stations for the final report, as well as plans to refine the methodological overview and discussion sections by providing context about other modeling efforts and historical storms.

Data visualization tools

The team created two data visualization tools to communicate the impacts of the inundation scenarios.

Online Mapping Tool

The interactive mapping tool found at http://seaplan.buzzardsbay.org/contains a tabbed viewer which allows the user to view hurricane inundation scenarios for each baseline water level. The viewer contains inundation polygons, as well as the following features:

- Water infrastructure (pump stations and treatment plants)
- Coastal protection structures
- Designated port areas
- Environmental justice communities
- Government buildings
- State-owned buildings
- Publically-owned buildings
- Built public parcels
- Outfalls (CSOs and stormwater pipes)
- Selected catch basins (in Category 3 hurricane floodplain)
- Town boundaries

Users can click on data features to access additional data about each location (Figure 29).

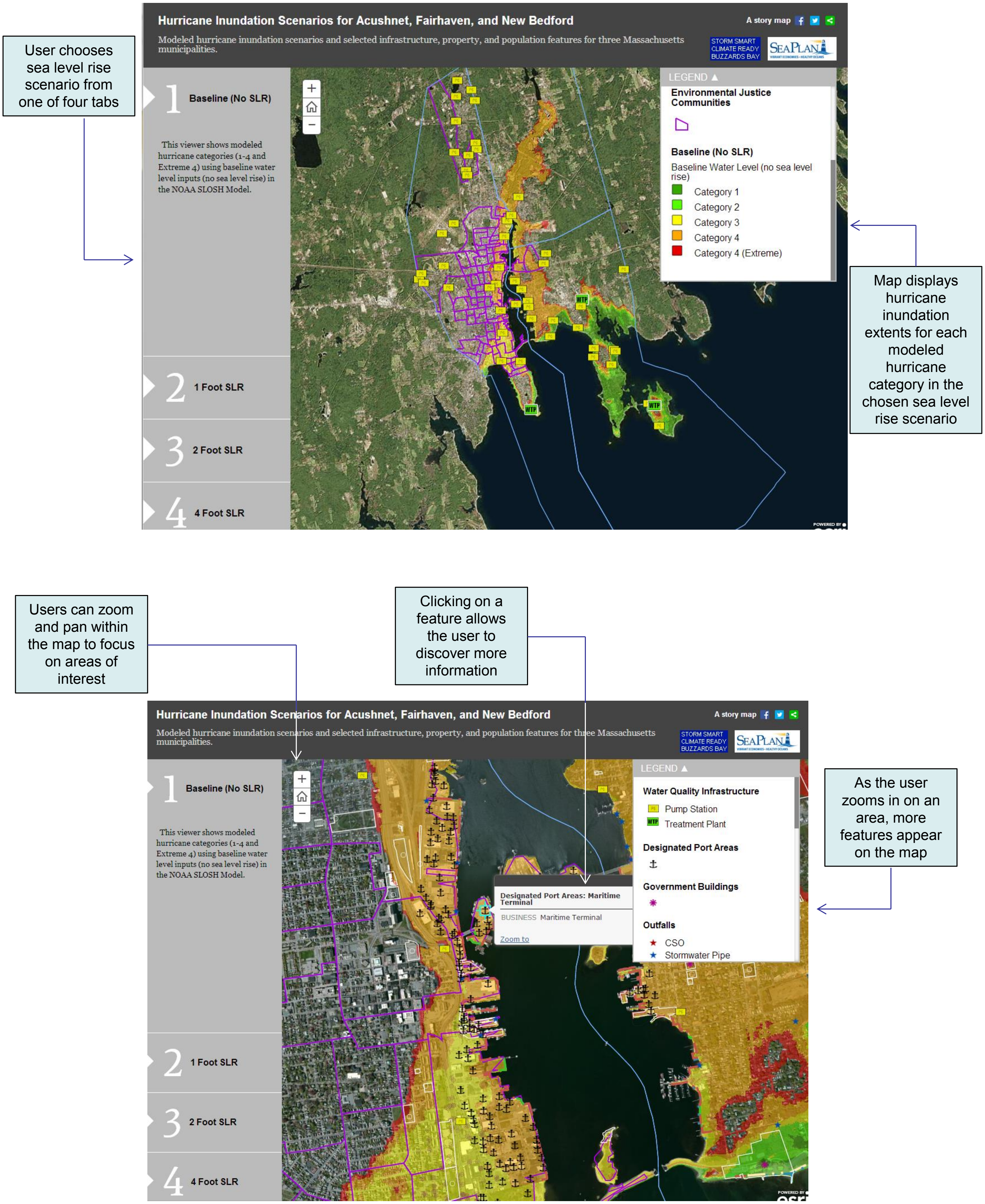

Figure 29. Online mapping tool available at [seaplan.buzzardsbay.org.](http://seaplan.buzzardsbay.org)

Risk Visualization Tool

The interactive risk visualization tool found at http://seaplan.buzzardsbay.org/risk.html allows users to choose hurricane parameters of interest and simultaneously view economic damage summary data from the Hazus model, flood inundation extents, storm surge elevation and its sensitivity to model inputs, and water level return period estimates. Each website component is dynamic and updated on-the-fly as users change the selected hurricane parameters (Figure 30). Unlike the building exposure values reflected in this report, the values displayed in the tool reflect estimates of economic loss, but do not include replacement costs.

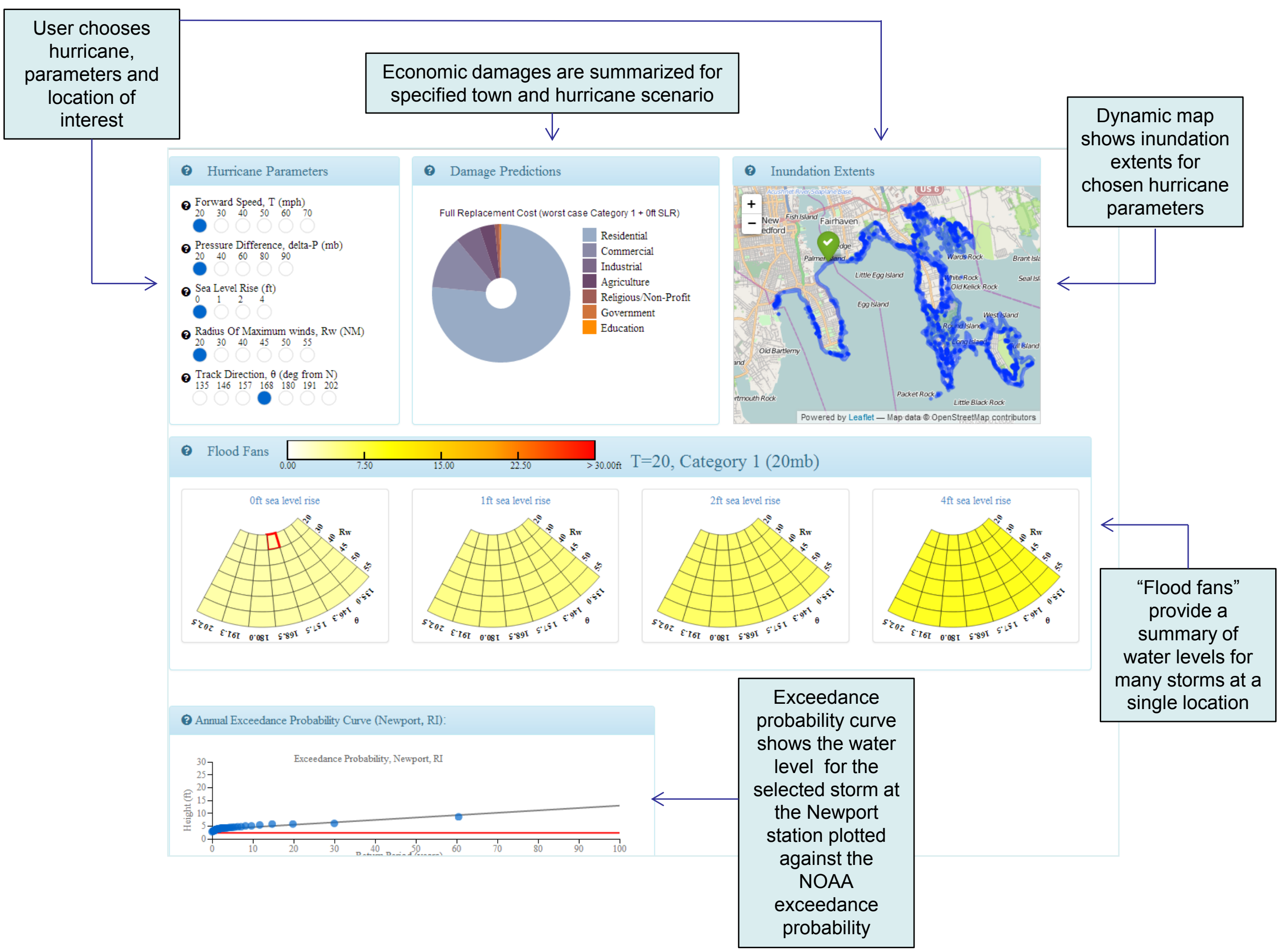

Figure 30. Online risk visualization tool available at http://seaplan.buzzardsbay.org/risk.html

Discussion

The 2014 National Climate Assessment stresses the climate change is already affecting the United States, and the Northeast will become increasingly impacted by SLR, coastal flooding, and intense precipitation events that will compromise existing infrastructure (Melillo et al. 2014). While federal, state, and local governments recognize these risks, there is much work to be done to implement adaptation measures. In order to prioritize adaptation strategies, governments need science-based predictive tools to support decision making which will lessen the impacts of climate change.

This study provided data, interpretive data products, and interactive tools which will help local governments prioritize adaptations actions for reducing the adverse impacts of climate change in these Buzzards Bay communities. The project team anticipates that in general, Category 3 storms and higher will have substantial impacts on the region that will be exacerbated with SLR as flooding will occur over and around the hurricane barriers. Although historically it has been rare for Category 3 storms to make landfall in the region, the intensity and frequency of North Atlantic hurricanes have been increasing since the 1980s, and are expected to continue to increase with rising global temperatures (Melillo et al. 2014). Given extreme SLR scenarios, even less severe storms might begin to damage facilities otherwise protected by the hurricane barrier. A Category 3 storm with 4-foot SLR has the potential to affect 26 pump stations and one wastewater treatment facilities in the region. The New Bedford wastewater treatment facility could potentially face substantial damages to its underground infrastructure if vulnerabilities are not addressed. SLR will also exacerbate existing vulnerabilities within the CSO system. Modeling the hydraulics of New Bedford's CSO system will be a necessary first step in identifying short-term adaptations to CSOs; however, it is recommended that the City of New Bedford pursue future studies of the CSO system to understand how to ready the system for sustained rising water levels and to identify alternative solutions that do not include CSOs. Without detailed, site-specific data at wastewater treatment facilities and pump stations, it is not possible to thoroughly evaluate the vulnerabilities of each structure; rather, this report identifies general geographic areas that are particularly vulnerable to flooding during a range of hurricane conditions. Municipal officials can use the data generated in this study to compare elevations of critical components of water quality infrastructure to projected inundation depths to further identify vulnerabilities and adaptive measures. By identifying vulnerable areas geographically, it is possible to prioritize which structures require further evaluation to determine flood preparedness.

In addition to wastewater infrastructure, a number of public properties, businesses, government buildings, and communities are at risk during the inundation scenarios. Federal, state, and municipal officials can use the data presented in the vulnerability analysis and in the interactive online tools to evaluate which of these areas are in need of further evaluation for flood management strategies.

The intent of this study was to provide a coarse overview of vulnerabilities to a variety of public property and infrastructure, focusing on water quality infrastructure, under a wide range of scenarios; however, these summary results are not intended to provide a definitive view of all possible impacts of climate change and SLR, nor can it provide insight on the likelihood of occurrence for any modeled inundation scenario. Inundation scenarios do not account for wave height, flood duration, or the potential for wave action to damage hurricane barriers. Modeling changes in precipitation and impacts associated with anticipated changes in watershed conditions that might also impact regional water quality infrastructure was also beyond the scope of this project. If more fine-scale modeling is required for future predictions and analyses, one potential approach would be to use the Finite-Volume Coastal Ocean Model (FVCOM) that is being developed by the University of Massachusetts Dartmouth. It would be possible to leverage the results of this project to model a reduced version of our matrix using parameters informed by our model outcomes, which would help to reduce the computational costs associated with this model.

Furthermore, the project team anticipates that the tools can be adapted to answer different questions about vulnerability and adaptation strategies in the same study area. For example, while analyzing indirect economic losses from flooding was beyond the scope of our study, it is possible to use to the SLOSH output results within the Hazus modeling environment to estimate job loss and other indirect costs under various inundation scenarios. Planners might also use the results to analyze risk to specific populations by looking at the data in conjunction with other datasets, including Census data, locations of emergency shelters, and evacuation routes, to identify vulnerable populations, and evaluate emergency preparedness strategies.

Climate change and its related effects pose an immense challenge to our region. It is imperative that communities continue to evaluate risk, and identify and assess adaptation actions to lessen impacts on critical infrastructure, and by extension, populations and the environment. This project is a critical first step for New Bedford Harbor municipalities to protect their communities from the impacts of climate change.

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Appendices

Appendix A: Depth Grid Maps

The following section contains maps of inundation extents and depths for each modeled scenario. The depths ranges reflect inundation elevations above sea level, and do not include inundation depths in areas with negative elevations (elevations below sea level), such as those in the Tilcon Quarry in Acushnet. Although a hurricane exceeding a Category 3 has never been recorded in New England, modeling results using Category 4 and Extreme Category 4 parameters have been included for informational purposes.

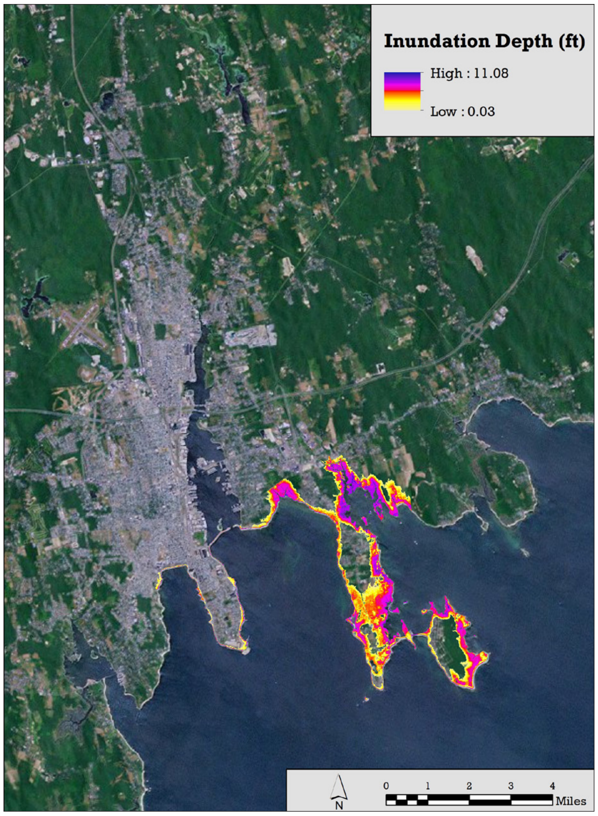

Figure A-1: Summary depth grid depicting inundation for a Category 1 Storm with no SLR

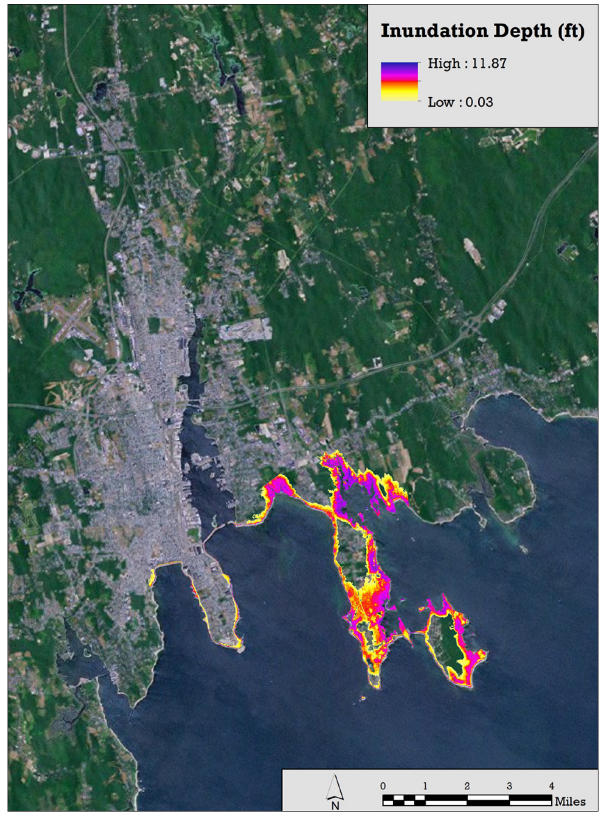

Figure A-2: Summary depth grid depicting inundation for a Category 1 storm with 1-foot SLR

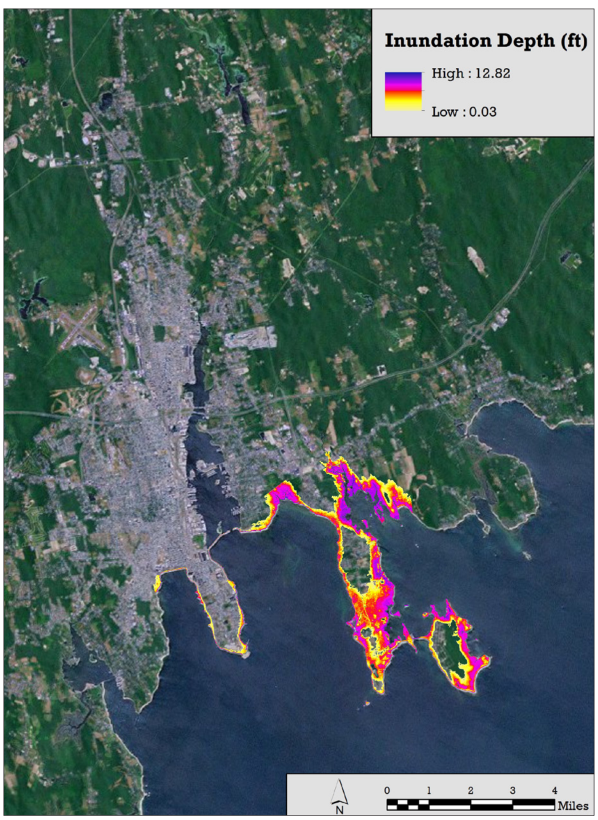

Figure A-3: Summary depth grid depicting inundation for a Category 1 storm with 2-foot SLR

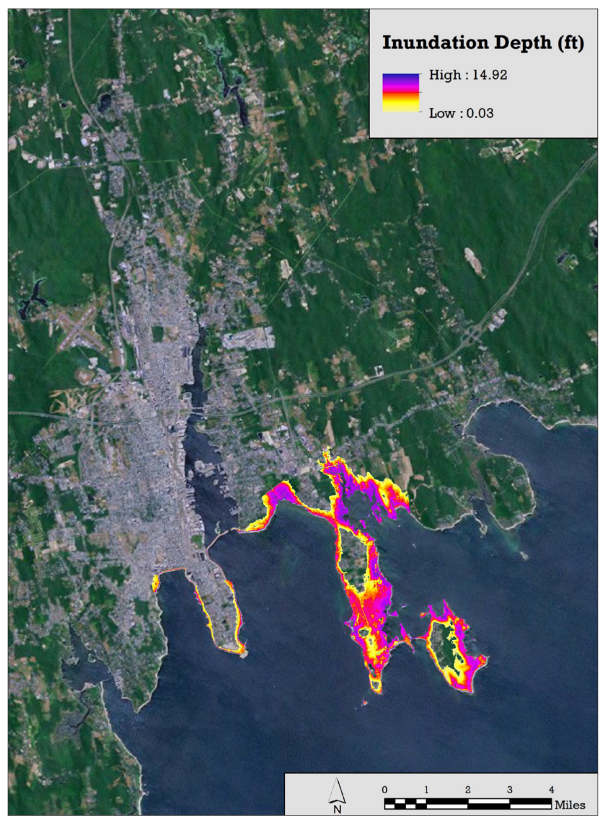

Figure A-4: Summary depth grid depicting inundation for a Category 1 storm with 4-foot SLR

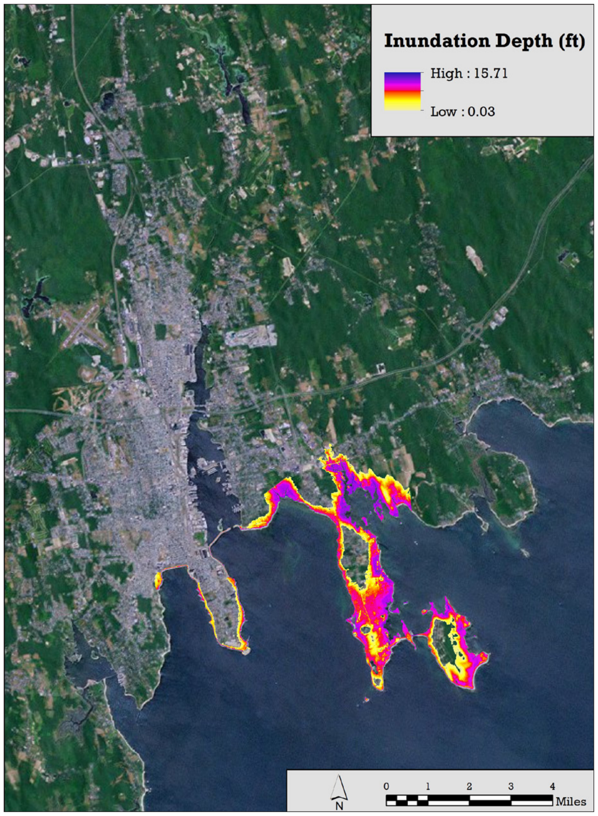

Figure A-5: Summary depth grid depicting inundation for a Category 2 storm with no SLR

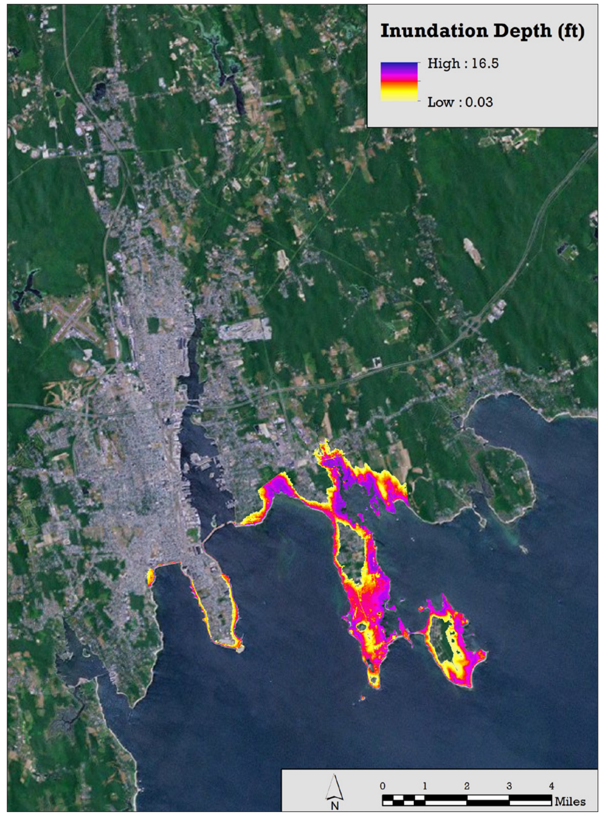

Figure A-6: Summary depth grid depicting inundation for a Category 2 storm with 1-foot SLR

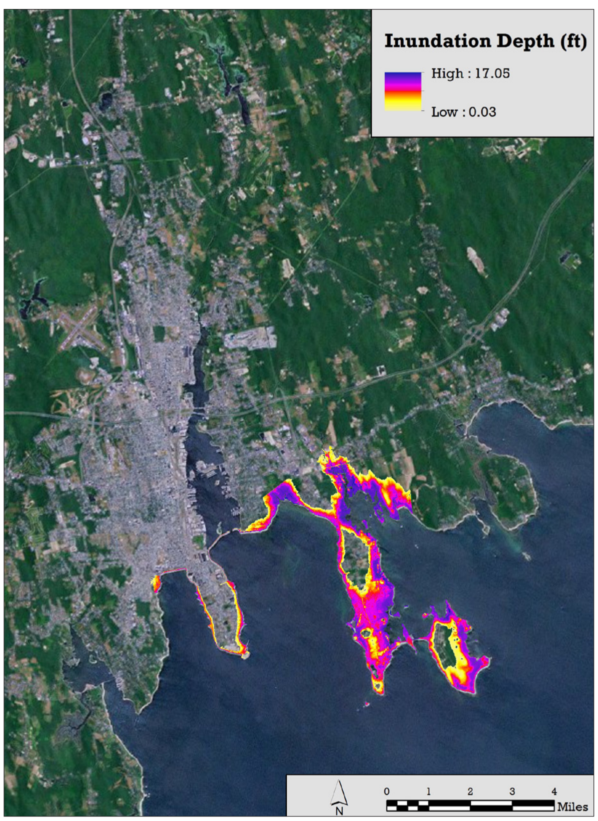

Figure A-7: Summary depth grid depicting inundation for a Category 2 storm with 2-foot SLR

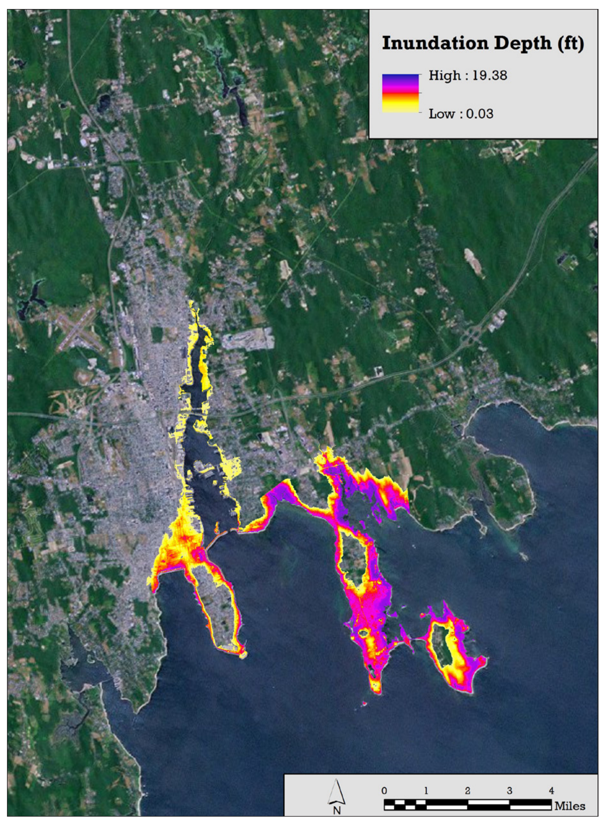

Figure A-8: Summary depth grid depicting inundation for a Category 2 storm with 4-foot SLR

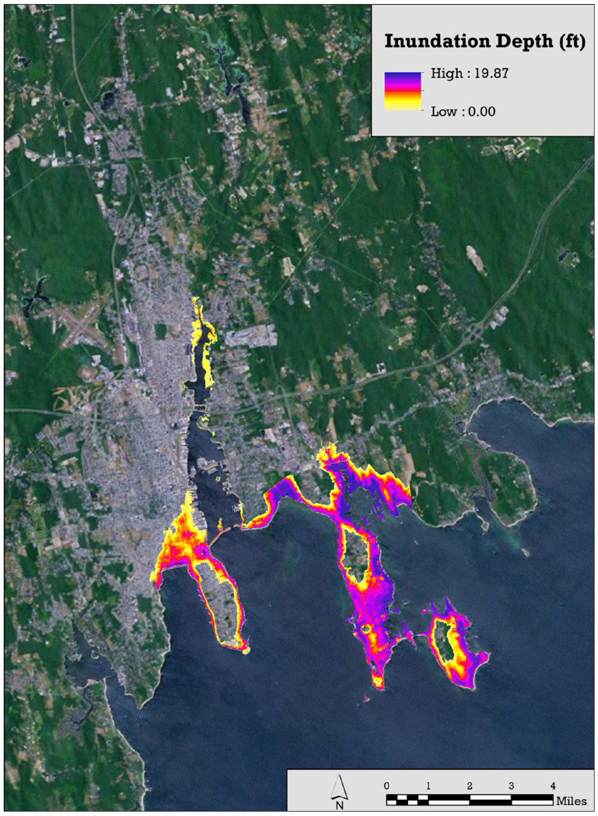

Figure A-9: Summary depth grid depicting inundation for a Category 3 storm with no SLR

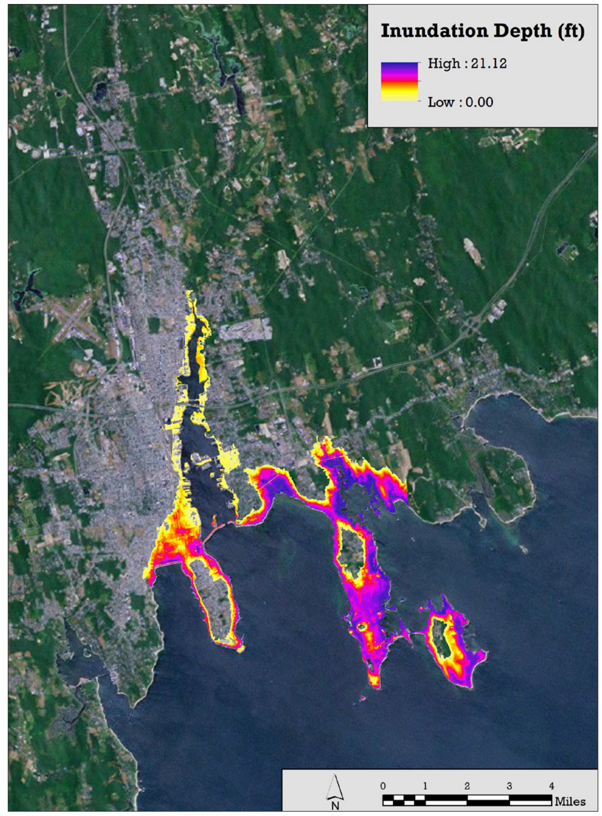

Figure A-10: Summary depth grid depicting inundation for a Category 3 storm with 1-foot SLR

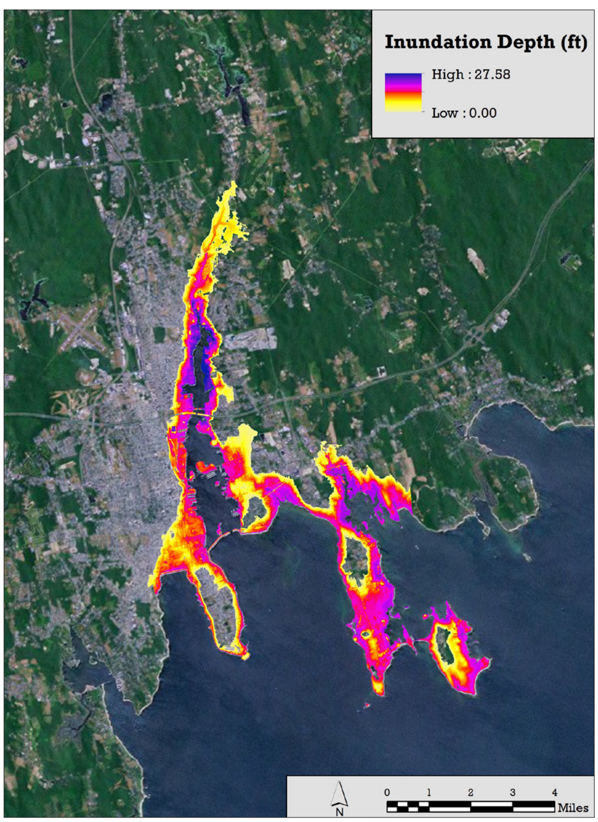

Figure A-11: Summary depth grid depicting inundation for a Category 3 storm with 2-foot SLR

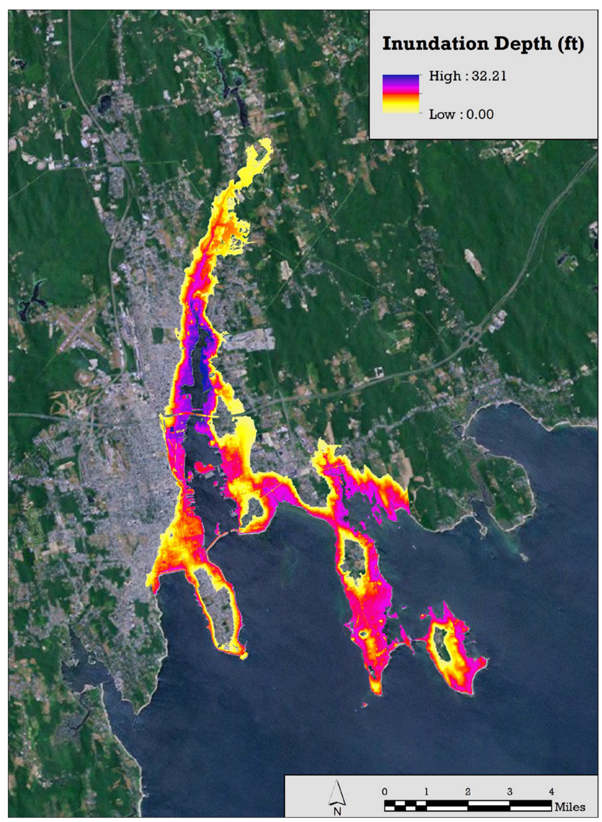

Figure A-12: Summary depth grid depicting inundation for a Category 3 storm with 4-foot SLR

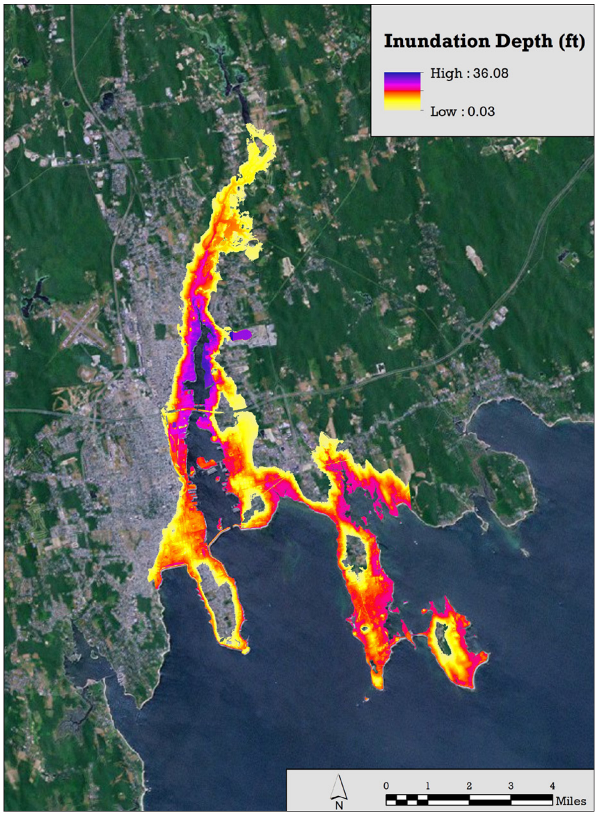

Figure A-13: Summary depth grid depicting inundation for a Category 4 storm with no SLR

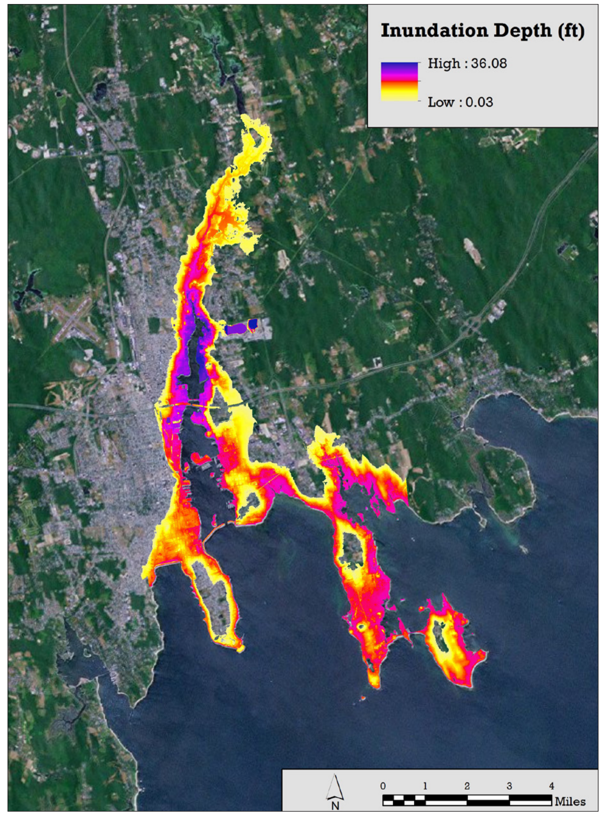

Figure A-14: Summary depth grid depicting inundation for a Category 4 storm with 1-foot SLR

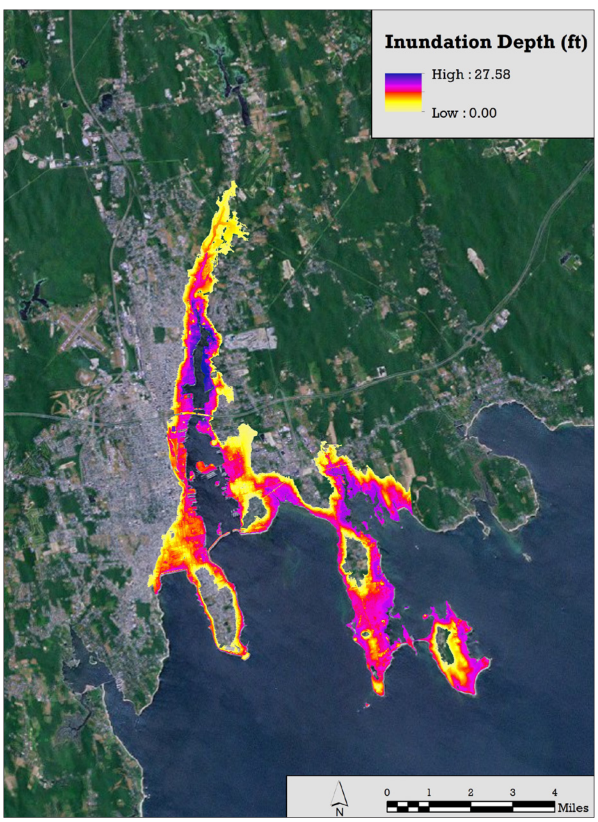

Figure A-15: Summary depth grid depicting inundation for a Category 4 storm with 2-foot SLR

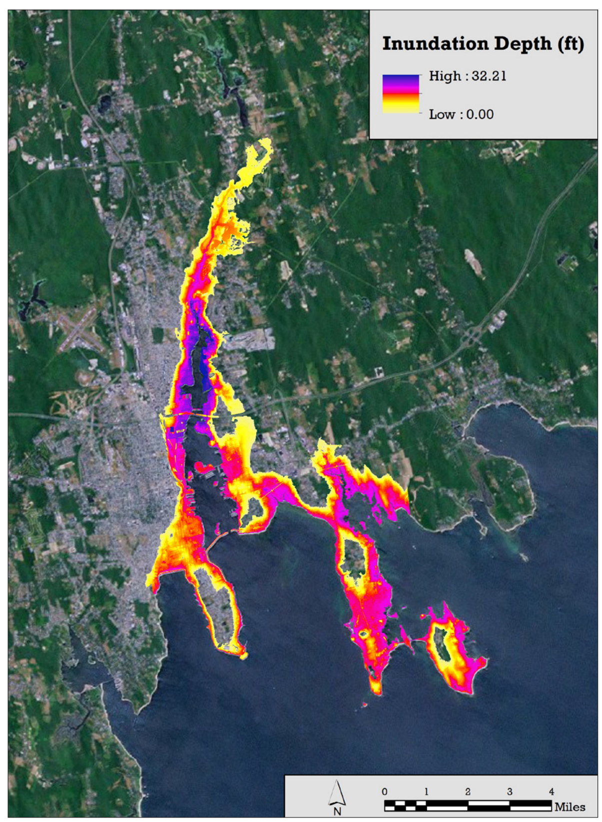

Figure A-16: Summary depth grid depicting inundation for a Category 4 storm with 4-foot SLR

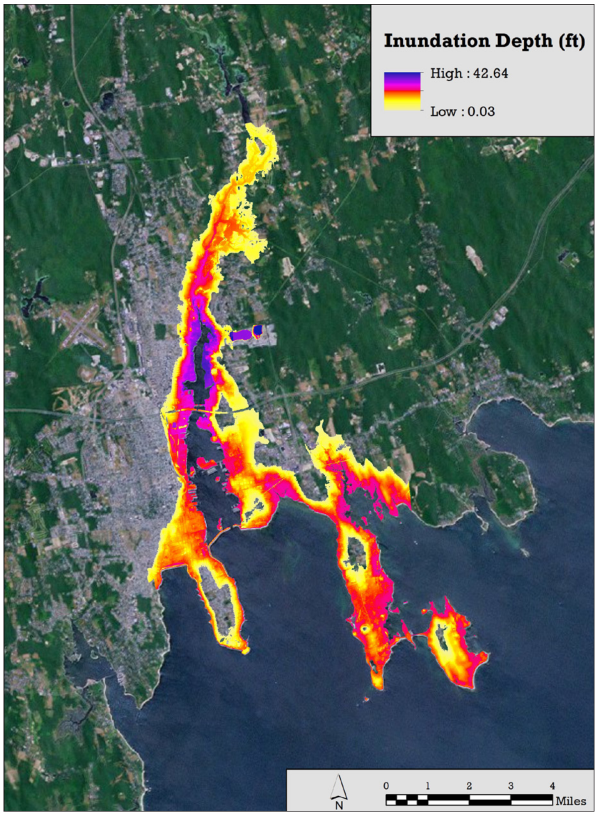

Figure A-17: Summary depth grid depicting inundation for an Extreme Category 4 storm with no SLR

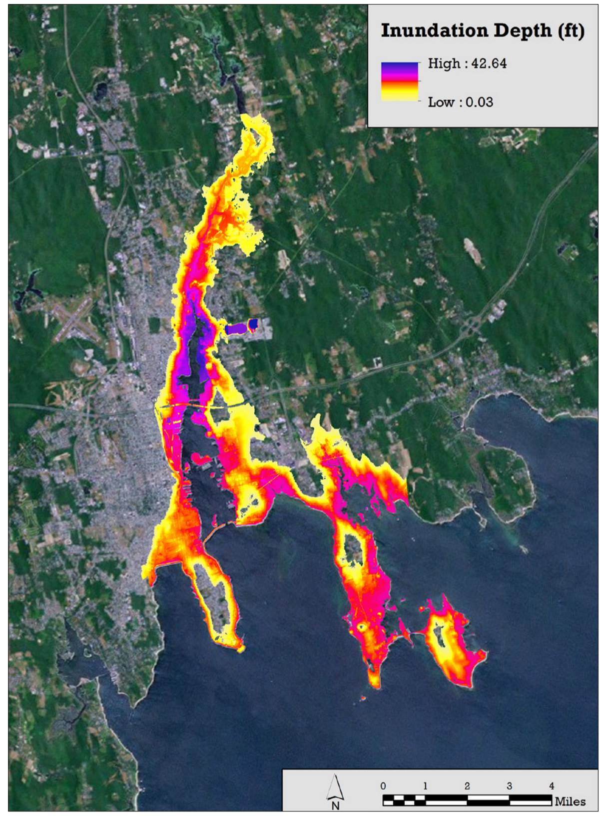

Figure A-18: Summary depth grid depicting inundation for an Extreme Category 4 storm with 1-foot SLR

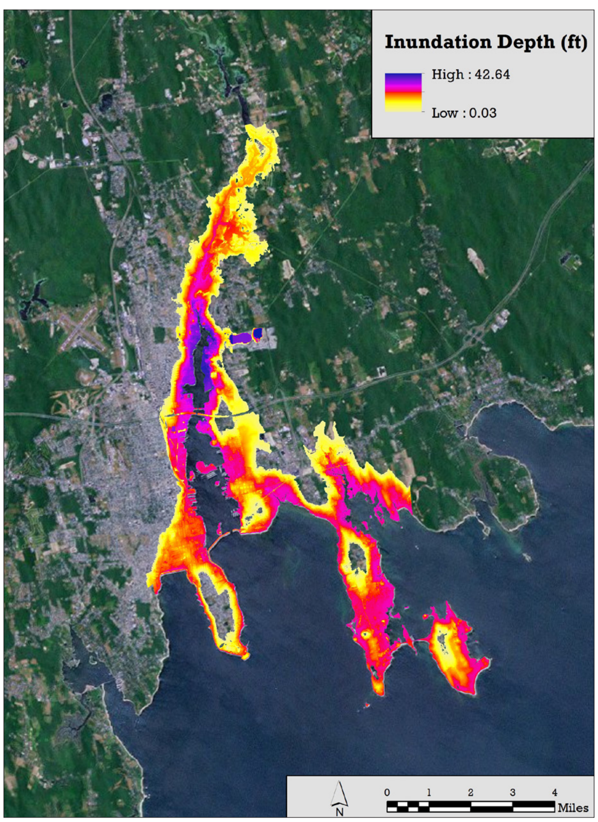

Figure A-19: Summary depth grid depicting inundation for an Extreme Category 4 storm with 2-foot SLR

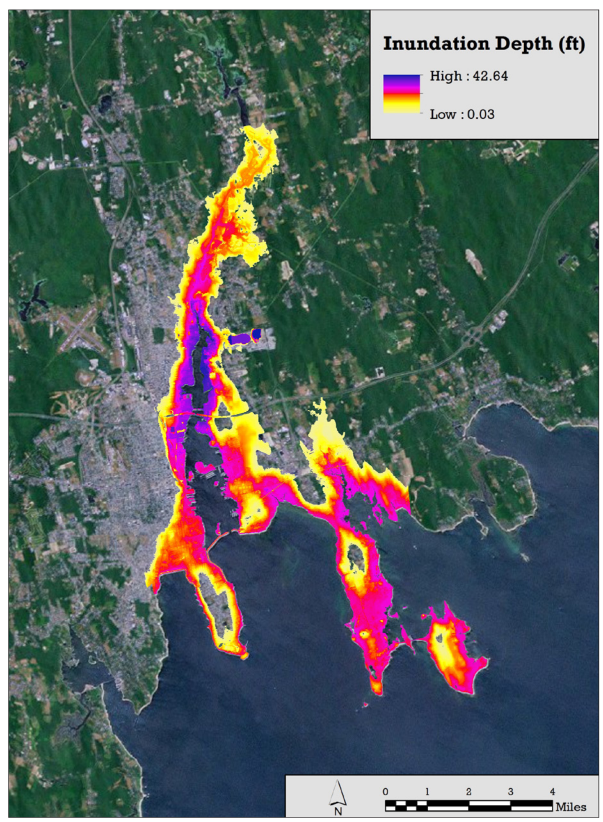

Figure A-20: Summary depth grid depicting inundation for an Extreme Category 4 storm with 4-foot SLR

Appendix B: Meeting Agendas and Summaries

AGENDA

SEAPLAN
VIBRANT ECONOMIES • HEALTHY OCEANS

Climate Change Vulnerability and Adaptation Planning Study for Water Quality Infrastructure in New Bedford, Fairhaven, and Acushnet Kick-off Meeting

Agenda

Date: 12-16-13

Time: 1:30 – 4:30 PM

Location: New Bedford Wastewater Treatment Facility

Meeting Objectives:

- Present study scope to municipal and state planning agencies
- Present interim data inventory to meeting participants
- Hold a listening session to obtain feedback and input on project scope and data inventory
- Strategize for filling any data gaps

Agenda:

I. Welcoming Remarks *(1:30 – 1:40 PM)*

II. Climate Change Vulnerability and Adaptation Planning Study Overview *(1:40 – 2:10 PM)*

III. Discussion and Listening Session *(2:15 – 3:15 PM)*

Break *(3:15 – 3:25)*

IV. Data Inventory Presentation and Discussion (*3:25 – 4:10 PM)*

- Presentation of interim data inventory *(3:25 – 3:35)*
- Participant discussion/Q&A (*3:35 – 4:10)*

V. Next Steps and Closing Remarks *(4:10 – 4:30)*

Climate Change Vulnerability Study: Next Steps and Action Items from Kick-off Meeting

December 16, 2013

1. **Project overview**

Joe Costa (Buzzards Bay National Estuary Program) provided project background and goals. Kate Longley (SeaPlan) presented an overview of the projected phases, timelines, and deliverables. Kelly Knee (ASA) presented an overview of the Sea, Lake and Overland Surges from Hurricanes (SLOSH) and Hazus models. Dean Audet (Fuss & O'Neill) presented an overview of the waste and stormwater components of the project.

Combined sewer overflows (CSOs) were identified as New Bedford's biggest concern, due to the undersized nature of the system and limited separation. It was suggested that it would be helpful to be able to predict where CSOs are likely to occur more often, and to identify specific CSOs where modifications or alterations would reduce overflows or discharge volumes. It was suggested that because much of Fairhaven isn't protected by the hurricane barrier that this municipality may be more interested in the SLOSH model results than Acushnet and New Bedford, which are protected by the barrier. That said, the barrier can be overtopped during some events and all communities should be interested in coastal flooding. The meeting participants suggested that it would be helpful if these models could identify low points along the barrier where failure would occur first and where the risk of failure could be mitigated.

2. **Discussion and Listening Session**

The consulting team posed a number of questions to the meeting participants, hereafter referred to as the project advisory group, to guide discussion and to obtain specific feedback on current adaptation measures and priorities and critical vulnerabilities. Meeting participants identified "King tide" monitoring and CSO monitoring as two areas of focus in New Bedford. Participants from New Bedford identified tidal inflow through wastewater infrastructure as a significant concern. Salinity changes are regularly observed at the wastewater treatment facility and it is estimated that half of the CSOs have limited capacity due to inflow issues; however, there is not enough information to characterize the extent of the problem. Several interceptors and pump stations were also identified as areas of concern. Although there is a lot of information about CSOs, bridge crossings, pump stations, and other infrastructure components, the data are not aggregated and pulling the totality of this information together could require significant time for the City of New Bedford. The project team will need to prioritize data needs and target areas. The project advisory group suggested that the Acushnet River and Harbor CSOs represent the bulk of the problem and might be a good candidate to focus attention. The project advisory group requested that erosion prone areas are also identified on vulnerability maps (Rebecca Haney from the Massachusetts Office of Coastal Zone Management (CZM) can help with this). The consulting team also posed the following questions to help the modelers develop assumptions and focus model results:

- We will be running SLOSH using base water levels that incorporate SLR. On what should we base the matrix of storm parameters that we use for these simulations? [options were explained]
- How should we define the base water level elevation for SLOSH? What combinations of tide level and and SLR are of interest?
- Once we have SLOSH results, how do we define the worst case storm(s)? Is National Oceanic and Atmospheric Administration Maximum of the Maximum (NOAA MOM) approach applicable?
- What do you see as the most useful outputs of Hazus for the project area?

The project advisory group reached the following decision points with respect to the Hazus and SLOSH data models:

- Project team should incorporate seaport-related infrastructure (provided by meeting participants) into Hazus model and consider including fueling facilities and hazardous waste sites.
- The matrix of storm parameters used in SLOSH should be based on the same matrix developed by NOAA for generation of the MOM as well as consider incorporating an increase in intensity due to climate change (e.g., changing central pressures, forward speeds)) Historical storms should also be included in the matrix as a reference. Reference storms can include hurricanes of 1938, 1954, Donna, and Sandy (if possible). Reference storms should be run with and without sea level rise.
- Consulting team will use best professional judgment to come up with a draft matrix of SLOSH projections vet it with the project advisory group before it is finalized.
- Mean, mean high, and MHHW (with and without sea level rise) will be the base water elevations used for SLOSH. Depending on the number of scenarios in the final matrix, the number of water levels may need to be reduced.
- Consulting team will use best professional judgment to develop model assumptions, and followed by project advisory group review to define what constitutes worst case inundation for the region. This will likely include a NOAA MOM-type approach as well as consideration of worst case scenarios at particularly vulnerable locations, including the hurricane barrier and Clark Cove dike

3. **Data Inventory Review**

The consulting team presented an interim list of spatial datasets and technical reports that will be used to inform the project and which will be used to create geospatial data products. Meeting participants provided feedback on additional or updated datasets and technical reports. The project advisory group also reached agreement that, given the scope of the project, policy analysis will be dependent on information provided by the planning team. Action items related to data exchange are summarized at the end of the document.

4. **Next Steps**

The team briefly re-visited the project timeline, focusing on the meetings. The project advisory group reached a decision that the next workshop planning meeting should be held the first week in February. Currently, the proposed project end date is April 30, but there is some flexibility to extend the timeline with a hard deadline falling at the end of the fiscal year in June.

The following action items were developed during the course of the meeting :

Buzzards Bay NEP:

- Look at the Vulnerability and Consequences Adaptation Planning Scenarios (VCAPS) report and comment on status of state hazard mitigation sites
- Direct SeaPlan to New Bedford hurricane barrier recertification documents
- Send the following data (spatial data or reports) to SeaPlan:
  - Seaport infrastructure/parcels with assessed values (completed on 12/18)
  - DTS census files
  - Designated port area coverage
  - Structure and pump stations with assessed value

SeaPlan:

- Send questionnaire to group so that remaining questions in listening session can be answered. Distribute questionnaire by January 2, 2014.
- Follow up with town officials regarding water quality site visits.
- Continue implementing Task 1. Develop materials in preparation for next planning meeting to be scheduled for the first week in February

Municipal Representatives:

- Provide a list of flooded streets, (include dates and photos if possible) to SeaPlan; List should be in excel table format; photos should be in zipped folder. Email to klongley@seaplan.org by January 8, 2014.
- Dave Fredette will introduce project team to CDM project manager to acquire New Bedford Wastewater Treatment Facility design report from 1996.
- Provide water infrastructure geodatabase to SeaPlan (email to klongley@seaplan.org) with the understanding that it may be incomplete

MEMA:

- Provide database of all state facilities/infrastructure in floodplain (send to klongley@seaplan.org)

AGENDA

Climate Change Vulnerability and Adaptation Planning Study for Water Quality Infrastructure in New Bedford, Fairhaven, and Acushnet Kick-off Meeting

Date: 2-4-14

Time: 1:30 – 3:50 PM

Location: Fairhaven Wastewater Treatment Facility

Meeting Purpose:

- Present project update, identifying lingering data gaps and next steps
- Plan interactive half-day workshop to be held in March

Agenda:

I. Welcoming Remarks *(1:30 – 1:40 PM)*

II. Project Update *(1:40 – 2:10 PM)*

III. Workshop Agenda Development *(2:10 – 3:00 PM)*

Break *(3:00 – 3:10)*

IV. Workshop Logistics (*3:10 – 3:40 PM)*

V. Next Steps and Closing Remarks *(3:40 – 3:50)*

Climate Change Vulnerability Assessment and Adaptation Planning Study for Water Quality Infrastructure in New Bedford, Fairhaven, and Acushnet: Meeting Summary and Action Items from Agenda Development Meeting

February 4, 2014

Attendees:

Andy Lipsky (SeaPlan), Kate Longley (SeaPlan), Kelly Knee (RPS ASA), Joe Costa (Buzzards Bay NEP), Vinnie Furtado (Town of Fairhaven), Dave Fredette (Town of New Bedford), Merilee Kelly (Town of Acushnet), Dave Janik (MA CZM)

On phone: Julia Knisel (MA CZM), Ann Rodney (EPA)

1. Project update

Kate Longley (SeaPlan) presented a project update, including pending data requests and a proposed organizational structure for inundation maps. Kelly Knee presented the draft matrix that will be used for SLOSH modeling, discussed the assumptions used to derive the matrix, and presented the next steps for matrix refinement. Next steps for the project will take place once the SLOSH model results are finalized. SLOSH model results will be used to create inundation maps, the online visualization tool, and Hazus model outputs.

The project advisory group reached the following decisions with respect to next steps and the SLOSH matrix:

- SLOSH results will include MHHW results only, at 0, 1, 2, and 4 ft SLR scenarios
- The datum conversion methodology using the Newport reference station is acceptable
- A 70 mph storm speed variable will be added to the matrix runs
- The assumptions used to create the SLOSH matrix should be clearly presented at the workshop
- A probability analysis of each matrix run is outside the scope of the project; however, the team can create of frequency distribution of the parameters that produced the worst case scenarios in the model runs; by using a range of storm categories, we are not biasing the results to unlikely scenarios.
- The team will rely largely on the default data included in Hazus for that aspect of the analysis, which does not include CSOs; however, CSOs and other water quality infrastructure will be part of the inundation maps. Local knowledge will result in a qualitative analysis of the water infrastructure (especially CSOs and pump stations) are likely to be affected in flooding scenarios. Municipalities would provide the team with information on the relative risk/importance of pump stations that overlay in the inundation zones.

2. Workshop agenda

The project advisory group reached the following decisions with respect to the workshop agenda:

- Draft maps and draft data viewer will be available prior to the workshop
- Buzzards Bay NEP will print draft inundation maps that will be presented at the workshop. Workshop participants can use sticky notes to provide comments on the map.
- We will present as much of the findings as possible during the meeting
- Depending on budget and time availability, the team will look into including cable stations in the analysis, as this is a key issue for Acushnet
- The project team will schedule a webinar meeting with a smaller group (key municipal officials) prior to the workshop to discuss preliminary results
- The team will investigate creating a few 3-D inundation visualizations for landmark buildings, provided that this information is available through Google Earth. If not, town officials may be able to supply photos and estimates of inundation depths

3. Workshop logistics

The team confirmed that there will be one workshop held, that will be attended by all three towns. The project team reached the following decisions with regard to workshop logistics:

Venue

The team will decide on a meeting venue as soon as possible. The following venues were identified as potential workshop locations:

- Coalition for Buzzards Bay – large space, parking may be limited to Elm Street garage
- Acushnet Council on Aging
- Agnes Braz Center in New Bedford
- Howland Green Library

Date and time

- The meeting will be held during the day to prioritize attendance by municipal officials
- The meeting will take place from 9 – 12, including breaks. Breakfast will be included.
- The meeting will be held on **April 16th or 17th**, avoiding school vacation week and Patriot's Day.

Audience and outreach

- Target audience in municipal officials, but other members of the public will be welcome, particularly waterfront users (e.g., business owners, marinas) and other stakeholders
- We expect a maximum of 30 attendees
- Joe will distribute the invitation, to be developed jointly by Team and BBNEP
- A general notice will be sent out a month before hand, followed by reminders two, and one week prior to the workshop
- A registration page will be used to track attendees
- We will incorporate some initial findings into our outreach strategy to improve interest and participation. For example, by stating that a certain amount of the DPA is threatened under projected inundation scenarios.

The following action items were developed over the course of the meeting:

Municipal Representatives

- Vinnie Furtado will send digitized map data of water infrastructure to Joe Costa, who will then forward it to Kate Longley at SeaPlan
- Municipal representatives have the option of sending a list of street's prone to flooding to SeaPlan to be included in the report's appendix

SeaPlan/ASA

- Finalize data inventory
- Complete SLOSH model
- Begin inundation mapping, Hazus modeling, and online data visualization using SLOSH results
- Put together an annotated list of potential second tier studies that might be candidates for resiliency grants offered by MA CZM
- If there is interest from municipal representatives, schedule scoping call for the week of February 10 with Buzzards Bay NEP and municipal leads to discuss possible resiliency grants/studies

AGENDA

Climate Change Vulnerability and Adaptation Planning Study for Water Quality Infrastructure in New Bedford, Fairhaven, and Acushnet - Workshop

Date: 4-17-14

Time: 9:00 am – 12:00 pm

Location: Acushnet Council on Aging

Workshop Participants:

- Municipal Representatives from New Bedford, Fairhaven, and Acushnet
- MA CZM/Buzzards Bay National Estuary Program Staff
- SeaPlan Team
- Other interested partners

Meeting Purpose:

- Provide a project overview
- Present major findings of vulnerability assessment, the Hazus damage assessment, and preliminary recommendations
- Present draft versions of data visualization tools, including the web viewer and the risk visualization tool
- Receive feedback from workshop participants on refining results, recommendations, and tools

Agenda:

I. Welcoming Remarks (*9:00 – 9:15 AM)*

II. Project Overview *(9:15 – 9:25)*

III. Modeling Analysis/Results (*9:25 – 10:20 AM)*

IV. Preliminary Recommendations *(10:20 – 10:30 AM)*

V. Breakout Sessions *(10:30-11:30)*

AGENDA

The following breakout sessions will occur concurrently:

1. Data Visualization Tools
2. Analysis and Results
3. Recommendations

VI. Next Steps and Closing Remarks (*11:30 AM – 11:50 PM)*

Climate Change Vulnerability Assessment and Adaptation Planning Study for Water Quality Infrastructure in New Bedford, Fairhaven, and Acushnet: Meeting Summary and Action Items from Workshop

April 17, 2014

Acushnet Council on Aging

Attendees:

Andy Lipsky (SeaPlan), Kate Longley (SeaPlan), Kelly Knee (RPS ASA), Joe Costa (Buzzards Bay NEP), Dean Audet (Fuss & O'Neill), Vinnie Furtado (Town of Fairhaven), Dave Fredette (Town of New Bedford), Merilee Kelly (Town of Acushnet), Gary Golas (Fairhaven Shipyard), Bill Ruth (Town of Fairhaven), Rebecca Haney (MA CZM), Mark Mahoney (New Bedford EMA), Michele Paul (New Bedford Office of Environmental Stewardship), Mel Cote (EPA Region 1), Dave Janik (MA CZM), Ryan McCoy (Pare Corporation), Ed Washburn (New Bedford Harbor Development Commission), Mark Rasmussen (Buzzards Bay Coalition), Kathy Baskin (MA Executive Office of Energy and Environmental Affairs)

1. Project Overview

Joe Costa (Buzzards Bay NEP) provided a background and overview of the project by introducing the overall goals of the project and of the workshop, by introducing the project team, and by providing the impetus for the project in terms of climate change and hurricane vulnerability. He also introduced key terminology and existing planning tools and projects that have been used to assess vulnerability in Buzzards Bay communities thus far.

2. Modeling Analysis/Results

SLOSH modeling

Kelly Knee (ASA) presented an overview of the SLOSH (Sea, Lake and Overland Surge from Hurricanes) models used to create the 20 different inundation used in this study. She described the data inputs, data processing, and caveats specific to the study, and summarized both the hurricane parameters that produced the worst case scenarios and the impacts of each hurricane scenario to the hurricane barrier and dikes in the study area.

Vulnerability Analysis

Kate Longley (SeaPlan) presented results of the vulnerability analysis, including maps of the inundation scenarios and graphical representations of inundation scenario depths at locations of interest. She also outlined the priority datasets that were used in the analysis, and provided example maps and tabular data generated during the analysis.

Hazus Analysis

Kate Longley presented an overview of FEMA's Hazus modeling tool, which quantifies damages costs associated with flooding. She described the data inputs, data processing steps, and caveats specific to this study. One major caveat is that the default data included in the model and used in the analysis is on a coarse scale, and from the 2000 Census. Results should be interpreted with caution and used as a tool for estimating overall scale and variations in damage with different scenarios, rather specific cost estimates. She presented examples of results from the Hazus analysis, including tabular data, summary reports generated by the tool, damage maps, and other graphical representations of damages at various scenarios.

Data Visualization Tools

Kate Longley presented a screen shot of the draft interactive online data viewer and described the layout, content, features, and anticipated updates to the site. A live version of the viewer was available during the breakout sessions. Kelly Knee presented screen shots which described the risk visualization tool, which will be populated with data from the Hazus analysis. A live version will be developed using feedback from the breakout sessions.

3. Preliminary Recommendations

Dean Audet (Fuss & O'Neill) presented assumptions, considerations, and methodology for identifying and recommending adaptation actions for selected CSOs, pump stations, and wastewater treatment facilities.

4. Break-out Sessions

Break-out sessions were a chance for meeting participants to get a more in-depth look at the information presented during the first meeting sessions. Participants were encouraged to visit three break-out stations to ask questions and provide feedback. They were also encouraged to make comments directly on the draft wall maps that were available to display inundation scenarios and select infrastructure and property features. The following are summaries of discussions, questions, and comments from each break-out session, as well as general comments from the post-presentation Q & A:

Data Visualization Tools

During this breakout session, participants could use a draft version of the interactive online mapping tool and review the mock-up of the risk analysis tool. Workshop participants had the following suggestions for improving the interactive online mapping tool:

- Filter road cuts from outfalls layers and symbolize conventional CSOs differently from other outfalls
- Highlight the accordion that is active
- Eliminate unbuilt public properties from the point layers (i.e. those that have no building/other value) – for example, points on empty plots and along the bike path should go away

- Show public parcel outlines; visualize building as dots and parcels as polygons
- Change the name of "Martha's Vineyard Ferry Terminal" to "Steamship Authority Maintenance Facility" in Fairhaven
- Use a town boundaries layer with no coast

Analysis and Results

During this breakout session, workshop participants could view inundation maps, see the range of inundation depths at specific features, and view Hazus results in greater detail. Participants were particularly interested in the potential for flooding at the site of the planned police station at 60 Middle St in Acushnet, as well as in municipal areas that are being targeted for development projects. Participants were also interested in how the data could be used in evacuation planning, including outreach to environmental justice communities and mapping evacuation routes, critical supplies, and areas of safe refuge. Participants were also interested in the ability of Hazus to estimate the damages to the local economy, particularly in terms of lost wages, and other indirect economic costs. Although in-depth analyses of these topics are beyond the scope of this project, we anticipate that our results will be leveraged in future studies to address these questions.

Recommendations

This breakout session was focused on obtaining more in-depth information on pump stations to be used in the next steps of the project. Representatives from Fairhaven and New Bedford will provide data on points of entry for water at specific stations and whether there are generators present at each site.

Other/General Comments and Questions

- Joe Costa pointed out that the inundation scenarios don't account for wave height or for the fact that extreme hurricanes may damage the hurricane barrier, or result in its possible failure (the barriers are earth filled dikes, covered with stone).
- One participant pointed out that the names of the dikes/hurricane barriers used in the presentation are not the same as the names used by locals
- There were questions as to how long flooding would take place in each scenario; although the SLOSH model does not account for duration, it is estimated that inundation could last 5-6 hours.
- One participant noted that given the IPCC's recent report, a 4 foot maximum SLR scenario might not be sufficient to estimate potential impacts of climate change
- One participant asked about the impacts on drinking water. It was noted that this study does not focus on drinking water since the focal communities do not rely on well water.

The following action items were developed over the course of the meeting:

Municipal Representatives

- Representatives from DPW in New Bedford and Fairhaven will help fill in data gaps on pump stations

SeaPlan/ASA/Fuss & O'Neill

- Finalize online data viewer and risk evaluation tool
- Finalize recommendations and begin prioritization matrix for adaptation recommendations
- Finalize vulnerability analysis and Hazus data products
- Begin first draft of technical report
- Create final wall maps
- Schedule final in-person meeting to review draft technical report and results

AGENDA

SeaPlan — VIBRANT ECONOMIES • HEALTHY OCEANS

Climate Change Vulnerability and Adaptation Planning Study for Water Quality Infrastructure in New Bedford, Fairhaven, and Acushnet – Presentation of Results

Date: 6-12-14

Time: 10:00 am – 12:00 pm

Location: New Bedford Wastewater Treatment Facility

Workshop Participants:

- Municipal Representatives from New Bedford, Fairhaven, and Acushnet
- MA CZM/Buzzards Bay National Estuary Program Staff
- SeaPlan Team
- Other interested partners

Meeting Purpose:

- Present major findings of project
- Present summary of recommendations for water quality infrastructure
- Present final versions of data visualization tools, including the web map viewer and the risk visualization tool
- Obtain any final feedback to be incorporated into final report or other deliverables

Agenda:

I. Welcoming Remarks (*10:00 – 10:15 AM)*

II. Present Major Findings *(10:15 – 10:35)*

III. Recommendation Summary *(10:35– 10:50)*

IV. Data Viewer Presentations (*10:50 – 11:10 AM)*

Break *(11:10 – 11:25)*

V. Questions and Feedback (*11:25 – 11:45)*

VI. Next Steps and Closing Remarks (*11:45 – 12:00)*

Climate Change Vulnerability Assessment and Adaptation Planning Study for Water Quality Infrastructure in New Bedford, Fairhaven, and Acushnet: Meeting Summary and Action Items Final Meeting

June 12, 2014

New Bedford Wastewater Treatment Facility

Attendees:

Andy Lipsky (SeaPlan), Kate Longley (SeaPlan), Supriya Khadke (SeaPlan), Kelly Knee (RPS ASA), Joe Costa (Buzzards Bay NEP) Vinnie Furtado (Town of Fairhaven), Dave Fredette (City of New Bedford), Merilee Kelly (Town of Acushnet), Rebecca Haney (MA CZM), Mark Mahoney (New Bedford EMA), Dave Janik (MA CZM), Jason Turgeon (U.S. EPA), Jeffrey Osuch (Town of Fairhaven)

1. Introduction

Joe Costa and Andy Lipsky welcomed participants and provided summary of the project, its status, and an overview of meeting objectives.

2. Modeling Analysis/Results

Kate Longley provided a brief overview of the project methodology and summarized the major findings, which included modeled storm scenarios that will inundate over or around the hurricane barrier, low points on the barrier, predicted maximum inundation depths by scenario, inundation depths at wastewater treatment plants, and damage estimates from the Hazus model. Joe Costa pointed out that the hurricane barrier might fail in even less severe storms since we didn't model for waves, and since wave action can result in erosive forces negatively impacting the structurally integrity of the hurricane barrier. He further emphasized that the hurricane barrier certification elevation is several feet lower than where it currently is. Discussion during this session revolved around how to present the range of impacts from the least to the most severe storms in a way that is both informative to municipal planners but will not be misinterpreted by those who don't read the complete report.

Meeting participants provided feedback and input as to how to enhance the summary results, vulnerability analysis and damage quantification sections of the report. This input included the following recommendations:

- Provide context for results by providing a list of New England storms which include intensities, landfall locations, and damages, if possible.
- Modify charts by eliminating zeroes on y-axes, and de-emphasizing the results of the higher intensity storms (4 and Extreme 4), possibly by making those results gray or otherwise muting the color. The caption should note that the extreme scenarios were studied, but that those scenarios have never occurred before, but could hypothetically occur in the future.

- Leave out the Hazus quantifications that deal with the wastewater treatment plant, as they are likely underestimates and don't account for the complexities of predicting damages to the underground structures.
- Leave results from extreme scenarios (4 and Extreme 4) out of the Executive Summary, but note that the town should plan for Category 3 hurricanes at baseline water levels.
- The Executive Summary should clearly layout next steps for the municipalities
- Provide a discussion of the differences between NOAA SLOSH models and FEMA FIRMs.

3. Recommendation Summary

Andy Lipsky and Kate Longley presented a summary of the recommendations for the towns based on the engineering analysis. Andy and Kate presented the methodology and criteria for recommendation development, identified high-risk wastewater infrastructure, with an emphasis on pump stations, and presented specific recommendations, as well as future work that the municipalities should pursue to further understand and address vulnerabilities. One discussion revolved around whether it made sense to take adaptive measures on individual CSOs in the face of sea level rise, when more costly, system-wide changes would be a more likely solution. The team agreed on language that will characterize these uncertainties in the report. Officials from the Town of Fairhaven also clarified characteristics of individual pump stations that will affect some of the project team's recommendations.

4. Data Visualization Tools

Kate Longley demonstrated the interactive mapping tool currently available at seaplan.buzzardsbay.org. This tool allows users to visualize hurricane extents under each sea-rise-scenario, and identify vulnerable infrastructure, public property, and populations. Kelly Knee demonstrated the risk visualization tool, which allows users to view estimates economic losses from various storm scenarios, and observe the flooding sensitivity of locations within the study area to different hurricane parameters and water levels.

The following action items were developed over the course of the meeting:

All Participants

- Anyone wishing to submit feedback on the draft report or data products should do so by Wednesday, June 18th. The hard deadline for submitting feedback is June 20th. Feedback should be submitted to Kate Longley (klongley@seaplan.org)

Municipal Representatives

- Representatives from each municipality will provide any final data that will help refine engineering recommendations. Data that will require any additional analysis should be submitted by June 18th for inclusion in the report.

SeaPlan/ASA/Fuss & O'Neill

- SeaPlan will incorporate comments and feedback into report
- SeaPlan will provide ASA will explanatory language on Hazus data to include in the risk visualization tool
- SeaPlan will coordinate with Buzzards Bay NEP to post risk visualization tool on website
- SeaPlan will submit all project deliverables, including technical report, geodatabase, and final wall map pdfs to Buzzards Bay NEP by June 30, 2014.

Appendix C: Depth Tables

Water Quality Infrastructure

Street	Municipality	Type	Comments	Cat.1 Hurricane				Cat.2 Hurricane				Cat.3 Hurricane				Cat.4 Hurricane				Cat.4 Extreme Hurricane			
Water Level Rise				0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft
Taber Street	Fairhaven	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	1.35	15.11	20.73	22.89	24.00	24.99	26.61	26.47	27.07	27.53	31.09
Pilgrim Avenue	Fairhaven	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.71	0.00	3.53	16.26	20.65	25.14	26.28	27.24	28.55	28.31	28.96	29.38	31.75
Arsene Street	Fairhaven	Treatment Plant		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50
Bridge Street	Fairhaven	Pump Station	Odor Control Only	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.57	0.00	2.90	15.59	18.05	19.51	20.82	21.78	24.44	23.52	24.31	26.26	27.84
Arsene Street	Fairhaven	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50
Middle Street	Fairhaven	Pump Station	Storm Drain Station	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.54	0.00	3.96	16.52	18.82	20.84	22.18	22.42	24.59	24.15	24.98	26.70	28.42
South Street	Fairhaven	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.44	11.74	12.98	14.28	15.18	17.26	16.97	17.68	18.41	20.55
Abbey Street	Fairhaven	Pump Station		3.26	4.23	5.23	7.56	8.16	8.93	9.86	11.93	12.50	13.66	14.35	16.75	18.04	19.27	20.11	21.95	21.88	22.65	23.38	25.13
Manhattan Avenue	Fairhaven	Pump Station		0.00	0.36	1.22	3.52	4.19	4.89	5.70	7.89	8.71	9.79	10.48	12.49	13.53	14.72	15.60	17.39	17.08	17.91	18.89	20.58
Bernese Street	Fairhaven	Pump Station		0.00	0.48	1.43	3.72	4.38	5.08	5.88	8.08	8.73	9.98	10.68	12.59	13.49	14.68	15.69	17.58	17.09	18.08	18.99	20.78
Seaview Avenue	Fairhaven	Pump Station		3.72	4.62	5.57	7.65	8.35	9.04	9.76	12.02	12.81	13.91	14.64	16.59	17.50	18.63	19.60	21.49	20.96	22.00	22.97	24.67
Waybridge Road	Fairhaven	Pump Station		3.27	4.20	5.18	7.50	8.20	8.90	9.70	11.91	12.59	13.80	14.49	16.40	17.28	18.49	19.50	21.38	20.89	21.89	22.80	24.59
Shore Drive	Fairhaven	Pump Station		3.10	4.00	4.96	7.06	7.76	8.40	9.17	11.40	12.18	13.29	14.05	15.98	16.81	17.97	18.98	20.88	20.31	21.38	22.32	24.02
Camel Street	Fairhaven	Pump Station		0.00	0.00	0.87	2.86	3.52	4.32	5.14	7.18	8.04	9.06	9.77	11.66	12.64	13.66	14.67	16.83	15.97	17.07	18.06	19.76
Rocky Point Road	Fairhaven	Pump Station		0.00	0.00	0.47	2.77	3.21	3.87	4.81	6.80	7.44	8.63	9.52	11.25	12.05	13.05	14.05	15.93	15.36	16.45	17.42	19.04
Rivard Street	Fairhaven	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Causeway Road	Fairhaven	Pump Station		0.00	0.00	0.00	0.00	0.00	0.19	1.10	3.14	3.93	5.06	5.90	7.66	8.46	9.56	10.60	12.43	11.83	13.04	13.86	15.54
Marguerite Street	Fairhaven	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pine Grove Road	Fairhaven	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Boulder Park	Fairhaven	Pump Station		3.93	4.73	5.73	8.23	8.89	9.61	10.46	12.51	13.20	14.37	14.87	17.33	18.35	19.59	20.54	22.30	22.19	23.03	23.80	25.46
Blueberry Drive	Acushnet	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Allen Street	Acushnet	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.74	7.23	8.16	8.96	10.37	11.59	12.72	13.38	14.20
Slocum Street	Acushnet	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.85	0.89	19.38	23.84	26.52	27.64	28.55	30.09	31.76	32.88	33.50	33.94
Belleville Avenue	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.07	17.73	20.32	21.72	22.91	24.16	25.97	27.04	27.71	28.19
East Rodney French Boulevard	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.80	11.39	12.70	13.52	15.74	16.34	17.62	18.79	20.23	20.33	21.24	22.07	23.79
South Rodney French Boulevard	New Bedford	Treatment Plant		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	1.38	2.88	3.71	5.40	5.96	7.27	8.55	10.22	9.75	10.78	11.70	13.63
Cove Road	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.90	11.89	12.51	13.41	15.12	16.01	17.11	18.11	19.68	19.59	20.49	21.31	23.09
South Water Street	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.07	6.82	8.70	13.31	15.11	15.90	17.30	18.50	20.03	20.13	21.03	21.72	23.72
MacArthur Drive	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.23	13.27	12.82	14.20	15.15	17.48	17.04	17.94	18.50	21.03
Wamsutta Street	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.04	0.00	2.13	15.99	23.53	24.73	25.75	26.69	27.83	27.42	28.04	28.65	32.81
Rowe Street	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coggeshall Street	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.37	16.66	18.06	19.14	20.08	21.02	20.83	21.46	22.08	26.04
Peckham Road	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sassaquin Avenue	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pequot Street	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phillips Road	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Marlborough Street	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Forbes Street	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hanover Street	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Welby Road	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Church Street	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Joyce Street	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aviation Way	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shawmut Avenue	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Howard Avenue	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.53	19.03	23.44	26.28	27.59	28.40	30.06	31.88	32.98	33.59	33.87
Valley View Drive	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Joy Street	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hathaway Road	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apple Tree Lane	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Merrimac Street	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Popes Island	New Bedford	Pump Station		0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.42	14.10	16.69	17.81	19.19	20.31	23.35	22.08	23.06	24.78	26.72
West Island	Fairhaven	Treatment Plant	Groundwater Discharge to the NW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.41

Outfalls

Municipality	Comments	Category 1				Category 2				Category 3				Category 4				Category 4 Extreme			
	Water Level Rise	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft
New Bedford	non-CSO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New Bedford	non-CSO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.27	14.08	13.53	14.89	15.94	18.53	18.04	18.94	19.59	22.17
New Bedford	non-CSO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.25	0.00	2.35	20.96	25.60	28.42	29.82	30.81	32.70	33.94	35.01	35.67	36.12
New Bedford	non-CSO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.73	21.25	23.40	23.87	24.63	26.06	26.74	27.93	28.61	29.72
New Bedford	non-CSO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.91	19.48	21.56	22.05	22.70	24.11	24.68	25.87	26.56	27.75
New Bedford	non-CSO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.45	20.01	21.74	22.60	23.25	24.31	25.24	26.43	27.12	28.30
New Bedford	non-CSO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.15	19.68	21.53	22.32	22.98	24.40	25.03	26.21	26.90	28.05
New Bedford	non-CSO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.74	5.37	2.63	21.11	25.61	29.66	31.28	29.24	32.47	31.54	32.71	33.39	34.38
New Bedford	non-CSO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.92	1.58	1.58	20.05	24.61	26.79	27.37	28.05	29.47	30.19	31.37	32.06	33.15
New Bedford	non-CSO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New Bedford	non-CSO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.79	12.49	13.39	14.73	16.56	17.50	18.75	19.66	21.29	21.19	22.09	22.89	24.66
New Bedford	CSO	0.00	0.58	1.57	3.95	4.38	5.02	5.83	8.14	8.86	9.88	10.76	13.06	13.76	14.72	15.75	17.48	17.12	18.12	19.03	20.77
New Bedford	CSO	0.20	1.22	2.22	4.53	4.95	5.66	6.43	8.69	9.37	10.42	11.29	13.49	14.21	15.31	16.29	18.09	17.64	18.65	19.57	21.32
New Bedford	CSO	0.29	1.30	2.30	4.61	5.02	5.82	6.40	8.85	9.45	10.47	11.35	13.54	14.28	15.37	16.35	18.12	17.68	18.69	19.62	21.38
New Bedford	CSO	0.00	0.00	0.00	1.89	2.30	3.38	4.12	6.40	6.98	7.74	8.62	10.78	11.53	12.63	13.62	15.40	14.94	15.96	16.89	18.65
New Bedford	CSO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.62	2.29	3.32	4.22	6.22	6.90	8.14	9.05	10.89	10.32	11.34	12.31	14.12
New Bedford	CSO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.77	3.52	4.74	6.69	7.58	7.12	9.79	11.43	11.33	12.23	13.03	14.79
New Bedford	CSO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.01	0.00	3.82	15.62	19.93	19.74	20.92	21.91	24.38	23.91	24.81	25.41	27.96
New Bedford	CSO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New Bedford	CSO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.20	18.70	23.11	26.17	27.41	28.11	29.69	31.61	32.71	33.32	33.58
New Bedford	CSO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.28	6.96	6.96	25.45	29.92	32.41	33.30	34.08	35.57	36.83	37.98	38.63	39.34
New Bedford	CSO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.10	1.75	1.69	20.16	24.73	26.91	27.44	28.03	29.51	30.06	31.25	31.94	33.10
New Bedford	CSO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.39	0.00	4.49	18.32	25.85	27.06	28.09	29.03	30.19	29.77	30.40	31.01	35.17
Acushnet	BBAC 2003 summer interns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.33	2.50	3.20	3.34
Acushnet	BBAC 2003 summer interns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	5.67	9.06	10.74	11.85	12.52	15.05	16.24	16.94	16.96
Acushnet	BBAC 2003 summer interns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.95	4.63	5.74	6.75	8.93	10.12	10.82	10.85
Acushnet	BBAC 2003 summer interns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.35	4.97	6.43	6.88	8.65	10.06	11.20	11.86	12.16
Acushnet	BBAC 2003 summer interns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	3.02	4.02	4.84	6.25	7.56	8.69	9.35	10.10
Acushnet	BBAC 2003 summer interns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.03	8.74	11.75	12.30	12.10	14.38	14.14	15.32	16.01	17.17
Acushnet	BBAC 2003 summer interns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	5.50	7.06	8.09	10.04	11.40	12.50	13.58	14.24	15.36
Acushnet	BBAC 2003 interns; assumed pipe location	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.92	6.84	9.36	10.28	11.05	12.42	13.56	14.69	15.36	16.28
Acushnet	BBAC 2003 interns; assumed pipe location	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.49	7.01	7.89	8.68	10.07	11.19	12.32	12.99	13.92
Acushnet	BBAC 2003 interns; assumed pipe location	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.22	7.17	9.67	10.59	11.39	13.05	13.89	15.02	15.68	16.63
Acushnet	BBAC 2003 interns; assumed pipe location	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.58	7.49	8.58	9.45	11.59	12.97	14.04	15.18	15.84	16.81
Acushnet	BBAC 2003 summer interns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.09	5.99	8.46	8.81	10.16	11.53	12.65	13.78	14.45	15.38
Acushnet	BBAC 2003 summer interns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.76	8.65	11.12	12.02	12.81	14.19	15.30	16.43	17.10	18.03
Acushnet	BBAC 2003 summer interns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acushnet	BBAC 2003 summer interns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.21	19.75	22.19	23.04	23.81	25.28	26.45	27.60	28.25	29.04
Acushnet	BBAC 2003 summer interns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.13	10.34	13.51	15.04	16.08	16.93	19.28	20.43	21.11	21.32
Acushnet	BBAC 2003 summer interns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.06	13.48	16.84	18.49	19.59	20.63	22.80	23.99	24.68	24.72
Acushnet	BBAC 2003 summer interns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.15	4.83	3.64	22.13	26.61	30.32	31.24	30.82	33.51	33.61	34.76	35.40	36.10
Acushnet	BBAC 2003 summer interns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acushnet		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.65	6.44	7.27	8.11	9.63	10.67	11.77	12.43	13.40
Acushnet		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.42	11.33	13.78	14.63	15.41	16.79	17.84	18.98	19.65	20.62
Acushnet	2005 Aug BBAC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	4.78	7.28	8.22	9.03	10.43	11.67	12.80	13.46	14.27
Fairhaven	16"; DMF survey	6.54	7.70	8.65	10.49	11.19	12.10	12.86	14.84	15.88	16.73	17.48	19.42	20.53	21.42	22.42	24.32	23.77	24.82	25.77	27.47
Fairhaven		3.27	4.17	5.12	7.22	7.92	8.57	9.32	11.58	11.79	13.45	14.19	16.12	16.97	18.12	19.13	21.03	20.47	21.53	22.49	24.19
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.29	6.02	6.65	7.94	8.95	11.48	10.82	11.52	13.72	15.06
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.06	4.98	5.29	6.71	7.58	10.21	9.43	10.13	12.28	13.65
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.32	6.18	6.58	7.87	8.87	11.39	10.73	11.43	13.61	14.97
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.73	5.42	5.39	6.64	7.62	9.72	9.23	9.92	11.56	13.17
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.38	7.57	8.67	9.87	10.83	12.53	12.15	12.80	14.02	15.92
Fairhaven	12" PVC; Fair DPW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.04	0.81	5.22	18.61	23.97	26.64	27.78	28.79	30.42	30.18	30.84	31.25	34.04
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.92	7.35	8.51	9.70	10.64	12.09	11.86	12.51	13.54	15.52
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.58	3.30	4.43	5.33	6.37	6.36	6.97	7.46	10.06

Outfalls

Municipality	Comments	Category 1				Category 2				Category 3				Category 4				Category 4 Extreme			
Water Level Rise		0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.55	1.62	2.53	3.57	3.52	4.12	4.64	7.13
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	1.22	2.15	3.31	3.24	3.86	4.50	6.86
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.03	3.19	4.36	5.28	6.48	6.45	7.08	7.79	10.17
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.73	1.99	1.90	2.54	3.30	5.55
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	1.52	1.48	2.07	2.50	5.08
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.29
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.79
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.49	0.00	0.00	0.00	0.00	0.00	31.50	0.00	0.00	0.00	0.00	0.00	0.00
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.18	0.00	1.61	17.80	23.90	25.29	25.19	26.93	27.42	27.68	27.92	28.32	34.34
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.81	21.90	22.23	23.15	24.90	24.37	25.64	25.89	26.28	32.13
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.61	2.40	5.70	21.92	28.01	29.39	30.30	31.03	31.50	31.77	32.00	32.40	38.42
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.24	16.31	17.57	18.52	19.28	19.82	20.02	20.33	20.70	26.07
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.00	21.11	22.32	23.23	24.13	24.42	24.86	25.09	25.50	31.58
Fairhaven	in culvert; E side	3.77	4.57	5.57	7.67	8.57	8.26	10.26	10.97	12.97	14.27	15.06	16.87	17.87	18.86	20.16	21.57	21.08	22.37	23.17	24.77
Fairhaven		0.00	0.00	0.00	1.61	2.50	3.79	4.60	6.11	7.83	8.20	8.99	10.80	12.72	13.73	14.09	15.52	15.04	16.30	17.11	18.71
Fairhaven	W side of River; S side of Rte 6	0.00	0.00	0.00	0.00	0.00	0.00	0.52	2.45	3.24	4.53	5.32	7.14	8.14	9.60	10.43	11.86	11.41	12.64	13.45	15.06
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.27	2.12	2.39	3.03	5.31	7.18	7.68	8.63	11.12	10.35	11.12	11.89	13.63
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.54	0.00	3.94	16.68	19.20	21.90	24.38	23.57	26.81	25.20	26.03	27.72	29.52
Fairhaven	Route 6 plans	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	2.10
Fairhaven	North of Rte 6; E side of River; pipe visible	0.00	0.00	3.88	5.98	6.87	8.34	8.57	11.05	11.27	12.57	13.37	15.17	16.17	17.17	18.47	19.88	19.39	20.67	21.48	23.08
Fairhaven	size unknown; buried in sand	5.85	6.76	7.68	9.98	10.46	11.15	11.99	14.16	14.76	16.03	16.83	18.56	19.26	20.54	21.55	23.35	22.75	23.93	24.85	26.55
Fairhaven	size unknown; buried in sand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fairhaven	12" RCP	5.70	6.76	7.76	9.97	10.66	11.36	13.04	14.39	15.17	16.26	16.95	18.86	19.74	20.95	21.96	23.97	23.35	24.35	25.26	27.05
Fairhaven	DMF suryev; 24"; infiltration	7.89	8.40	9.34	11.79	12.49	12.83	13.54	15.84	16.59	18.09	18.79	20.78	21.39	22.39	23.79	25.30	25.19	26.19	27.18	28.89
Fairhaven	DMF; 12" RCP; app. 1-5gpm	5.63	6.32	7.55	9.94	10.62	11.36	12.21	14.34	14.96	16.17	16.71	18.98	20.01	21.22	22.16	23.94	23.78	24.60	25.44	27.08
Fairhaven	12"; immeasureable flow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fairhaven	DMF survey; 18" cement	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.03	0.00	7.72	19.17	21.49	22.59	0.00	24.89	26.77	26.67	27.39	28.00	30.16
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fairhaven	regularly sampled by DMF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fairhaven	DMF Survey; app 40gpm	4.93	5.83	6.98	9.12	9.78	10.65	11.45	13.65	14.35	15.39	16.08	18.09	19.15	20.35	21.19	23.15	22.68	23.50	24.49	26.19
Fairhaven		4.96	5.50	6.86	9.26	9.95	10.64	11.55	13.28	14.23	15.44	15.99	18.39	19.51	20.72	21.62	23.42	23.34	24.13	24.92	26.55
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.45	2.01	1.55	2.69	3.57	5.20
Fairhaven		1.28	2.08	3.08	5.18	6.05	6.91	7.70	9.67	10.46	11.74	12.52	14.35	15.34	16.36	17.62	19.10	18.61	19.84	20.68	22.29
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71
Fairhaven		3.97	4.87	5.87	8.25	8.94	9.66	10.54	13.05	13.28	14.49	15.03	17.31	18.38	19.58	20.52	22.29	22.16	22.97	23.79	25.44
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.04	2.17	3.18	4.32	5.76	5.31	6.54	7.35	8.96
Fairhaven	12" PVC	6.75	7.55	8.37	10.59	11.43	11.99	12.78	15.08	15.83	17.06	17.79	19.71	20.53	21.77	22.87	24.63	24.14	25.16	26.14	27.76
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.96	3.05	4.19	5.11	6.23	6.07	6.69	7.28	9.54
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.41	2.01	6.04	18.79	21.45	22.92	25.26	26.30	28.67	27.84	28.65	30.15	32.04
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.02	1.33	6.58	19.38	22.65	25.36	26.57	28.66	29.35	29.90	30.63	31.59	33.69
Fairhaven	24" clay	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.30	1.85	6.34	19.50	24.73	27.35	28.68	29.71	31.26	31.18	31.86	32.30	35.01
Fairhaven	16" clay	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fairhaven		3.88	4.78	5.78	8.18	8.78	9.48	10.39	12.50	13.13	14.27	14.99	17.39	18.90	20.14	20.74	22.55	22.52	23.28	24.01	25.76
Fairhaven	Assumed location	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.60	17.32	19.72	21.10	22.39	23.30	23.25	25.19	25.90	26.51	28.49
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.77	19.03	21.39	22.71	23.98	24.89	26.73	26.73	27.46	28.20	30.06
Fairhaven	assumed location	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.59	16.81	19.21	20.62	21.89	22.80	24.64	24.69	25.39	26.03	28.01
Fairhaven	DPW data; 12" RCP	0.00	0.71	1.95	4.25	4.81	5.50	6.31	8.59	9.20	10.45	11.15	13.05	13.86	15.10	16.11	17.96	17.42	18.46	19.45	21.21
Fairhaven	assumed drainage location	6.60	7.50	8.49	10.64	11.30	11.91	12.74	14.95	15.63	16.83	17.54	19.44	20.24	21.44	22.44	24.34	23.74	24.84	25.82	27.53
Fairhaven		7.83	8.75	9.70	12.00	12.44	13.13	14.00	16.14	16.74	17.97	18.77	20.54	21.23	22.51	23.53	25.33	24.73	25.86	26.83	28.53
Fairhaven	assumed to exist	2.75	3.64	4.64	6.95	7.35	8.04	8.95	11.05	11.65	12.85	13.65	15.45	16.36	17.66	18.45	20.25	19.65	20.75	21.75	23.45
Fairhaven	assumed to exist	3.74	4.68	5.68	7.95	8.34	9.07	9.97	12.05	12.67	13.84	14.65	16.44	17.14	18.43	19.44	21.27	20.64	21.74	22.74	24.44
Fairhaven	assumed to exist	5.52	5.30	6.26	9.74	10.11	10.09	10.99	13.47	13.23	15.61	16.42	18.21	18.48	18.92	21.15	21.79	22.35	23.44	24.44	26.16
Fairhaven		0.00	0.00	0.00	0.00	0.30	1.00	1.90	3.89	4.63	5.79	6.64	8.40	9.19	10.23	11.23	13.12	12.53	13.63	14.58	16.20
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.24	1.85	3.01	3.86	5.62	6.42	7.46	8.46	10.36	9.77	10.86	11.79	13.42
Fairhaven	assumed drainage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.80	2.58	3.84	4.89	5.41	7.78	6.73	7.81	8.73	10.36
Fairhaven	DPW; 12" RCP	5.41	6.45	7.35	9.56	10.10	10.89	11.79	13.85	14.59	15.66	16.50	18.25	18.91	20.25	21.20	23.10	22.41	23.65	24.46	26.16
Fairhaven	24" RCP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fairhaven	4'x9' culvert	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.55	2.29	5.98	23.37	29.15	31.40	32.67	33.58	33.69	35.40	36.07	36.62	39.91
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.56	14.08	17.29	18.90	19.93	20.94	22.87	23.97	24.64	25.21

Outfalls

Municipality	Comments	Category 1				Category 2				Category 3				Category 4				Category 4 Extreme			
Water Level Rise		0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.84	2.02	3.18	4.10	5.24	5.26	5.88	6.53	9.05
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.43	3.79	4.93	5.84	6.90	6.97	7.58	8.12	10.83
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.79	3.29	4.41	5.33	6.39	6.43	7.03	7.57	10.21
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.73	11.24	14.50	16.15	17.24	18.22	20.28	21.43	22.11	22.44
Fairhaven	16" corrugated	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.43	0.00	2.83	19.16	25.25	26.67	27.57	28.29	28.70	29.02	29.23	29.64	35.84
Fairhaven	24" RCP	5.45	6.11	7.09	9.32	10.18	10.97	11.63	13.81	14.45	15.84	16.61	18.47	19.31	20.50	21.70	23.15	22.79	23.95	24.84	26.45
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.25	16.10	18.48	19.75	21.01	21.92	23.74	23.73	24.47	25.21	27.02
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.44	2.43	3.17	4.27	4.83	7.10	8.22	9.54	10.39	12.15	12.08	12.86	13.63	15.35
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.38	6.73	7.01	8.22	9.31	10.91	10.67	11.34	12.58	14.41
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.40	6.75	7.18	8.39	9.35	11.08	10.71	11.38	12.62	14.45
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	2.02	3.05	4.21	5.80	5.23	6.44	7.29	8.90
Fairhaven	assumed discharge	0.00	0.00	0.00	0.00	0.00	0.00	1.01	2.95	3.73	5.04	5.83	7.65	8.62	9.63	10.93	12.37	11.90	13.14	13.96	15.56
Fairhaven	assumed discharge	0.00	0.00	0.00	0.00	0.00	0.00	0.69	2.73	3.52	4.81	5.61	7.42	8.42	9.43	10.71	12.14	11.67	12.92	13.73	15.34
Fairhaven	assumed discharge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.33	2.12	3.41	4.20	6.02	7.02	8.03	9.30	10.75	10.30	11.52	12.34	13.94
Fairhaven	assumed discharge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.72	2.55	3.55	4.56	5.83	7.29	6.84	8.05	8.88	10.48
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	1.13	3.53	2.77	3.57	4.34	6.06
Fairhaven		0.00	0.00	0.00	0.00	0.32	0.87	1.74	4.03	4.50	5.88	6.45	8.67	9.70	10.89	11.86	13.62	13.45	14.27	15.12	16.77
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.51
Fairhaven		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fairhaven	Assumed BT	0.00	0.00	0.00	0.00	0.00	0.00	0.35	2.52	2.81	4.19	5.14	7.70	8.66	9.95	10.93	12.66	12.57	13.44	14.14	15.88
Fairhaven		0.54	1.62	2.53	4.45	5.15	5.83	6.56	8.84	9.77	10.72	11.42	13.39	14.45	15.58	16.40	18.48	17.78	18.80	19.79	21.49
Fairhaven	plans	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.03	0.00	2.45	15.01	17.30	18.52	19.82	20.87	23.50	22.59	23.43	25.07	26.85
Fairhaven	plans	5.00	7.03	7.97	8.94	9.64	11.43	11.31	13.30	15.20	15.19	15.92	17.87	19.86	20.36	20.88	23.27	22.23	23.28	24.24	25.94
Fairhaven	plans	2.96	3.86	4.80	6.90	7.60	8.26	9.01	11.27	12.04	13.15	13.88	15.84	16.69	18.13	18.84	20.74	20.19	21.24	22.21	23.90
Fairhaven	plans	4.00	4.90	5.84	7.94	8.63	9.30	10.04	12.30	13.07	14.19	14.92	16.87	17.73	18.87	19.87	21.77	21.23	22.27	23.24	24.94
Fairhaven	plans	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.29	4.74	7.16	8.53	9.82	10.73	12.53	12.61	13.32	13.94	15.91
Fairhaven	plan 31-C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	1.88
Fairhaven	plan 30-A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	1.79	1.53	2.55	3.36	4.99
Fairhaven	plan 29 B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.78	1.76	3.48
Fairhaven	plan 29 EE	3.49	4.41	5.39	7.70	8.15	8.81	9.69	11.85	12.16	13.64	14.44	16.23	16.96	18.23	19.26	21.06	20.46	21.58	22.56	24.28
Fairhaven	plan 28 D	7.42	8.24	9.15	11.27	11.99	12.66	13.46	15.69	16.39	17.60	18.30	20.28	21.18	22.37	23.38	25.23	24.81	25.70	26.71	28.39
Fairhaven	plan 22-A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.91	5.74	6.89	7.79	8.70	9.06	9.67	10.14	13.14
Fairhaven	plan 24-A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.51	7.68	8.09	9.36	10.36	12.74	12.13	12.82	14.85	16.29
Fairhaven	plan 25-A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.52

Designated Port Areas

Area	Category 1				Category 2				Category 3				Category 4				Category 4 Extreme			
Water Level Rise	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft
Harbor Hydraulics	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	1.25	13.76	16.04	16.87	18.21	19.57	21.91	21.27	22.12	23.57	25.46
Frhvn Shipyard	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.44	0.00	1.93	14.38	16.65	17.76	19.10	20.14	22.17	21.86	22.69	23.93	25.90
Union Wharf-Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.69	0.00	2.20	14.64	16.92	18.02	19.35	20.39	22.70	22.11	22.92	24.05	26.07
Union Wharf-Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.00	2.09	14.54	16.82	18.22	19.49	20.29	22.63	22.01	22.83	23.99	26.00
Union Wharf-Town	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.33	0.00	2.80	15.28	17.55	18.64	19.98	21.03	23.42	22.74	23.57	24.79	26.78
Frhvn Shipyard	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.05	0.00	2.56	15.00	17.28	18.37	19.70	20.74	23.01	22.47	23.27	24.35	26.38
Union Wharf-Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.91	1.65	5.64	18.16	20.42	21.43	22.78	23.90	26.31	25.60	26.46	27.76	29.73
Reidars	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.84	13.22	15.51	16.62	17.94	18.96	21.11	20.72	21.49	22.42	24.50
Atlantic Fisheries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.55	0.00	3.10	15.50	17.79	19.43	20.75	21.23	23.91	22.99	23.75	24.67	26.75
Steamship Authority Maintenance Facility	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.27	14.56	15.67	16.97	17.99	20.06	19.76	20.51	21.33	23.45
North Coast Seafoods	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.38	3.76	5.72	10.24	12.06	13.07	14.43	15.30	16.95	16.84	17.74	18.50	20.27
Field/Club	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.58	6.44	7.11	8.47	10.04	10.97	12.30	13.18	14.79	14.69	15.59	16.39	18.16
South Shore Dry Dock Marine, SK Marine Electronics, Creative Canvas Works, Bayline Boatyard and Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.17	11.04	11.82	13.10	14.68	15.49	16.80	17.80	19.31	19.31	20.21	21.00	22.79
Residential	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.53	4.93	5.95	8.37	10.01	10.99	12.33	13.25	14.86	14.77	15.67	16.45	18.20
Residential	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.17	5.42	6.46	8.80	10.44	11.57	12.72	13.68	15.42	15.19	16.09	16.88	18.63
Residential	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.62	5.05	6.05	8.37	10.01	10.98	12.33	13.24	14.85	14.76	15.66	16.44	18.19
Residential	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.14	5.63	6.58	8.79	10.41	11.39	12.74	13.64	15.25	15.16	16.06	16.84	18.60
Residential	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.93	5.28	6.26	8.53	10.16	11.14	12.58	13.38	15.10	14.90	15.80	16.59	18.34
Residential	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.64	5.30	6.16	8.24	9.86	10.82	12.16	13.07	14.61	14.58	15.48	16.27	18.03
Residential	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.24	6.72	7.69	9.89	11.52	12.48	13.82	14.73	16.33	16.24	17.14	17.93	19.69
Residential	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.33	5.67	6.57	8.61	10.22	11.40	12.74	13.43	15.25	14.94	15.84	16.63	18.39
Residential	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.26	6.89	7.78	9.80	11.41	12.32	13.60	14.62	16.16	16.13	17.03	17.82	19.58
Residential	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.71	7.32	8.18	10.12	11.73	12.68	14.02	14.93	16.53	16.44	17.34	18.13	19.89
Finicky Pet Food Inc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.45	7.97	8.99	11.08	12.70	13.61	14.94	15.88	17.44	17.40	18.30	19.09	20.86
Finicky Pet Food Inc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.33	8.41	9.77	12.79	14.49	15.46	16.72	17.68	19.31	19.21	20.11	20.88	22.66
Field/Club	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.01	7.23	8.51	10.89	12.56	13.03	14.35	15.71	17.32	17.23	18.13	18.92	20.70
SK Marine Electronics	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.02	9.96	11.62	14.73	16.46	17.16	18.48	19.62	21.23	21.15	22.05	22.83	24.62
Sea Gold Seafood Prods	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.65	6.10	8.04	12.42	14.25	15.19	16.54	17.45	19.05	18.99	19.89	20.65	22.44
Fleet Fisheries Inc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.63	5.84	7.94	12.65	14.56	15.55	16.89	17.75	19.47	19.30	20.20	20.96	22.75
Vacant-South Terminal Expansion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.52	4.89	7.78	14.24	16.29	17.31	18.67	19.51	20.94	21.08	21.97	22.72	24.51
Vacant-South Terminal Expansion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.20	3.68	7.47	15.02	17.10	18.07	19.44	20.35	21.96	21.92	22.82	23.56	25.35
South Shore Dry Dock Marine, SK Marine Electronics, Creative Canvas Works, Bayline Boatyard and Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.36	10.59	11.96	14.58	16.29	17.21	18.52	19.43	21.04	20.95	21.85	22.64	24.43
Field/Club	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.08	8.90	9.60	11.36	12.97	13.90	15.21	16.12	17.72	17.63	18.53	19.32	21.10
Field/Club	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.02	6.76	7.43	9.06	10.64	11.69	13.01	13.82	15.44	15.32	16.22	17.02	18.79
Field/Club	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.36	7.81	8.80	10.91	12.55	13.53	14.85	15.71	17.37	17.23	18.13	18.92	20.69
Field/Club	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.88	7.52	8.38	10.13	11.73	12.70	14.00	14.90	16.51	16.41	17.31	18.10	19.87
Field/Club	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.60	8.20	9.08	11.02	12.63	13.58	15.06	15.81	17.42	17.32	18.22	19.01	20.78
South Shore Dry Dock Marine, SK Marine Electronics, Creative Canvas Works, Bayline Boatyard and Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.04	11.27	12.59	15.08	16.90	17.81	19.12	20.03	21.66	21.57	22.47	23.25	25.03
Seatrade International Corp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.97	8.20	9.34	12.51	14.21	15.21	16.71	17.49	19.10	19.01	19.91	20.69	22.44
Carlos Seafood Inc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.04	8.70	10.39	13.81	15.52	16.52	17.63	18.81	20.42	20.34	21.24	22.01	23.76
WBSM Radio Tower Site	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.23	6.51	8.57	13.41	15.24	16.19	17.56	18.52	20.11	20.06	20.96	21.72	23.49
Carlos Seafood Inc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.69	9.16	10.65	14.35	16.09	17.47	18.73	19.37	21.37	20.91	21.81	22.57	24.33
Quality Custom Packing, Inc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.24	0.00	2.44	10.98	13.09	14.09	15.47	16.38	17.99	17.96	18.86	19.58	21.37
Bergie's Seafood, Inc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.00	1.89	13.24	15.54	16.54	17.83	18.84	20.44	20.44	21.34	22.04	23.84
Northern Wind	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.60	0.00	2.78	13.70	15.99	16.98	18.37	19.28	20.88	20.88	21.78	22.48	24.28
Eastern Fisheries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.00	2.69	13.11	15.37	16.40	17.75	18.66	20.27	20.25	21.15	21.86	23.66
Shuster Corp-South Terminal Expansion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.54	11.76	12.75	14.14	15.04	16.72	16.63	17.53	18.25	20.04
CP Brodeur Inc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.67	2.94	5.21	10.48	12.34	13.27	14.65	15.63	16.96	17.18	18.08	18.83	20.61
Tomtronics	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.78	0.97	4.01	11.16	13.16	14.20	15.58	16.45	18.11	18.02	18.92	19.65	21.44
Top Quality Seafood & Shellfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	9.59	11.75	12.75	14.14	15.05	16.66	16.63	17.53	18.25	20.05
Oceans Alive Scallop Corp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69	10.86	13.08	14.08	15.47	16.37	17.98	17.97	18.87	19.58	21.38
MF Foley Co. Inc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.04	1.66	4.30	10.58	12.51	13.51	14.90	15.80	17.44	17.37	18.27	19.01	20.80
IMP Fishing Gear Inc.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	7.33	9.28	10.29	11.68	12.58	14.14	14.15	15.05	15.79	17.59
Mariner Seafood LCC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	1.45	9.65	11.72	12.77	14.15	15.02	16.69	16.60	17.50	18.23	20.03
Seatrade International Corp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.14	11.53	13.69	14.69	16.08	16.98	18.61	18.57	19.47	20.19	21.99
Parking Lot for Northern Wind	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	11.07	13.32	14.32	15.71	16.61	18.22	18.21	19.11	19.82	21.62
Vacant-South Terminal Expansion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.20	0.48	4.40	13.43	15.61	16.59	17.97	18.88	20.96	20.47	21.37	22.09	23.88
C&P Bait	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.07	0.00	2.25	10.70	12.79	13.79	15.18	16.09	17.71	17.67	18.57	19.29	21.09
Marine Enterprises and Servcies	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.69	1.13	4.08	10.78	12.75	13.70	15.09	16.14	17.86	17.80	18.70	19.36	21.42
Skips Marine Supply	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.60	1.33	4.02	10.75	12.72	13.58	14.98	16.09	17.82	17.73	18.63	19.31	21.30
Bay Fuel Home Heating & Skips Marine Supply	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.49	0.87	3.72	10.41	12.37	13.43	14.79	15.74	17.52	17.36	18.26	18.95	20.92

Designated Port Areas

Area	Category 1				Category 2				Category 3				Category 4				Category 4 Extreme			
Water Level Rise	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft
Advanced Marine Technologies	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	9.91	12.07	13.11	14.50	15.44	17.24	17.08	17.99	18.65	20.65
Continental Plastics & Packaging	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.03	10.32	12.47	13.49	14.91	15.82	17.55	17.45	18.35	19.03	20.98
Bruce's Splicing & Rigging Co	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.80	0.95	4.02	11.31	13.31	14.15	15.54	16.62	18.09	18.20	19.10	19.83	21.64
Trio Algarvio Inc(Rope/netting storage)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00	1.93	12.41	14.64	15.69	17.08	17.99	19.72	19.62	20.52	21.20	23.14
Access to Mass Fab & Welding 42-260	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.24	0.00	2.37	12.52	14.73	15.84	16.91	18.09	19.66	19.74	20.64	21.31	23.30
Seaway Co.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.69	0.00	2.79	14.19	16.49	17.49	18.88	19.79	21.42	21.40	22.30	23.00	24.82
Tempist Fisheries Inc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.00	1.89	13.34	15.64	16.64	18.03	18.94	20.54	20.54	21.44	22.14	23.94
Whaling City Seafood Display Auction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.64	0.00	1.74	13.17	15.47	16.47	17.86	18.77	20.39	20.37	21.28	21.98	23.79
Pier Fish Co.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	9.84	12.00	12.86	14.25	15.33	16.82	16.93	17.83	18.54	20.39
New Bedford Shellfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	10.74	12.99	14.01	15.41	16.29	17.93	17.89	18.79	19.49	21.31
Pauls Truck Repair	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.93	0.00	2.12	10.67	12.77	13.78	15.17	16.08	17.74	17.66	18.56	19.28	21.10
Saraiva Enterprises, Inc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	10.00	12.12	13.10	14.49	15.45	17.12	17.06	17.96	18.66	20.55
Hygrade Ocean Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.88	0.00	3.10	10.56	12.57	13.58	14.97	15.90	17.57	17.49	18.39	19.11	20.96
Parking-Very Small	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.26	2.02	4.52	10.53	12.42	13.19	14.58	15.76	17.33	17.34	18.24	18.97	20.82
Marder Trawling Inc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.21	12.44	13.46	14.85	15.76	17.19	17.37	18.27	18.97	20.81
Northern Wind Inc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.76	0.00	1.86	13.30	15.60	16.60	18.00	18.90	20.52	20.50	21.40	22.10	23.91
Advanced Marine Technologies	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.20	9.77	11.88	12.99	14.38	15.26	17.12	16.92	17.82	18.48	20.53
Sprague Oil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	2.13	10.72	12.91	13.99	15.39	16.28	18.36	18.03	18.93	19.50	21.81
NSTAR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.25	0.63	4.41	13.36	15.49	16.60	17.99	18.90	20.81	20.59	21.49	22.12	24.24
Mass Fabricating & Welding	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.34	0.00	2.47	12.80	15.03	16.10	17.49	18.40	20.23	20.07	20.97	21.62	23.66
Trio Algarvio Inc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.65	0.00	2.78	13.51	15.77	16.79	18.18	19.11	20.82	20.74	21.64	22.32	24.25
Luzo Fishing Gear, Inc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.89	0.59	3.13	9.30	11.22	12.30	13.69	14.65	16.53	16.33	17.23	17.87	20.00
NSTAR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.36	0.86	3.58	10.22	12.19	13.37	14.76	15.67	17.71	17.40	18.30	18.89	21.17
NSTAR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.60	2.62	5.73	13.54	15.79	16.77	18.17	19.06	21.21	20.83	21.73	22.27	24.68
NSTAR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.93	1.64	5.08	13.56	15.81	16.79	18.18	19.12	21.19	20.89	21.79	22.33	24.71
parking	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.08	2.41	6.10	15.63	18.29	18.92	20.32	21.22	23.43	23.02	23.92	24.43	26.92
Homers Wharf	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.63	0.00	3.60	13.59	16.08	16.98	18.38	19.25	21.61	21.05	21.95	22.45	24.95
NSTAR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.80	1.37	4.90	13.54	15.85	16.71	18.10	19.12	21.24	20.89	21.79	22.33	24.74
DEM State Pier	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.99	12.91	13.25	14.69	15.60	17.76	17.40	18.30	18.81	21.31
parking	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.06	2.44	6.10	15.51	18.13	18.85	20.22	21.11	23.35	22.91	23.81	24.32	26.81
Leonards Wharf	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.53	0.00	3.55	13.59	15.98	16.94	18.33	19.26	21.42	21.05	21.95	22.46	24.93
Waterfront Grille	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.54	0.00	3.63	13.24	15.68	16.52	17.98	18.89	21.02	20.69	21.59	22.09	24.59
parking	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.60	3.31	6.86	15.87	18.32	19.20	20.37	21.47	23.59	23.26	24.17	24.67	27.16
Bourne Counting House	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.41	1.00	4.64	13.85	16.43	17.11	18.50	19.44	21.61	21.24	22.14	22.65	25.14
Ocean C-Star Inc, International Seafood Inc, Liberty Lobster	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.83	1.11	4.86	14.46	17.01	17.78	19.18	20.08	22.28	21.88	22.78	23.29	25.78
greenspace	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.10	0.52	4.27	14.03	16.84	17.31	18.71	19.62	21.82	21.42	22.32	22.82	25.32
Moses Smith & Markey Attorneys	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.15	0.50	4.25	13.66	16.12	16.93	18.33	19.28	21.43	21.08	21.98	22.48	24.98
Sprague Oil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.96	4.75	14.25	16.60	17.58	18.98	19.88	22.03	21.66	22.56	23.09	25.51
Crystal Ice	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.00	1.65	13.20	17.18	16.86	18.24	19.19	21.55	21.12	22.02	22.58	25.11
Fishermans Wharf	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.64	0.00	2.37	13.76	17.19	17.25	18.66	19.41	21.79	21.23	22.13	22.65	25.15
DEM State Pier	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.38	13.38	13.74	15.13	16.04	18.25	17.84	18.74	19.26	21.75
Crystal Ice	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.00	1.39	13.03	17.17	16.78	18.16	19.13	21.53	21.08	21.98	22.55	25.09
NB Seafood Coalition	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.51	0.00	3.45	14.74	18.40	18.12	19.51	20.43	22.69	22.28	23.18	23.70	26.21
NB Harbor Dev Commission	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.03	0.00	2.96	14.00	17.42	17.27	18.66	19.57	21.78	21.37	22.27	22.78	25.28
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.19	0.00	4.13	14.98	18.32	18.24	19.45	20.55	22.56	22.35	23.25	23.76	26.25
Harbormaster Building	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.66	0.00	2.58	13.82	17.39	17.13	18.52	19.44	21.67	21.26	22.16	22.67	25.17
Access to Crystal Ice	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.88	0.00	2.63	14.35	18.67	18.23	19.60	20.55	23.01	22.53	23.43	24.01	26.57
Global Fuel Coop & Sea Fuels Marine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.00	2.53	13.96	17.77	17.48	18.86	19.80	22.12	21.68	22.58	23.13	25.65
Maritime Terminal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00	1.51	13.29	17.65	17.25	18.61	19.55	22.06	21.54	22.44	23.03	25.58
Maritime Terminal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	12.04	16.71	16.38	17.74	18.40	21.19	20.39	21.28	21.89	24.48
Maritime Terminal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.00	1.48	13.22	17.68	17.03	18.39	19.44	21.80	21.41	22.30	22.89	25.47
Infrastructure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	2.68	15.07	20.25	19.91	21.23	22.13	24.68	24.18	25.06	25.69	28.44
Infrastructure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.90	0.00	2.94	15.28	20.34	19.64	21.07	22.10	24.64	24.15	25.03	25.66	28.34
Infrastructure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.94	16.72	16.57	17.92	18.42	21.42	20.43	21.32	21.94	24.54
Infrastructure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.79	0.00	2.91	14.96	19.68	18.96	20.32	21.41	23.91	23.43	24.32	24.94	27.53
Maritime Terminal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	12.16	16.96	16.21	17.57	18.74	21.18	20.80	21.69	22.33	24.92
Maritime Terminal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	1.10	13.35	18.25	17.63	18.98	20.04	22.59	22.12	23.01	23.65	26.27
NB Seafoods	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.17	17.26	17.11	18.44	19.51	22.22	21.70	22.58	23.24	25.96
Maritime Terminal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.46	16.45	15.60	16.95	17.96	20.39	19.93	20.81	21.42	24.08
Infrastructure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.72	0.00	4.43	16.86	22.17	21.90	23.20	24.25	26.80	26.30	27.16	27.81	30.63

Designated Port Areas

Area	Category 1				Category 2				Category 3				Category 4				Category 4 Extreme			
Water Level Rise	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft
Maritime Terminal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.60	0.00	2.59	14.72	19.28	19.44	20.79	21.88	24.80	24.15	25.05	25.81	28.37
Niemic Marine, Sequin Enterprises, Ocean Marine Fabricating, & Commercial Strip Mall	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.68	14.62	15.90	17.24	18.43	21.69	20.83	21.76	22.87	25.28
Vacant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.96	15.91	17.27	18.60	19.80	23.10	22.21	23.14	24.29	26.69
Fish Island Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.27	9.37	9.40	10.77	11.79	14.37	13.85	14.76	15.41	17.95
Niemic Yatch Sales, Niemic Marine, DG Marine Services, Fathoms Bar & Grille, CMS Fishing Tackle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.70	13.54	14.70	16.04	17.20	20.37	19.51	20.44	21.56	23.94
RA Mitchell and Ricks Outboards	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.86	14.18	15.44	16.79	17.96	21.17	20.06	21.01	22.42	24.62
Fairhaven True Value Hardware	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.28	11.45	12.71	14.06	15.37	18.44	17.36	18.30	19.76	21.90
Dunkin Donuts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.72	14.83	16.14	17.49	18.64	21.79	20.63	21.58	23.08	25.20
Fishing Boat Docking & Access	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	12.54	16.70	17.03	18.30	19.35	22.15	21.51	22.42	23.13	25.66
Temptations	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.80	14.30	15.53	16.88	18.05	21.23	20.23	21.18	22.49	24.75
Maritime Terminal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	12.36	16.71	16.68	18.04	19.07	21.74	21.20	22.10	22.79	25.33
Maritime Terminal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.40	14.73	15.55	16.90	17.35	20.13	19.55	20.46	21.19	23.73
AGM Marine Contractors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	12.64	16.71	16.90	18.26	19.29	21.93	21.40	22.30	22.98	25.51
Sea Watch International	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	12.30	17.79	19.03	20.28	21.50	24.65	24.08	24.94	25.64	28.63
Eastern Fisheries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.15	17.45	18.52	19.81	21.01	24.23	23.66	24.53	25.23	28.11
NB Seafoods	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.06	0.00	3.15	15.43	20.68	20.95	22.25	23.36	26.19	25.66	26.53	27.20	30.03
Eastern Fisheries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.30	15.87	16.91	18.40	19.61	22.48	22.15	23.00	23.69	26.73
Big G Seafood & Marder Trawler Inc. Freezer Plant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.04	17.53	18.27	19.54	20.76	23.64	23.15	24.00	24.69	27.66
Sea Watch International	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.35	18.12	19.11	20.34	21.44	24.25	23.66	24.49	25.17	28.31
Eastern Fisheries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.02	15.58	16.95	18.20	19.39	22.56	21.97	22.81	23.51	26.55
Eastern Fisheries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.00	17.78	18.96	20.19	21.36	24.21	23.67	24.49	25.18	28.34
Packaging Products Corp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.55	13.21	19.21	21.36	21.56	22.70	25.32	24.80	25.60	26.28	29.56
Sea Watch International	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	12.77	18.71	19.73	21.05	22.07	24.70	24.17	24.97	25.65	28.89
Atlantic Red Crab & M&B Sea Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.13	17.70	18.25	19.51	20.70	23.47	22.94	23.78	24.46	27.47
J.C. Fish Inc & LWS Inc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.82	18.27	18.73	20.00	21.27	23.99	23.59	24.44	25.13	28.07
Sea Watch International	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.04	17.75	18.82	20.05	21.22	24.10	23.55	24.38	25.07	28.18
Bulk Material Barge Loading Sand & Gravel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.72	12.80	17.99	18.82	20.12	21.35	24.44	23.96	24.84	25.54	28.36
Eastern Fisheries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	12.61	18.25	19.61	20.85	22.06	25.13	24.57	25.41	26.10	29.19
Eastern Fisheries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.26	13.71	19.50	20.92	22.14	23.20	26.22	25.55	26.38	27.06	30.23
Marine Hydraulics Inc. w/boatyard in back	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.90	16.26	17.59	18.71	19.86	22.23	21.73	22.49	23.15	26.65
Wharf Tavern and BJ Temp Services	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.77	19.13	20.26	21.42	22.50	24.76	24.27	25.03	25.69	29.18
US EPA Dredge Dewatering Facility	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.35	18.28	19.33	20.54	21.97	24.53	24.23	25.03	25.71	28.96
New Bedford Welding Supply	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.44	17.19	18.43	19.45	20.60	22.56	22.09	22.81	23.45	27.16
Small Marine Related Business (5) including NB Welding Supply	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.76	17.48	18.76	19.86	20.92	22.91	22.44	23.16	23.81	27.50
Bulk Material Barge Loading Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	14.05	21.27	22.58	23.64	24.57	26.12	25.61	26.27	26.90	30.88
No Active Use too small	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.70	19.15	20.43	21.53	22.62	25.23	24.37	25.12	25.78	29.32
No Active Use-for sale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.71	17.59	18.84	19.94	20.97	22.79	22.33	23.03	23.67	27.46
Ever Green Sheet Metal Inc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.76	14.20	21.23	22.28	23.41	24.57	26.04	25.79	26.48	27.11	30.98
No Active Use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.17	0.00	5.29	18.64	25.55	26.56	26.03	28.93	28.86	30.27	30.96	31.60	35.41

Public Structures

Object	Location	Municipality	Category 1				Category 2				Category 3				Category 4				Category 4 Extreme			
Water Level Rise			0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft
1	RIVERSIDE AVE	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00	0.87	19.83	24.84	27.44	29.11	30.23	31.51	32.30	33.31	34.10	35.08
2	144 COFFIN AVE	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.30	21.35	23.72	25.65	26.69	27.78	28.67	29.66	30.45	31.55
3	COFFIN AVE	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.59	19.55	24.57	27.18	28.86	29.95	31.26	31.94	32.93	33.73	34.77
4	26 MADEIRA AVE	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.47	3.96	5.58	6.75	7.95	8.81	9.81	10.58	11.67
5	56 NASH RD	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.47	13.44	15.82	17.41	18.72	19.76	20.95	21.96	22.72	23.68
6	215 W RODNEY FRENCH BLVD	New Bedford	1.59	2.93	3.71	5.98	6.47	7.45	8.38	10.59	11.25	12.09	12.95	15.15	16.26	17.08	17.79	19.70	19.17	20.16	21.05	22.79
7	603 BROCK AVE	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	618 BELLEVILLE AVE	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.07	17.73	20.32	21.72	22.91	24.16	25.97	27.04	27.71	28.19
9	ACUSHNET AVE	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	BELLEVILLE AVE	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.40	4.10	4.10	22.60	27.01	29.90	31.18	32.09	33.63	35.67	36.77	37.37	37.58
11	1997 ACUSHNET AVE	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	246 RIVER RD	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.15	2.82	2.83	21.32	25.80	28.12	28.84	29.56	31.02	31.98	33.15	33.82	34.74
13	119 FREDERICK ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.68	2.34	3.54	4.54	6.23	5.95	6.94	7.83	9.54
14	E RODNEY FRENCH BLVD	New Bedford	1.18	2.13	3.04	5.58	6.08	6.52	7.54	10.00	10.43	11.59	12.14	14.33	15.30	16.39	17.45	19.03	18.86	19.79	20.68	22.45
15	E RODNEY FRENCH BLVD	New Bedford	1.20	2.19	3.37	5.59	6.09	6.79	7.60	10.17	10.76	11.60	12.12	14.32	15.46	16.73	17.47	19.36	18.86	19.79	20.68	22.47
16	E RODNEY FRENCH BLVD	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.71	5.32	6.15	6.83	8.99	9.95	11.18	11.98	13.90	13.40	14.37	15.25	16.98
17	620 BROCK AVE	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	TARKILN HILL RD	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	2203 ACUSHNET AVE	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	99 RUTH ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.03	0.92	1.82	2.63	4.42
21	48 W RODNEY FRENCH BLVD	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.27	2.50	3.01	3.82	5.33	6.10	7.38	8.42	9.89	9.92	10.82	11.63	13.42
22	1699 E RODNEY FRENCH BLVD	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.80	11.39	12.70	13.52	15.74	16.34	17.62	18.79	20.23	20.33	21.24	22.07	23.79
23	18 CLEVELAND ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.85	6.68	7.45	8.49	10.17	11.06	12.35	13.26	14.88	14.77	15.68	16.48	18.26
24	1000 S RODNEY FRENCH BLVD	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	1.38	2.88	3.71	5.40	5.96	7.27	8.55	10.22	9.75	10.78	11.70	13.63
25	960 S RODNEY FRENCH BLVD	New Bedford	1.55	2.55	3.45	5.85	6.24	6.85	7.64	9.94	10.35	11.65	12.45	14.15	14.77	16.15	17.25	19.15	18.45	19.46	20.36	22.35
26	S RODNEY FRENCH BLVD	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	1.33	2.77	3.57	5.27	5.76	7.15	8.37	9.94	9.57	10.57	11.48	13.47
27	170 COVE ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.39	8.44	8.96	9.87	11.43	12.36	13.67	14.53	16.13	16.03	16.93	17.73	19.51
28	3 W RODNEY FRENCH BLVD	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.61	4.72	5.20	6.06	7.59	8.55	9.83	10.69	12.29	12.19	13.09	13.89	15.68
29	1095 COVE RD	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.90	11.89	12.51	13.41	15.12	16.01	17.11	18.11	19.68	19.59	20.49	21.31	23.09
30	45 COVE ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.24	15.91	16.73	18.08	19.75	20.41	21.71	22.86	24.57	24.38	25.28	26.07	27.86
31	RIVET ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.80	2.95	3.93	4.80	6.41	6.27	7.18	8.00	9.72
32	KATHARINE ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.01	3.99	4.55	5.63	7.51	8.57	9.56	10.52	12.12	11.99	12.89	13.72	15.43
33	S FIRST ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.99	7.72	8.40	9.89	11.45	12.43	13.69	14.71	16.31	16.21	17.11	17.91	19.63
34	S FIRST ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.91	8.08	8.57	9.83	11.37	12.13	13.71	14.62	16.00	16.12	17.02	17.82	19.54
35	S FIRST ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.18	6.25	6.73	7.96	9.50	10.48	11.83	12.74	14.34	14.24	15.14	15.94	17.67
36	S FIRST ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.55	5.59	6.08	7.29	8.84	9.73	11.08	12.07	13.59	13.57	14.47	15.27	17.00
37	BLACKMER ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.08	8.90	9.60	11.36	12.97	13.90	15.21	16.12	17.72	17.63	18.53	19.32	21.10
38	GIFFORD ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.04	11.27	12.59	15.08	16.90	17.81	19.12	20.03	21.66	21.57	22.47	23.25	25.03
39	160 THOMPSON ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	838 S RODNEY FRENCH BLVD	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	2.27	1.64	2.71	3.63	5.47
41	PURCHASE ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.89	6.00	6.29	7.29	8.79	9.81	11.20	12.09	13.71	13.59	14.49	15.29	17.00
42	137 PURCHASE ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.74	5.84	6.04	7.04	8.55	9.63	11.04	11.85	13.54	13.35	14.25	15.05	16.75
43	THOMPSON ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.31	4.37	4.72	5.77	7.30	8.30	9.66	10.58	12.17	12.08	12.98	13.78	15.48
44	S SECOND ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.49	6.37	6.88	8.34	9.88	10.88	12.28	13.18	14.80	14.69	15.59	16.38	18.11
45	PALMERS ISLAND	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.91	2.13	6.15	15.83	18.14	18.99	20.35	21.43	23.14	23.07	23.93	24.65	26.52
46	458 S WATER ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.07	6.82	8.70	13.31	15.11	15.90	17.30	18.50	20.03	20.13	21.03	21.72	23.72
47	458 S WATER ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.81	5.98	8.12	12.67	14.46	15.55	16.94	17.85	19.39	19.48	20.38	21.06	23.06
48	JOHN F KENNEDY HWY	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.38	5.67	7.32	11.45	13.22	14.69	15.70	16.61	18.83	18.23	19.13	19.82	21.83
49	MACARTHUR DR	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.40	4.58	6.37	11.45	13.28	14.66	16.05	16.67	19.05	18.30	19.20	19.89	21.89
50	286 S SECOND ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.04	5.80	6.42	8.15	9.71	10.73	12.12	13.03	14.66	14.55	15.45	16.23	17.97
51	E RODNEY FRENCH BLVD	New Bedford	0.00	0.00	0.00	0.72	1.12	1.74	2.53	4.82	5.35	6.53	7.32	9.09	10.25	11.40	12.33	14.15	13.53	14.61	15.51	17.35
52	E RODNEY FRENCH BLVD	New Bedford	0.00	0.00	0.00	0.31	0.72	1.34	2.14	4.42	4.98	6.14	6.91	8.70	9.84	11.06	11.96	13.76	13.16	14.26	15.16	16.96
53	E RODNEY FRENCH BLVD	New Bedford	0.00	0.00	0.00	0.44	0.86	1.47	2.29	4.56	5.03	6.29	7.04	8.85	9.94	11.05	12.06	13.87	13.26	14.36	15.26	17.07
54	918 E RODNEY FRENCH BLVD	New Bedford	0.00	0.54	1.49	3.89	4.32	4.94	5.76	8.03	8.51	9.76	10.49	12.33	13.33	14.47	15.48	17.30	16.69	17.78	18.68	20.50
55	950 S RODNEY FRENCH BLVD	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.25	2.54	2.97	4.24	5.04	6.79	7.75	8.96	10.00	11.84	11.20	12.26	13.17	15.04
56	PURCHASE ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	1.21	2.58	3.49	5.28	5.09	5.99	6.70	8.65
57	CANNON ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.02	4.80	5.98	7.38	8.26	10.29	9.97	10.87	11.49	13.70
58	ACUSHNET AVE	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	1.48	2.87	3.77	5.82	5.49	6.39	6.99	9.25
59	MACARTHUR DR	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.08	2.41	6.10	15.63	18.29	18.92	20.32	21.22	23.43	23.02	23.92	24.43	26.92
60	HOMERS WHF	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.63	0.00	3.60	13.59	16.08	16.98	18.38	19.25	21.61	21.05	21.95	22.45	24.95

Public Structures

Object	Location	Municipality	Category 1				Category 2				Category 3				Category 4				Category 4 Extreme			
Water Level Rise			0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft
61	MACARTHUR DR	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.06	2.44	6.10	15.51	18.13	18.85	20.22	21.11	23.35	22.91	23.81	24.32	26.81
62	LEONARDS WHARF	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.53	0.00	3.55	13.59	15.98	16.94	18.33	19.26	21.42	21.05	21.95	22.46	24.93
63	MACARTHUR DR	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.60	3.31	6.86	15.87	18.32	19.20	20.37	21.47	23.59	23.26	24.17	24.67	27.16
64	MACARTHUR DR	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.10	0.52	4.27	14.03	16.84	17.31	18.71	19.62	21.82	21.42	22.32	22.82	25.32
65	680 PURCHASE ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
66	51 MACARTHUR DR	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.64	0.00	2.37	13.76	17.19	17.25	18.66	19.41	21.79	21.23	22.13	22.65	25.15
67	51 ELM ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
68	MACARTHUR DR	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.03	0.00	2.96	14.00	17.42	17.27	18.66	19.57	21.78	21.37	22.27	22.78	25.28
69	MACARTHUR DR	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.19	0.00	4.13	14.98	18.32	18.24	19.45	20.55	22.56	22.35	23.25	23.76	26.25
70	MACARTHUR DR	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.66	0.00	2.58	13.82	17.39	17.13	18.52	19.44	21.67	21.26	22.16	22.67	25.17
71	249 MACARTHUR DR	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.23	13.27	12.82	14.20	15.15	17.48	17.04	17.94	18.50	21.03
72	1150 PURCHASE ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73	E RODNEY FRENCH BLVD	New Bedford	3.71	4.70	5.67	8.08	8.54	9.16	10.01	11.86	12.94	14.01	14.67	16.61	17.09	18.23	19.64	21.06	20.86	21.95	22.85	24.66
74	BROCK AVE	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75	71 PORTLAND ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
76	86 POPES ISLAND	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.42	14.10	16.69	17.81	19.19	20.31	23.35	22.08	23.06	24.78	26.72
77	E OF O C R R TRACK	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	13.19	18.78	19.18	20.45	21.52	24.16	23.65	24.48	25.15	28.17
78	PEARL ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.63	20.07	20.88	22.04	23.08	25.11	24.66	25.40	26.03	29.57
79	532 ACUSHNET AVE	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.36	16.25	16.80	18.02	19.03	21.46	20.98	21.77	22.41	25.64
80	1204 PURCHASE ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69
81	519 W RODNEY FRENCH BLVD	New Bedford	0.00	0.66	1.66	3.96	4.36	5.27	5.99	8.28	8.79	9.78	10.67	12.79	13.37	14.57	15.57	17.41	16.86	17.88	18.84	20.63
82	BROCK AVE	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
83	235 BROCK AVE	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
84	190 POPE ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
85	38 WAMSUTTA ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.04	0.00	2.13	15.99	23.53	24.73	25.75	26.69	27.83	27.42	28.04	28.65	32.81
86	WAMSUTTA ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.54	0.00	3.61	17.45	25.00	26.38	27.22	28.16	29.30	28.89	29.51	30.13	34.29
87	352 HERMAN MELVILLE BLVD	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	14.05	21.27	22.58	23.64	24.57	26.12	25.61	26.27	26.90	30.88
88	LOGAN ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.15	10.89	12.09	13.09	14.01	14.96	14.56	15.16	15.76	20.03
89	PURCHASE ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.18	2.11	3.10	2.81	3.43	4.04	8.17
90	PURCHASE ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
91	COGGESHALL ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.63	3.99	5.07	6.03	7.01	6.80	7.44	8.06	11.98
92	360 COGGESHALL ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.11	0.76	1.38	5.24
93	COGGESHALL ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.82	4.13	5.21	6.24	7.23	7.02	7.67	8.29	12.18
94	COGGESHALL ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.37	16.66	18.06	19.14	20.08	21.02	20.83	21.46	22.08	26.04
95	BELLEVILLE AVE	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.88	0.00	2.90	17.24	24.82	26.11	27.14	28.05	28.97	28.66	29.27	29.88	34.04
96	597 BROCK AVE	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
97	SAWYER ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	2.44	3.66	4.66	5.69	5.73	6.45	7.11	10.37
98	SAWYER ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	2.27	3.49	4.49	5.52	5.55	6.27	6.92	10.21
99	BEETLE ST	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.16	3.72	5.01	5.91	6.73	6.90	7.60	8.25	11.68
100	BELLEVILLE AVE	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.87	16.17	18.52	20.11	21.28	22.44	23.12	24.06	24.83	26.30
101	MAIN STREET	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
102	MILL ROAD	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	2.29	3.29	4.30	5.57	6.68	6.58	7.79	8.62	10.22
103	TABER STREET	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	1.35	15.11	20.73	22.89	24.00	24.99	26.61	26.47	27.07	27.53	31.09
104	MAIN STREET	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.06	1.97	2.80	2.70	3.30	3.52	5.83
105	MAIN STREET	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	1.22	2.10	2.98	2.84	3.44	3.67	5.98
106	NORTH STREET	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.69	5.21	6.31	7.23	8.74	7.97	8.58	8.85	11.13
107	SCHOOL STREET	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	2.72	2.13	2.83	4.82	6.26
108	CHERRY STREET	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.85	11.64	15.51	16.64	17.60	18.83	18.62	19.26	19.64	22.02
109	HUTTLESTON AVENUE	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36
110	PILGRIM AVENUE	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.71	0.00	3.53	16.26	20.65	25.14	26.28	27.24	28.55	28.31	28.96	29.38	31.75
111	ASH STREET	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.89	4.74	5.17	6.46	7.46	9.96	9.31	10.01	12.15	13.53
112	HUTTLESTON AVENUE	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.63	15.35	16.72	18.00	19.16	21.55	20.89	21.60	23.59	25.07
113	BRIDGE STREET	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.20	13.84	14.77	15.98	16.99	19.58	18.89	19.59	21.87	23.18
114	GREEN STREET	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.63	12.93	15.24	16.56	17.87	18.88	21.42	20.72	21.45	23.50	24.96
115	HUTTLESTON AVENUE	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
116	BRIDGE STREET	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.57	0.00	2.90	15.59	18.05	19.51	20.82	21.78	24.44	23.52	24.31	26.26	27.84
117	MCGANN TERRACE	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.73	0.57	1.27	2.32	4.13
118	BRYANT LANE	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.88
119	MCGANN TERRACE	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.28	3.67	4.96	5.87	7.73	7.77	8.47	9.20	11.14

Public Structures

Object	Location	Municipality	Category 1				Category 2				Category 3				Category 4				Category 4 Extreme			
Water Level Rise			0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft
120	WASHINGTON STREET	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	2.35	3.64	4.56	6.40	6.45	7.15	7.86	9.81
121	ARSENE STREET	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50
122	RAILROAD WAY	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.41	2.27	3.11	4.41	5.21	7.02	7.97	8.97	10.31	11.72	11.21	12.51	13.32	14.92
123	SPRING STREET	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.05	0.00	2.66	15.04	17.35	18.48	19.79	20.95	23.38	22.73	23.50	25.13	26.83
124	MIDDLE STREET	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.54	0.00	3.96	16.52	18.82	20.84	22.18	22.42	24.59	24.15	24.98	26.70	28.42
125	WASHINGTON STREET	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.24	13.55	14.91	16.44	17.11	19.57	18.90	19.65	21.09	22.89
126	SCONTICUT NECK ROAD	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
127	PLEASANT STREET	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.85	5.19	6.53	7.83	8.74	10.59	10.63	11.33	12.03	14.00
128	CENTER STREET	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.86	4.15	5.37	6.67	7.67	9.74	9.47	10.20	11.15	13.16
129	WILLIAM STREET	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.76	7.06	8.26	9.56	10.56	12.62	12.36	13.08	14.00	16.03
130	UNION WHARF	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.33	0.00	2.80	15.28	17.55	18.64	19.98	21.03	23.42	22.74	23.57	24.79	26.78
131	MAIN STREET	WOOD`S HOLE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.27	14.56	15.67	16.97	17.99	20.06	19.76	20.51	21.33	23.45
132	SOUTH STREET	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.44	11.74	12.98	14.28	15.18	17.26	16.97	17.68	18.41	20.55
133	ABBEY STREET	Fairhaven	3.26	4.23	5.23	7.56	8.16	8.93	9.86	11.93	12.50	13.66	14.35	16.75	18.04	19.27	20.11	21.95	21.88	22.65	23.38	25.13
134	MANHATTAN AVENUE	Fairhaven	0.00	0.36	1.22	3.52	4.19	4.89	5.70	7.89	8.71	9.79	10.48	12.49	13.53	14.72	15.60	17.39	17.08	17.91	18.89	20.58
135	BERNESE STREET	Fairhaven	0.00	0.48	1.43	3.72	4.38	5.08	5.88	8.08	8.73	9.98	10.68	12.59	13.49	14.68	15.69	17.58	17.09	18.08	18.99	20.78
136	DIAMOND STREET	Fairhaven	0.00	0.00	0.00	1.45	2.11	2.73	3.56	5.73	6.81	7.66	8.37	10.27	11.41	12.60	13.27	15.51	14.57	15.67	16.66	18.36
137	CAUSEWAY ROAD	Fairhaven	4.73	5.67	6.67	8.87	9.43	10.49	11.38	13.07	14.65	14.98	15.82	17.57	18.93	20.03	20.52	22.34	21.74	22.97	23.78	25.47
138	GOULART MEMORIAL DRIVE	Fairhaven	1.81	2.72	3.64	5.93	6.43	7.11	7.93	10.12	10.72	12.02	12.83	14.54	15.22	16.49	17.53	19.31	18.73	19.93	20.83	22.53
139	FIR STREET	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41
140	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
141	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
142	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
143	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
144	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
145	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
146	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
147	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
148	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
149	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
150	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
151	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
152	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
153	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
154	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
155	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
156	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
157	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
158	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
159	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
160	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
161	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
162	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
163	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
164	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
165	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
166	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
167	ARSENE WAY	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.10	1.65	2.87	3.69	5.29
168		Acushnet	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
169		Acushnet	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.96	2.91	3.78	5.21	6.35	7.44	8.09	9.11
170		Acushnet	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.81	8.52	10.66	11.19	11.86	13.26	13.89	15.07	15.76	16.92
171		Acushnet	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.98	18.55	20.77	21.40	22.09	23.58	24.31	25.49	26.16	27.21
172		Acushnet	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.11	12.70	15.21	16.14	16.94	18.40	19.70	20.84	21.49	22.21
173		Acushnet	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.17	1.87	1.88
174		Acushnet	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.20	1.90	1.92
175		Acushnet	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

State Owned Structures

Object ID	Structure Name	Municipality	Category 1				Category 2				Category 3				Category 4				Category 4 Extreme			
	Water Level Rise		0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft
1	FT12-Fire Sighting Tower	Acushnet	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	Telecommunication Building	Acushnet	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	West Island State Reservation	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	Pavilion	Fairhaven	0.00	0.07	0.88	2.25	2.91	4.32	4.59	6.78	7.27	8.56	8.97	11.42	12.32	14.42	14.62	16.47	16.22	17.12	17.82	19.52
5	Maintenance / Concession Stand	Fairhaven	0.97	2.83	3.97	5.27	5.79	7.27	7.45	9.66	10.25	11.29	11.67	14.38	15.20	17.38	17.58	19.20	19.17	20.07	20.78	22.48
6	Bathhouse	Fairhaven	0.97	2.83	3.97	5.27	5.79	7.27	7.45	9.66	10.25	11.29	11.67	14.38	15.20	17.38	17.58	19.20	19.17	20.07	20.78	22.48
7	Contact Station	Fairhaven	0.00	0.00	0.00	0.00	0.00	0.63	0.86	3.16	3.41	4.59	5.02	7.91	8.52	10.91	10.82	12.81	12.71	13.61	14.31	16.01
8	Skating Rink	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	Sign	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	Career Center (New Bedford)	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	LGR Region V (Brockton)	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	Shed	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.44	0.26	12.03	14.21	15.38	17.48	17.59	19.83	19.47	20.37	20.89	23.33
13	Salt/Sand Storage #6-285	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	Snow/Ice Trailer	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	Armory/Garage	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	Probate Court	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	West Purchase Street Bldg	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	East Purchase Street Bldg	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	Marine Science Lab (CMAST)	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	1.41	2.28	4.17	4.83	6.79	7.09	8.94	8.34	9.39	10.34	12.16
20	Pump House	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	Pier Building 1	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.01	12.38	13.47	15.67	15.78	17.97	17.56	18.46	18.98	21.47
22	Pier Building 2	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.45	13.75	14.84	17.04	17.15	19.37	18.96	19.86	20.36	22.86
23		New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.85	1.24	2.32	3.23	5.06
24	Basketball Court	Fairhaven	0.00	0.00	0.00	0.16	0.73	2.17	2.37	4.57	5.16	6.24	6.69	9.29	10.16	12.26	12.49	14.16	14.06	14.96	15.70	17.40
25	Tennis Court(s)	Fairhaven	0.00	0.00	0.00	0.34	0.91	2.36	2.57	4.77	5.28	6.40	6.91	9.51	10.32	12.51	12.71	14.32	14.22	15.12	15.91	17.62
26	Asphalt Paving	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	Asphalt Paving	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	Fence	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	Asphalt Paving	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	Jail	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31	Asphalt Paving	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.85	8.06	8.37	9.31	10.84	11.75	13.84	13.95	15.55	15.57	16.35	17.15	18.94
32	Asphalt Paving	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.58	8.70	9.17	9.97	11.48	12.46	14.48	14.59	16.19	16.16	17.06	17.79	19.58
33	Asphalt Paving	New Bedford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.52	0.00	2.28	14.55	16.82	17.98	20.18	20.31	22.72	22.51	23.14	23.67	26.19

Coastal Protection Structures

Municipality	Location	Primary Type	Property Type	Category 1				Category 2				Category 3				Category 4				Category 4 Extreme			
Water Level Rise				0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft
Fairhaven	Goulart Memorial Drive	Bulkhead/ Seawall	Public	5.88	6.81	7.76	10.03	10.52	11.74	12.59	14.21	15.37	16.11	16.93	18.66	19.89	21.08	21.63	23.92	22.83	24.04	24.91	26.61
Fairhaven	Goulart Memorial Drive	Bulkhead/ Seawall	Public	7.19	8.12	9.07	11.35	11.83	12.56	13.48	15.53	16.19	17.43	18.24	19.97	20.70	21.90	22.94	24.74	24.14	25.35	26.23	27.93
Fairhaven	Goulart Memorial Drive	Revetment	Public	3.30	4.20	5.11	7.41	7.91	9.00	9.41	11.61	12.60	13.50	14.30	16.01	16.71	18.00	19.01	20.81	20.21	21.41	22.31	24.01
Fairhaven	Goulart Memorial Drive	Revetment	Public	2.24	3.14	4.04	6.34	6.84	7.68	8.35	10.54	11.28	12.44	13.24	14.95	15.65	16.94	17.94	19.74	19.14	20.34	21.24	22.94
Fairhaven	Shore Drive	Groin/ Jetty	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fairhaven	Shore Drive	Revetment	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fairhaven	Little Bay/Nashetucket River	Groin/ Jetty	Public	7.57	8.57	9.48	11.39	12.20	13.02	13.74	16.00	16.79	17.81	18.52	20.50	21.60	22.77	23.62	25.66	24.96	25.91	26.97	28.58
New Bedford	Fort Rodman	Revetment	Public	0.00	0.00	0.00	0.00	0.00	0.04	0.00	2.83	3.54	3.88	4.68	6.38	6.98	9.03	9.48	12.34	10.68	11.68	12.58	14.58
New Bedford	West Rodney French Boulevard	Bulkhead/ Seawall	Public	1.50	1.19	2.19	5.82	6.24	5.63	6.42	10.00	9.35	11.73	12.61	14.88	14.33	15.30	17.60	18.02	18.95	19.96	20.88	22.62
New Bedford	South Pier	Bulkhead/ Seawall	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New Bedford	Fisherman's Wharf	Bulkhead/ Seawall	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.56	7.71	19.01	22.33	22.31	23.70	24.61	0.00	26.41	27.31	27.83	30.32
New Bedford	State Pier	Bulkhead/ Seawall	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.98	0.00	2.88	13.73	16.64	17.07	18.47	19.37	21.57	21.18	22.08	22.59	25.08
New Bedford	Coal Pocket Pier	Bulkhead/ Seawall	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.68	4.04	7.96	17.65	20.30	22.71	22.19	23.26	27.21	25.06	25.96	26.47	28.97
New Bedford	Homer's Wharf	Bulkhead/ Seawall	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New Bedford	Between Leonard's Wharf and Homer's Wharf	Bulkhead/ Seawall	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.61	1.44	5.27	14.98	17.41	22.70	24.10	20.63	27.20	22.43	23.33	23.83	26.32
New Bedford	Leonard's Wharf	Bulkhead/ Seawall	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New Bedford	North Terminal Bulkhead	Bulkhead/ Seawall	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New Bedford	North Terminal Bulkhead	Bulkhead/ Seawall	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.58	0.00	7.75	19.83	25.22	0.00	27.86	29.10	32.42	31.84	32.71	33.41	36.35
New Bedford	North Terminal Bulkhead	Bulkhead/ Seawall	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New Bedford	Gifford Street	Revetment	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.97	10.50	12.45	16.29	18.29	19.22	20.54	21.45	23.09	23.01	23.91	24.68	26.45
New Bedford	West Rodney French Boulevard	Bulkhead/ Seawall	Public	0.00	0.89	1.90	4.17	4.66	5.44	6.38	8.59	9.46	10.30	11.16	13.30	14.09	15.02	15.97	17.66	17.36	18.34	19.23	20.97
New Bedford	East Rodney French Boulevard	Groin/ Jetty	Public	8.04	9.02	9.98	12.42	12.91	13.52	14.40	16.62	16.89	18.40	19.00	21.03	21.83	22.98	24.01	25.49	25.27	26.34	27.24	29.04
New Bedford	West Rodney French Boulevard	Groin/ Jetty	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New Bedford	West Rodney French Boulevard	Groin/ Jetty	Public	5.43	7.71	8.71	9.86	10.37	12.27	13.25	14.34	15.58	16.05	16.90	18.99	21.02	21.86	21.67	23.35	23.07	24.04	24.92	26.67
New Bedford	West Rodney French Boulevard	Groin/ Jetty	Public	0.00	0.00	0.00	0.00	0.00	0.00	9.60	11.84	12.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New Bedford	East Rodney French Boulevard	Revetment	Public	4.25	5.52	6.44	8.65	9.15	10.12	10.94	12.96	14.09	14.66	15.21	17.40	18.26	19.78	20.53	22.43	21.93	22.86	23.76	25.53
New Bedford	East Rodney French Boulevard	Bulkhead/ Seawall	Public	2.17	3.17	0.49	6.57	7.07	7.75	8.57	10.85	11.37	12.57	13.10	15.25	16.02	17.25	18.33	20.01	19.69	20.65	21.55	23.34
New Bedford	West Rodney French Boulevard	Bulkhead/ Seawall	Public	7.05	8.17	8.53	11.45	11.93	12.05	12.99	15.19	16.46	17.56	18.42	20.61	21.23	21.68	23.25	24.30	24.63	25.62	26.51	28.26
New Bedford	West Rodney French Boulevard	Bulkhead/ Seawall	Public	1.52	2.65	3.65	5.92	6.41	7.18	8.12	10.33	11.22	12.05	12.91	15.07	15.90	16.78	17.72	19.42	19.11	20.09	20.98	22.72
New Bedford	West Rodney French Boulevard	Bulkhead/ Seawall	Public	5.77	6.98	7.98	10.23	10.76	11.57	12.60	14.80	15.76	16.48	17.33	19.30	20.17	21.12	22.05	23.72	23.47	24.43	25.30	27.05
New Bedford	West Rodney French Boulevard	Bulkhead/ Seawall	Public	0.86	1.78	2.86	5.16	5.56	6.19	6.91	9.20	9.81	10.98	11.88	14.00	14.59	15.70	16.77	19.76	18.07	19.09	20.05	21.84
New Bedford	East Rodney French Boulevard	Groin/ Jetty	Public	4.34	4.06	6.26	8.66	9.06	8.40	10.48	12.77	11.93	14.48	15.26	17.01	18.02	19.21	20.24	22.07	21.44	22.52	23.42	25.27
New Bedford	East Rodney French Boulevard	Groin/ Jetty	Public	3.63	4.84	5.57	7.98	8.43	9.03	9.39	12.13	12.87	13.88	14.57	16.44	17.31	18.50	19.53	20.88	20.75	21.83	22.73	24.57
New Bedford	West Rodney French Boulevard	Bulkhead/ Seawall	Public	6.03	7.03	8.45	10.34	10.74	11.44	12.17	14.45	14.59	16.16	17.06	19.19	19.80	20.97	21.97	23.80	23.27	24.28	25.24	27.03
New Bedford	West Rodney French Boulevard	Revetment	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New Bedford	East Rodney French Boulevard	Bulkhead/ Seawall	Public	1.94	3.13	3.89	6.29	6.74	7.54	8.18	10.44	11.14	12.18	12.89	14.76	15.69	16.84	17.86	19.69	19.08	20.16	21.06	22.89
New Bedford	East Rodney French Boulevard	Bulkhead/ Seawall	Public	0.00	0.13	1.06	3.61	4.03	4.49	5.49	7.58	8.00	9.45	10.21	12.00	12.92	14.04	15.24	16.90	16.44	17.53	18.43	20.25
New Bedford	West Rodney French Boulevard	Revetment	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New Bedford	Fort Rodman	Revetment	Public	4.68	5.68	6.58	8.98	9.38	9.98	10.78	13.08	13.49	14.78	15.59	17.29	17.89	19.28	20.39	22.29	21.59	22.59	23.49	25.49
New Bedford	Fort Rodman	Groin/ Jetty	Public	8.01	9.00	9.91	12.31	12.71	13.30	14.11	16.41	16.81	18.11	18.91	20.61	21.21	22.61	23.71	25.61	24.91	25.91	26.81	28.81
New Bedford	Merchant Mariner Memorial Walkway	Groin/ Jetty	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New Bedford	Fort Rodman	Groin/ Jetty	Public	6.14	7.48	8.04	10.44	10.84	11.44	12.24	14.54	15.29	16.24	17.04	18.75	20.13	21.46	21.89	23.78	23.10	24.12	25.02	26.98
New Bedford	West Rodney French Boulevard	Revetment	Public	0.37	1.37	1.97	4.68	5.07	5.77	6.48	8.38	8.88	10.48	11.37	13.44	13.98	15.21	16.22	18.09	17.50	18.52	19.49	21.30
Fairhaven	Fort Phoenix Beach	Coastal Beach	Public	3.87	4.79	5.98	8.17	8.74	9.74	10.34	12.55	13.32	14.24	14.73	17.30	18.21	19.70	20.49	22.21	22.10	22.99	23.70	25.41
Fairhaven	Fort Phoenix	Groin/ Jetty	Public	8.24	8.86	9.86	12.54	13.13	0.00	14.70	16.61	0.00	18.60	19.12	21.67	22.59	23.88	24.87	26.59	26.47	27.36	28.09	29.80
Fairhaven	Fort Phoenix Beach	Bulkhead/ Seawall	Public	0.63	1.25	2.37	4.93	5.49	6.31	7.11	8.99	9.61	11.01	11.47	14.07	14.68	16.09	17.27	18.68	18.87	19.77	20.47	22.17
Fairhaven	Steamship Authority Warehouses	Bulkhead/ Seawall	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.30	0.00	1.87	14.25	16.55	17.82	19.12	19.98	22.19	21.75	22.49	23.29	25.42
Fairhaven	Union Wharf	Bulkhead/ Seawall	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fairhaven	Main Street/Church Street	Bulkhead/ Seawall	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.20	0.00	2.80	15.16	17.46	18.57	19.86	20.87	22.78	22.67	23.37	23.99	26.18
Fairhaven	Pease Park	Bulkhead/ Seawall	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.48	0.92	6.23	18.88	21.17	20.80	22.33	24.76	25.93	26.46	27.33	29.17	30.88
Fairhaven	Route 6	Bulkhead/ Seawall	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.12	0.00	3.52	16.26	18.78	20.73	22.04	23.16	25.70	24.78	25.62	27.30	29.10
Fairhaven	Pilgrim Avenue	Bulkhead/ Seawall	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.14	0.54	4.79	17.49	21.99	26.50	27.45	28.42	29.96	29.52	30.18	30.61	32.99
Fairhaven	Hedge Street	Bulkhead/ Seawall	Public	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.07	5.50	19.08	24.62	27.01	28.14	29.14	30.76	30.55	31.19	31.61	34.75
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	2.41	3.08	4.01	6.64	6.98	7.70	8.60	10.71	11.28	12.48	13.31	15.07	15.65	16.56	17.98	19.81	19.18	20.25	21.25	22.98
FAIRHAVEN		Groin/Jetty	Private	5.90	6.94	7.86	10.12	10.47	11.19	12.09	14.24	14.77	15.97	16.80	18.56	19.19	20.42	21.47	23.34	22.67	23.74	24.74	26.47
FAIRHAVEN		Groin/Jetty	Private	5.91	6.99	7.93	10.14	10.47	11.20	12.10	14.30	14.77	15.97	16.80	18.56	19.23	0.00	21.47	23.39	22.67	23.74	24.73	26.47
FAIRHAVEN		Revetment	Private	0.00	0.49	1.44	3.74	4.06	5.07	5.70	7.80	8.63	9.56	10.40	12.15	12.72	13.96	15.06	16.90	16.26	17.32	18.31	20.06
FAIRHAVEN		Revetment	Private	0.55	1.31	2.27	4.80	5.10	5.57	6.48	8.79	9.13	10.59	11.45	13.19	13.52	14.77	16.09	17.89	17.29	18.34	19.34	21.10
FAIRHAVEN		Bulkhead/Seawall	Private	3.28	4.27	5.22	7.53	7.83	8.79	9.69	11.58	12.34	13.33	14.18	15.92	16.49	17.73	18.83	20.68	20.03	21.08	22.08	23.83
FAIRHAVEN		Revetment	Private	1.81	2.66	3.62	6.06	6.36	6.96	7.86	10.02	10.51	11.85	12.71	14.44	14.86	16.11	17.35	19.12	18.55	19.60	20.59	22.35
FAIRHAVEN		Revetment	Private	2.74	3.72	4.70	7.00	7.28	8.03	8.93	11.04	11.57	12.77	13.64	15.36	15.91	17.18	18.27	20.14	19.47	20.50	21.50	23.28

Coastal Protection Structures

Municipality	Location	Primary Type	Property Type	Category 1				Category 2				Category 3				Category 4				Category 4 Extreme			
	Water Level Rise			0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft
FAIRHAVEN		Revetment	Private	4.07	4.90	5.89	8.35	8.61	9.21	10.11	12.37	12.74	14.10	14.97	16.70	17.08	18.36	19.61	21.48	20.81	21.84	22.84	24.61
FAIRHAVEN		Bulkhead/Seawall	Private	0.60	1.36	2.35	4.87	5.13	5.68	6.79	8.90	10.14	10.63	11.50	13.22	14.59	15.76	16.14	18.83	17.34	18.37	19.37	21.15
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	5.75	0.00	0.00	10.02	10.28	0.00	0.00	14.05	14.70	15.78	16.65	18.38	0.00	20.32	21.30	23.17	22.50	23.53	24.52	26.30
FAIRHAVEN		Groin/Jetty	Private	5.96	6.94	7.92	10.23	10.49	11.25	12.15	14.26	14.79	15.98	16.86	18.58	19.14	20.42	21.50	23.38	22.70	23.73	24.73	26.50
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	5.64	0.00	0.00	9.92	10.17	0.00	11.84	13.94	14.47	15.67	16.54	18.27	18.81	0.00	21.18	23.06	22.38	23.41	24.41	26.19
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.56	2.52	2.79	3.55	4.45	6.90	7.43	8.29	9.15	10.88	11.79	13.07	13.80	16.02	15.00	16.04	17.04	18.81
FAIRHAVEN		Bulkhead/Seawall	Private	1.42	0.00	0.36	5.68	5.97	6.72	7.61	6.71	7.25	11.46	12.32	14.06	11.62	12.90	16.99	15.84	18.19	19.23	20.23	21.99
FAIRHAVEN		Bulkhead/Seawall	Private	1.21	2.16	3.15	5.46	5.78	8.33	7.41	9.51	10.07	11.27	12.11	13.87	14.47	15.76	16.82	18.66	18.02	19.07	20.07	21.82
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	7.18	7.67	8.66	11.42	11.75	12.45	13.37	15.02	15.59	17.24	18.08	19.84	19.99	21.28	22.79	24.18	23.99	25.05	26.05	27.80
FAIRHAVEN		Groin/Jetty	Private	7.04	7.99	8.97	11.28	11.60	12.34	13.23	15.34	15.90	17.10	17.94	19.70	20.30	21.59	22.65	24.49	23.85	24.90	25.90	27.66
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.05	2.57	6.65	19.01	21.31	22.42	23.72	24.73	26.66	26.52	27.23	27.89	30.06
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.28	2.78	6.82	19.23	21.51	22.61	23.93	24.96	27.14	26.71	27.49	28.45	30.52
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.85	16.34	18.61	20.85	22.19	22.10	24.54	23.80	24.65	25.92	27.89
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.84	3.24	7.29	19.82	22.08	23.16	24.45	25.57	28.09	27.26	28.13	29.50	31.44
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.42	1.86	5.80	18.44	20.68	21.75	23.12	24.19	26.95	25.85	26.77	28.39	30.27
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Revetment	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.31	0.00	5.38	17.95	20.25	22.81	24.14	23.85	0.00	25.58	26.40	28.12	29.84
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.56	0.00	2.26	14.86	17.14	19.02	20.36	20.72	24.07	22.42	23.28	25.00	26.76
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.00	0.97	13.61	15.87	17.33	18.36	19.43	22.47	21.11	22.01	23.72	25.51
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.83	1.22	6.23	18.79	21.06	22.18	23.53	24.59	27.18	26.28	27.15	28.69	30.55
FAIRHAVEN		Revetment	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.64	0.00	3.89	16.59	18.87	20.17	21.53	22.49	25.39	24.17	25.06	26.95	28.66
FAIRHAVEN		Revetment	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.22	0.63	4.57	17.31	19.63	20.45	22.32	23.39	26.19	25.04	25.95	27.79	29.55
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.59	19.31	21.60	0.00	0.00	25.26	0.00	26.91	27.83	29.70	31.44
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.30	1.74	5.70	18.45	20.83	22.39	23.74	24.83	27.61	26.44	27.36	29.11	30.95
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.22	2.62	6.59	19.34	21.78	20.28	24.84	25.92	28.64	27.53	28.44	30.14	31.99
NEW BED-FORD		Revetment	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.13	1.51	5.32	18.01	20.57	20.97	22.35	24.20	27.23	25.95	26.93	28.67	30.59
NEW BED-FORD		Revetment	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.78	1.45	5.75	18.18	21.58	21.78	22.73	25.19	28.26	27.29	28.24	29.52	31.76
NEW BED-FORD		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NEW BED-FORD		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.11	0.53	3.74	15.71	19.78	21.29	22.65	22.40	26.36	24.52	25.43	26.12	28.65
NEW BED-FORD		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.64	0.00	2.53	14.36	18.22	18.33	19.70	20.69	23.77	22.70	23.60	24.23	26.75
NEW BED-FORD		Revetment	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.96	2.92	6.88	18.63	22.57	22.51	23.89	24.87	27.77	26.85	27.76	28.36	30.89
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.50	6.76	8.55	12.86	15.35	16.83	17.91	18.61	20.68	20.28	21.12	21.79	23.66
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Revetment	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.58	9.10	12.06	17.80	20.26	22.00	23.30	23.55	25.34	25.24	26.05	26.71	28.64
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.23	6.57	12.00	19.03	21.45	19.78	21.07	24.77	23.89	26.48	27.27	27.92	29.90
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.86	9.43	9.25	15.57	18.02	21.80	23.09	21.32	25.90	23.02	23.82	24.48	26.42
FAIRHAVEN		Revetment	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.67	4.72	7.72	15.69	18.09	19.16	20.38	21.42	23.29	23.15	23.92	24.57	26.58
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.78	4.27	8.80	18.32	20.68	20.57	21.87	24.04	24.72	25.79	26.54	27.17	29.25
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.46	0.00	0.00	0.00	0.00	22.51	23.81	0.00	26.65	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.26	0.93	4.75	16.02	18.34	19.66	20.85	21.73	23.84	23.51	24.23	24.84	26.99
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.38	1.04	3.91	15.83	18.14	20.35	21.65	21.54	25.56	23.33	24.04	24.65	26.83
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.73	1.56	5.42	16.84	19.16	21.12	22.22	22.55	25.30	24.34	25.05	25.67	27.82
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.75	2.41	6.33	18.29	20.60	21.74	23.04	24.00	25.94	25.79	26.50	27.11	29.29
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.40	1.51	5.04	17.03	19.34	20.57	21.86	22.74	24.60	24.53	25.24	25.85	28.03
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.90	0.00	4.08	16.18	18.49	19.03	20.40	21.89	23.23	23.68	24.39	25.00	27.18
FAIRHAVEN		Revetment	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.55	0.00	3.16	15.46	17.76	18.86	20.16	21.16	23.07	22.96	23.66	24.27	26.46
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.07	0.22	4.31	16.66	18.96	19.62	20.91	22.36	23.60	24.16	24.86	25.47	27.66
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.21	0.00	6.81	19.17	21.47	0.00	0.00	24.87	26.77	26.67	27.37	27.98	30.17
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	6.53	7.48	8.47	10.78	11.09	12.28	12.72	14.83	15.84	16.58	17.43	19.18	19.77	21.06	22.12	23.97	23.32	24.37	25.37	27.13
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Coastal Protection Structures

Municipality	Location	Primary Type	Property Type	Category 1				Category 2				Category 3				Category 4				Category 4 Extreme			
Water Level Rise				0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft
FAIRHAVEN		Groin/Jetty	Private	5.81	6.78	7.76	10.07	10.36	11.11	12.00	14.11	14.65	15.85	16.71	18.45	19.02	20.30	21.38	23.24	22.58	23.62	24.62	26.39
FAIRHAVEN		Revetment	Private	3.67	4.37	5.36	7.91	8.25	9.15	10.05	11.98	12.31	13.74	14.58	16.34	16.58	18.02	19.30	20.90	20.50	21.57	22.57	24.31
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	4.86	5.77	6.76	9.07	9.46	10.16	11.05	13.16	13.13	14.95	15.76	17.55	17.83	19.54	20.55	21.74	21.75	22.84	23.84	25.56
FAIRHAVEN		Bulkhead/Seawall	Private	3.10	4.01	5.00	7.31	7.70	8.40	9.29	11.41	11.99	13.19	14.00	15.79	16.48	17.78	18.79	20.60	19.99	21.08	22.08	23.80
FAIRHAVEN		Bulkhead/Seawall	Private	5.02	5.92	6.92	9.23	9.62	10.32	11.21	13.32	13.91	15.11	15.92	17.71	18.40	19.70	20.71	22.52	21.91	23.00	24.00	25.72
FAIRHAVEN		Bulkhead/Seawall	Private	3.61	4.52	5.52	7.82	8.21	8.91	9.81	11.92	12.51	13.71	14.52	16.31	17.00	18.30	19.31	21.12	20.51	21.61	22.61	24.32
FAIRHAVEN		Bulkhead/Seawall	Private	3.73	4.97	5.97	7.93	8.33	9.37	9.92	12.03	12.97	13.82	14.63	16.42	17.12	18.41	19.42	21.57	20.62	21.72	22.72	24.43
FAIRHAVEN		Bulkhead/Seawall	Private	3.82	4.73	5.73	8.03	8.43	9.17	10.02	12.13	12.72	13.92	14.73	16.52	17.22	18.52	19.52	21.33	20.72	21.82	22.82	24.53
FAIRHAVEN		Bulkhead/Seawall	Private	4.34	5.18	6.11	8.55	8.95	9.65	10.47	12.51	13.10	14.44	15.25	17.04	17.60	18.89	20.04	21.71	21.24	22.34	23.34	25.05
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.86	3.00	3.47	4.09	4.91	7.42	6.60	8.89	9.70	11.49	12.26	13.49	14.57	16.38	15.77	16.86	17.86	19.65
FAIRHAVEN		Revetment	Private	0.00	0.00	0.26	2.65	3.12	3.74	8.63	10.91	6.07	8.54	9.34	11.14	10.65	11.87	14.22	16.03	15.42	16.51	17.51	19.31
FAIRHAVEN		Groin/Jetty	Private	8.28	7.82	9.32	12.58	13.05	13.67	14.31	16.59	15.82	18.47	19.27	21.07	21.67	22.89	24.15	25.79	25.35	26.44	27.44	29.24
NEW BED-FORD		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.78	0.00	0.00	0.00	0.00
NEW BED-FORD		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.38	0.00	3.32	14.90	18.82	18.58	19.96	20.92	23.30	22.85	23.75	24.32	26.84
NEW BED-FORD		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NEW BED-FORD		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.75	0.72	4.60	14.68	17.02	18.49	19.62	20.35	22.67	22.12	23.02	23.56	25.96
NEW BED-FORD		Revetment	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.39	1.09	5.46	16.02	18.31	19.37	21.64	21.68	23.63	23.39	24.29	24.90	27.08
NEW BED-FORD		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.22	0.00	4.33	14.86	17.12	18.19	19.06	20.49	22.36	22.17	23.07	23.71	25.79
NEW BED-FORD		Revetment	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.98	0.30	5.08	16.33	18.61	19.63	21.02	21.93	23.58	23.54	24.44	25.14	26.99
NEW BED-FORD		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.76	0.00	3.92	13.97	16.23	17.26	18.64	19.51	21.23	21.10	22.00	22.72	24.51
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	8.45	9.35	10.33	12.62	13.30	13.13	0.00	0.00	16.83	18.90	19.60	21.51	21.95	0.00	24.61	0.00	26.01	27.01	27.91	29.71
FAIRHAVEN		Bulkhead/Seawall	Private	4.81	7.50	8.47	8.96	9.65	10.34	11.15	13.35	15.84	15.25	15.95	17.85	18.75	19.95	20.95	22.85	22.35	23.35	24.25	26.05
FAIRHAVEN		Revetment	Private	3.14	4.03	4.99	7.26	7.94	8.63	9.44	11.64	12.34	13.54	14.24	16.14	17.04	18.45	19.24	21.14	20.64	21.64	22.54	24.34
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Revetment	Private	2.99	3.87	4.83	7.10	7.77	8.43	9.49	11.69	12.13	13.36	14.06	15.97	17.10	18.24	19.07	21.19	20.48	21.47	22.37	24.17
FAIRHAVEN		Groin/Jetty	Private	8.10	8.84	9.80	12.21	12.88	13.58	14.38	16.58	17.13	18.48	19.18	21.09	21.99	23.18	24.19	26.08	25.60	26.58	27.49	29.28
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	11.90	0.00	0.00	16.10	0.00	0.00	0.00	0.00	21.51	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	7.75	8.63	9.59	11.83	12.49	13.19	13.99	16.19	16.89	18.09	18.79	20.70	21.59	22.79	23.80	25.69	25.20	26.19	27.10	28.89
FAIRHAVEN		Bulkhead/Seawall	Private	8.86	9.19	10.69	12.92	13.58	14.27	15.07	16.73	17.97	19.18	19.87	21.78	22.68	23.88	24.88	26.23	26.29	27.28	28.18	29.98
FAIRHAVEN		Groin/Jetty	Private	6.94	7.81	8.76	10.99	11.64	12.33	13.14	15.34	16.04	17.24	17.94	19.85	0.00	21.94	22.95	24.84	24.35	25.34	26.25	28.04
FAIRHAVEN		Bulkhead/Seawall	Private	5.79	6.66	7.61	9.83	10.47	11.17	11.97	14.17	14.82	16.07	16.77	18.68	19.58	20.77	21.78	23.67	23.19	24.17	25.08	26.87
FAIRHAVEN		Groin/Jetty	Private	7.75	8.02	9.56	11.77	12.42	13.43	14.24	15.84	16.82	18.02	18.72	20.63	21.84	23.04	23.73	25.94	25.13	26.12	27.03	28.82
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Revetment	Private	3.54	4.41	5.53	7.56	8.20	9.07	9.70	11.90	12.77	13.80	14.50	16.41	17.31	18.68	19.51	21.40	20.92	21.90	22.81	24.60
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Revetment	Private	3.38	4.79	5.77	7.34	8.02	9.31	9.51	12.32	13.02	13.62	14.32	16.28	17.78	18.37	19.38	21.83	20.83	21.72	22.68	24.42
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	8.12	8.98	9.60	12.12	12.77	13.14	13.94	16.47	16.84	18.37	19.07	20.98	21.88	22.75	24.08	25.97	25.50	26.47	27.39	29.17
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Coastal Protection Structures

Municipality	Location	Primary Type	Property Type	Category 1				Category 2				Category 3				Category 4				Category 4 Extreme			
Water Level Rise				0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Revetment	Private	4.08	4.95	5.91	8.13	8.80	9.34	10.32	12.50	13.20	14.41	15.11	17.10	17.90	19.20	20.21	21.90	21.70	22.51	23.51	25.21
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	13.70	14.50	16.70	17.40	0.00	0.00	0.00	22.20	23.40	0.00	26.20	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	5.71	6.62	8.31	9.93	10.60	11.30	12.80	14.31	15.69	16.20	16.90	18.90	20.50	21.70	22.01	24.50	23.50	24.31	25.31	27.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Revetment	Private	1.77	2.70	3.70	6.05	6.73	7.64	8.28	10.49	11.31	12.32	12.94	15.04	16.18	17.18	18.17	20.15	19.66	20.53	21.45	23.13
FAIRHAVEN		Bulkhead/Seawall	Private	3.47	4.40	5.39	7.75	8.43	10.49	11.34	12.14	12.80	14.01	14.63	16.75	17.70	18.90	19.89	21.66	21.39	22.25	23.16	24.83
FAIRHAVEN		Groin/Jetty	Private	7.70	8.62	9.62	11.98	12.66	13.38	14.24	16.53	17.03	18.24	18.83	20.99	21.88	23.08	24.14	25.91	25.67	26.53	27.42	29.08
FAIRHAVEN		Groin/Jetty	Private	8.37	9.30	10.30	12.68	13.36	13.92	14.80	17.08	17.56	18.92	19.47	21.70	22.70	23.91	24.86	26.64	26.44	27.28	28.15	29.80
FAIRHAVEN		Revetment	Private	2.70	3.16	4.84	7.00	7.71	8.40	10.07	11.63	12.00	13.20	13.71	16.11	17.21	18.40	19.31	21.11	21.01	21.81	22.61	24.22
FAIRHAVEN		Revetment	Private	2.65	3.57	4.56	6.96	7.63	8.34	9.24	11.35	11.94	13.14	13.65	16.06	17.15	18.35	19.26	21.06	20.95	21.76	22.55	24.18
FAIRHAVEN		Bulkhead/Seawall	Private	4.12	6.08	7.02	8.13	8.77	10.56	11.36	13.57	14.26	14.37	15.07	16.98	18.97	20.17	20.08	23.07	21.49	22.47	23.38	25.17
FAIRHAVEN		Revetment	Private	2.26	3.13	4.07	6.27	6.91	7.81	8.41	10.61	11.52	12.51	13.21	15.13	16.02	17.43	18.22	20.11	19.63	20.61	21.53	23.31
FAIRHAVEN		Revetment	Private	4.22	5.08	6.02	8.20	8.87	9.56	10.36	12.57	13.68	14.47	15.17	17.11	18.01	19.20	20.21	22.07	21.64	22.57	23.51	25.27
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	2.11	2.48	3.46	6.40	6.91	6.98	7.78	10.38	10.64	12.51	13.23	15.11	15.31	16.55	18.19	20.01	19.46	20.51	21.51	23.29
FAIRHAVEN		Bulkhead/Seawall	Private	1.27	2.27	3.64	5.57	6.08	6.75	7.56	9.85	10.43	11.68	12.40	14.28	15.08	16.33	17.36	19.18	18.64	19.68	20.68	22.46
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	8.58	9.57	0.00	12.87	13.38	0.00	14.95	17.24	17.71	18.99	19.70	21.59	22.39	23.66	24.67	26.49	25.96	26.99	27.99	29.77
FAIRHAVEN		Bulkhead/Seawall	Private	5.38	6.21	7.58	9.67	10.18	10.86	11.89	14.19	14.37	15.79	16.50	18.39	18.69	19.95	21.47	23.29	22.75	23.79	24.79	26.57
FAIRHAVEN		Bulkhead/Seawall	Private	6.64	7.63	8.62	10.93	11.44	12.13	12.93	15.23	15.79	17.06	17.77	19.66	20.46	21.73	22.74	24.57	24.04	25.07	26.06	27.84
FAIRHAVEN		Bulkhead/Seawall	Private	6.11	8.23	9.37	10.41	10.92	11.60	12.41	14.70	16.54	16.54	17.25	19.14	19.95	21.21	22.22	24.05	23.52	24.55	25.54	27.32
FAIRHAVEN		Revetment	Private	4.06	5.06	6.05	8.36	8.88	9.57	10.38	12.67	13.24	14.51	15.21	17.11	17.91	19.18	20.19	22.01	21.49	22.51	23.51	25.29
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	1.80	2.47	3.46	6.08	6.74	7.16	7.96	10.20	10.83	12.34	13.03	14.95	15.52	16.75	18.04	19.62	19.41	20.41	21.35	23.13
FAIRHAVEN		Revetment	Private	4.44	5.37	6.37	8.71	9.40	10.10	10.90	13.13	13.78	15.00	15.69	17.60	18.48	19.69	20.70	22.58	22.09	23.09	24.00	25.79
FAIRHAVEN		Bulkhead/Seawall	Private	0.44	1.60	2.37	4.70	5.40	6.10	6.90	9.12	9.78	11.00	11.69	13.60	14.48	15.69	16.70	18.58	18.08	19.09	20.00	21.78
FAIRHAVEN		Groin/Jetty	Private	6.21	8.34	9.33	10.47	11.17	13.06	13.87	16.09	16.75	16.77	17.46	19.37	21.44	22.66	22.46	25.54	23.85	24.86	25.77	27.55
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	6.08	6.99	7.39	10.31	11.00	11.11	11.92	14.71	14.81	16.61	17.30	19.21	19.51	20.71	22.31	24.20	23.70	24.70	25.61	27.40
FAIRHAVEN		Bulkhead/Seawall	Private	4.80	0.00	0.00	9.02	9.72	10.41	11.22	13.42	0.00	15.32	16.02	17.92	18.82	20.01	21.02	22.92	22.42	23.42	24.32	26.12
NEW BEDFORD		Bulkhead/Seawall	Private	4.49	5.49	4.89	8.80	9.30	10.00	10.81	11.50	13.91	14.90	15.80	18.58	19.88	19.90	20.90	22.50	22.28	23.20	24.10	25.80
NEW BEDFORD		Revetment	Private	0.00	0.51	1.91	4.35	4.85	5.50	6.82	8.60	8.16	10.34	10.91	13.00	14.25	15.42	15.95	17.72	17.22	18.27	19.17	20.97
NEW BEDFORD		Revetment	Private	1.21	2.26	3.17	5.61	6.11	6.86	7.73	9.73	10.57	11.61	12.13	14.32	15.00	16.50	17.44	18.90	18.83	19.77	20.67	22.45
NEW BEDFORD		Bulkhead/Seawall	Private	3.71	3.96	5.62	8.11	8.61	9.31	10.12	12.41	12.27	14.12	14.63	16.82	17.70	18.97	19.98	21.60	21.37	22.29	23.19	24.98
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.71	3.37	7.36	19.27	21.58	22.68	23.97	24.98	26.87	26.77	27.48	28.09	30.26
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NEW BEDFORD		Revetment	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.12	0.00	0.00	0.00	23.56	24.93	0.00	28.50	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	4.33	5.26	6.25	8.62	9.30	10.01	11.43	13.02	14.22	14.87	15.46	17.63	18.61	19.81	20.78	22.55	22.32	23.17	24.06	25.72
FAIRHAVEN		Bulkhead/Seawall	Private	4.73	5.84	6.65	9.01	9.69	10.40	11.26	13.40	14.24	15.26	15.85	18.02	19.18	20.38	21.17	22.94	22.70	23.55	24.44	26.11
FAIRHAVEN		Revetment	Private	4.87	5.74	6.74	9.14	9.83	10.49	10.71	13.50	13.51	15.40	16.01	18.15	19.07	20.27	21.30	23.07	22.82	23.67	24.57	26.24
FAIRHAVEN		Bulkhead/Seawall	Private	1.79	2.71	3.71	6.06	6.75	7.13	7.99	10.46	10.79	12.33	12.93	15.07	16.03	17.23	18.21	19.98	19.73	20.59	21.49	23.16
FAIRHAVEN		Bulkhead/Seawall	Private	4.28	6.21	6.20	8.55	9.23	8.71	9.56	12.95	13.09	14.82	15.44	17.55	19.50	20.71	20.68	22.45	22.18	23.04	23.96	25.63
FAIRHAVEN		Bulkhead/Seawall	Private	2.72	3.65	4.65	6.98	7.66	8.60	9.43	11.60	12.27	13.26	13.90	15.97	16.90	18.10	19.10	20.87	20.57	21.44	22.38	24.06
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	5.36	6.20	7.14	9.31	10.01	10.70	10.32	13.70	14.40	15.61	16.31	18.29	18.02	19.21	21.39	22.03	22.87	23.71	24.70	26.40
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Coastal Protection Structures

Municipality	Location	Primary Type	Property Type	Category 1				Category 2				Category 3				Category 4				Category 4 Extreme			
Water Level Rise				0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft
FAIRHAVEN		Bulkhead/Seawall	Private	2.66	3.48	4.24	6.62	7.30	7.99	8.59	11.00	11.49	12.90	13.60	15.55	16.45	17.44	18.65	20.50	20.10	21.00	21.96	23.70
FAIRHAVEN		Bulkhead/Seawall	Private	3.41	4.03	4.83	7.38	8.05	9.07	9.18	12.08	12.22	13.65	14.35	16.30	16.97	18.02	19.40	21.58	20.85	21.75	22.71	24.45
FAIRHAVEN		Bulkhead/Seawall	Private	2.77	3.67	4.66	7.03	7.73	8.42	9.16	11.45	12.07	13.32	14.01	15.93	16.80	18.02	19.02	20.84	20.41	21.41	22.33	24.11
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	7.21	0.00	0.00	11.11	11.81	0.00	13.21	15.51	0.00	17.41	18.11	20.11	0.00	0.00	23.11	0.00	24.51	25.51	26.51	28.21
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	6.15	7.04	7.97	10.07	10.77	10.92	12.17	13.93	14.71	16.34	17.06	19.03	19.91	20.51	22.04	23.42	23.41	24.44	25.41	27.11
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	4.74	5.64	6.74	8.69	9.39	10.04	10.79	13.05	13.82	14.94	15.67	17.63	18.48	19.62	20.63	22.53	21.98	23.03	23.99	25.69
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Revetment	Private	2.57	3.57	4.57	6.54	7.24	8.00	8.77	10.98	11.78	12.76	13.53	15.45	16.41	17.58	18.46	20.45	19.79	20.86	21.79	23.49
FAIRHAVEN		Revetment	Private	4.00	4.71	5.88	7.98	8.68	9.10	10.08	12.30	12.89	14.19	14.96	16.88	17.51	18.68	19.88	21.59	21.20	22.28	23.21	24.91
FAIRHAVEN		Revetment	Private	3.41	4.31	5.30	7.41	8.10	8.71	9.43	11.72	12.38	13.59	14.36	16.26	17.07	18.26	19.27	21.16	20.57	21.67	22.60	24.30
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	8.21	9.11	9.22	12.23	12.91	12.62	14.34	16.53	17.29	18.43	19.21	21.08	21.88	23.08	24.09	25.09	25.38	26.49	27.41	29.11
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	4.07	4.73	5.73	8.09	8.76	9.34	10.18	12.15	12.91	14.29	15.07	16.93	17.49	18.69	19.95	21.59	21.23	22.35	23.27	24.97
FAIRHAVEN		Bulkhead/Seawall	Private	3.30	4.28	5.28	7.34	8.00	8.68	9.52	11.64	12.47	13.53	14.31	16.17	16.97	18.18	19.18	21.14	20.46	21.58	22.51	24.21
FAIRHAVEN		Bulkhead/Seawall	Private	3.34	4.47	5.47	7.37	8.03	8.87	9.71	11.67	12.66	13.57	14.34	16.20	17.00	18.44	19.21	21.32	20.49	21.61	22.54	24.24
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	5.09	5.51	6.51	9.15	9.79	9.91	10.80	13.45	13.71	15.35	16.15	17.94	18.26	19.48	20.96	22.30	22.21	23.36	24.26	25.96
FAIRHAVEN		Groin/Jetty	Private	5.27	6.17	7.16	9.38	9.96	10.57	11.46	13.66	14.90	15.56	16.36	18.06	18.85	20.14	21.14	22.94	22.34	23.54	24.44	26.14
FAIRHAVEN		Groin/Jetty	Private	6.93	7.83	8.81	11.04	11.61	12.25	13.13	15.31	15.98	17.20	18.00	19.71	20.48	21.77	22.78	24.58	23.98	25.18	26.08	27.78
FAIRHAVEN		Groin/Jetty	Private	6.67	7.51	8.49	10.78	11.35	11.97	12.85	14.98	15.72	16.94	17.74	19.45	20.22	21.45	22.52	24.32	23.72	24.92	25.82	27.52
FAIRHAVEN		Bulkhead/Seawall	Private	4.08	4.99	5.95	8.25	8.68	9.41	10.25	12.39	13.02	14.23	15.03	16.79	17.49	19.29	19.79	21.59	20.99	22.12	23.09	24.79
FAIRHAVEN		Bulkhead/Seawall	Private	5.31	5.99	6.99	9.62	10.29	11.00	11.89	13.79	14.38	15.80	16.30	18.71	19.79	21.00	21.92	23.71	23.60	24.42	25.21	26.83
FAIRHAVEN		Revetment	Private	6.45	7.36	8.35	10.76	11.43	12.68	13.45	15.22	16.28	16.94	17.44	19.85	21.47	22.68	23.06	25.39	24.74	25.56	26.35	27.97
FAIRHAVEN		Revetment	Private	2.68	3.58	4.58	6.98	7.66	8.41	9.30	11.37	12.01	13.17	13.68	16.08	17.21	18.42	19.29	21.12	20.98	21.79	22.58	24.20
FAIRHAVEN		Bulkhead/Seawall	Private	4.11	4.50	5.49	8.42	9.08	9.65	10.68	12.29	13.26	14.59	15.08	17.50	18.56	19.78	20.71	22.49	22.38	23.20	23.99	25.63
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Revetment	Private	0.00	0.00	0.00	1.14	1.67	2.51	3.32	5.51	6.04	7.21	7.69	10.29	11.19	12.48	13.49	15.14	15.09	15.99	16.69	18.39
NEW BED-FORD		Revetment	Private	3.63	4.65	5.56	8.03	8.53	9.23	10.04	12.35	12.95	14.04	14.55	16.75	17.64	18.92	19.91	21.55	21.30	22.22	23.12	24.91
NEW BED-FORD		Revetment	Private	0.10	1.57	2.48	4.50	5.00	5.69	6.51	8.80	10.81	10.50	11.01	13.20	15.48	16.75	16.34	18.45	17.73	18.66	19.56	21.34
NEW BED-FORD		Groin/Jetty	Private	7.74	8.69	0.00	12.07	12.60	13.31	14.21	16.43	17.01	18.12	18.77	21.07	21.93	23.21	24.15	0.00	25.69	26.60	27.43	29.15
NEW BED-FORD		Groin/Jetty	Private	6.94	8.01	8.99	11.28	11.81	12.52	13.41	15.64	16.34	17.32	17.97	20.27	21.25	22.53	23.35	25.15	24.88	25.80	26.63	28.35
NEW BED-FORD		Groin/Jetty	Private	7.91	8.50	9.45	12.31	12.80	13.46	13.64	16.75	17.34	18.30	18.86	20.96	21.34	22.51	23.93	25.88	25.21	26.25	27.15	28.94
NEW BED-FORD		Bulkhead/Seawall	Private	2.22	2.43	3.40	6.60	7.08	8.32	9.18	10.81	11.38	12.57	13.18	15.19	16.63	17.78	18.18	19.99	19.43	20.51	21.41	23.21
NEW BED-FORD		Bulkhead/Seawall	Private	4.84	4.68	7.67	9.22	9.70	10.33	10.03	14.30	14.87	15.18	15.80	17.81	18.84	20.67	20.80	23.48	22.04	23.12	24.02	25.83
NEW BED-FORD		Groin/Jetty	Private	3.90	4.94	5.91	8.28	8.76	9.44	9.98	12.48	13.05	14.24	14.86	16.86	17.75	18.90	19.86	21.67	21.10	22.18	23.08	24.89
NEW BED-FORD		Revetment	Private	1.79	3.99	4.96	6.17	6.65	8.48	8.73	10.92	11.48	12.13	12.76	14.74	16.80	17.94	17.74	20.11	18.98	20.06	20.96	22.77
NEW BED-FORD		Groin/Jetty	Private	5.08	5.00	5.97	9.46	9.94	9.48	10.53	13.44	14.00	15.42	16.05	18.03	17.80	19.81	21.03	22.64	22.27	23.36	24.26	26.06
NEW BED-FORD		Groin/Jetty	Private	3.85	4.84	5.82	8.23	8.70	0.00	10.18	12.41	12.84	14.18	14.82	16.78	17.64	18.77	19.78	21.61	21.01	22.10	23.01	24.81
NEW BED-FORD		Groin/Jetty	Private	7.00	8.00	8.96	11.37	11.82	12.59	13.29	15.53	16.06	17.29	17.96	19.87	20.76	21.91	22.93	24.76	24.15	25.24	26.14	27.96
NEW BED-FORD		Revetment	Private	2.33	3.32	4.14	6.69	7.15	7.77	8.62	10.87	11.25	12.62	13.28	15.21	16.11	17.10	18.25	20.14	19.48	20.57	21.47	23.28
NEW BED-FORD		Bulkhead/Seawall	Private	0.24	1.26	2.23	4.61	5.08	5.70	6.56	8.80	9.39	10.56	11.20	13.17	14.04	15.17	16.17	17.99	17.40	18.49	19.39	21.20

Coastal Protection Structures

Municipality	Location	Primary Type	Property Type	Category 1				Category 2				Category 3				Category 4				Category 4 Extreme			
Water Level Rise				0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft
NEW BEDFORD		Bulkhead/Seawall	Private	0.33	1.32	2.28	4.69	5.14	5.75	6.59	8.85	9.36	10.60	11.28	13.18	14.11	15.25	16.26	18.08	17.47	18.56	19.46	21.28
NEW BEDFORD		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NEW BEDFORD		Groin/Jetty	Private	6.65	8.12	8.94	10.96	11.37	12.09	12.78	15.07	15.87	16.78	17.57	19.32	20.69	21.88	22.54	24.85	23.75	24.82	25.72	27.58
NEW BEDFORD		Revetment	Private	0.81	1.80	2.74	5.12	5.50	6.11	6.90	9.20	9.62	10.90	11.72	13.41	14.07	15.43	16.52	18.41	17.72	18.73	19.64	21.61
NEW BEDFORD		Revetment	Private	3.50	4.44	5.07	7.80	8.14	8.81	9.54	11.84	11.91	13.54	14.41	16.10	16.53	17.78	19.19	20.73	20.40	21.43	22.39	24.27
NEW BEDFORD		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NEW BEDFORD		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NEW BEDFORD		Revetment	Private	3.55	4.56	5.56	7.86	8.36	9.07	8.66	12.17	11.76	13.96	14.88	17.64	18.93	18.97	19.97	21.57	21.37	22.27	23.17	24.87
NEW BEDFORD		Bulkhead/Seawall	Private	6.21	6.67	8.22	10.52	11.02	11.72	13.41	14.82	15.96	16.62	17.53	20.31	21.60	21.62	22.62	24.22	24.02	24.92	25.82	27.52
NEW BEDFORD		Revetment	Private	3.19	4.27	5.19	7.49	7.99	8.69	9.58	11.80	12.60	13.59	14.50	17.28	18.58	18.59	19.59	21.20	20.99	21.90	22.79	24.50
NEW BEDFORD		Bulkhead/Seawall	Private	1.71	2.71	3.72	6.02	6.52	7.22	7.53	10.32	10.63	12.12	13.02	15.81	17.10	17.12	18.12	19.72	19.52	20.42	21.32	23.02
NEW BEDFORD		Revetment	Private	1.33	2.96	3.46	5.63	6.13	7.86	7.77	9.94	10.74	11.73	12.64	15.42	16.72	16.73	17.74	19.47	19.13	20.04	20.94	22.64
NEW BEDFORD		Bulkhead/Seawall	Private	3.55	4.55	5.55	7.85	8.36	9.06	9.86	12.16	12.96	13.96	14.86	17.65	18.94	18.95	19.96	21.56	21.36	22.26	23.16	24.86
NEW BEDFORD		Revetment	Private	1.62	2.62	3.62	5.92	6.42	7.12	7.92	10.22	11.02	12.02	12.92	15.71	17.01	17.02	18.02	19.62	19.42	20.32	21.22	22.92
NEW BEDFORD		Bulkhead/Seawall	Private	5.90	8.05	9.05	10.20	10.70	12.55	12.20	15.66	15.30	16.30	17.20	19.99	21.29	22.45	22.30	23.90	23.70	24.60	25.50	27.20
NEW BEDFORD		Bulkhead/Seawall	Private	2.42	3.42	4.15	6.72	7.22	7.65	8.46	11.03	11.83	12.82	13.73	16.51	17.81	17.82	18.82	20.16	20.22	21.13	22.02	23.73
NEW BEDFORD		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NEW BEDFORD		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NEW BEDFORD		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NEW BEDFORD		Groin/Jetty	Private	7.28	8.03	9.34	11.58	12.08	12.53	13.34	16.09	16.44	17.69	18.59	21.37	22.42	22.43	23.68	25.29	25.08	25.99	26.88	28.59
NEW BEDFORD		Bulkhead/Seawall	Private	2.53	3.53	4.53	6.83	7.34	8.04	8.84	10.36	11.94	12.94	13.84	16.62	17.92	17.93	18.94	20.54	20.33	21.24	22.14	23.84
NEW BEDFORD		Bulkhead/Seawall	Private	2.12	3.12	4.13	6.43	6.93	7.63	8.44	10.73	11.54	12.53	13.43	16.21	17.51	17.53	18.53	20.13	19.92	20.83	21.73	23.43
NEW BEDFORD		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NEW BEDFORD		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NEW BEDFORD		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NEW BEDFORD		Bulkhead/Seawall	Private	1.03	2.03	3.04	5.34	5.84	6.54	7.35	9.65	10.10	11.44	12.34	15.12	16.06	16.44	17.44	19.04	18.82	19.74	20.64	22.34
NEW BEDFORD		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NEW BEDFORD		Revetment	Private	2.02	2.78	4.02	6.32	6.83	7.29	8.09	10.63	11.19	12.43	13.33	16.09	17.39	17.42	18.41	20.02	19.78	20.72	21.62	23.32
FAIRHAVEN		Revetment	Private	5.64	6.45	7.36	9.46	10.30	10.90	11.70	13.95	14.70	15.90	16.60	18.55	19.50	20.64	21.66	23.59	23.09	24.00	25.05	26.69
FAIRHAVEN		Groin/Jetty	Private	7.44	8.28	9.19	11.30	12.00	12.67	13.44	15.70	15.75	17.60	18.30	20.27	21.17	22.33	23.34	24.56	24.74	25.70	26.70	28.40
FAIRHAVEN		Revetment	Private	5.91	6.75	7.76	9.76	10.47	11.24	12.08	14.34	15.00	16.07	16.77	18.74	19.64	20.80	21.81	23.81	23.21	24.17	25.17	26.87
FAIRHAVEN		Groin/Jetty	Private	6.97	7.79	8.69	10.85	11.54	12.22	12.98	15.19	15.93	17.14	17.84	19.81	20.66	21.80	22.86	24.70	24.26	25.24	26.23	27.94
FAIRHAVEN		Bulkhead/Seawall	Private	5.01	5.89	6.80	8.90	9.59	10.28	11.01	13.29	14.06	15.19	15.89	17.87	18.77	19.89	20.90	22.80	22.29	23.29	24.28	25.99
FAIRHAVEN		Revetment	Private	3.12	4.01	4.92	7.02	7.72	7.38	9.13	11.42	10.46	13.31	14.02	16.00	16.07	18.01	19.02	19.18	20.42	21.41	22.41	24.11
FAIRHAVEN		Groin/Jetty	Private	8.61	9.51	10.41	12.51	13.21	14.48	14.61	16.91	18.02	18.81	19.51	21.51	22.37	23.50	24.51	27.15	25.91	26.91	27.91	29.61
FAIRHAVEN		Revetment	Private	7.37	8.45	9.17	11.28	11.97	12.67	13.38	15.85	16.65	17.57	18.27	20.27	21.17	22.27	23.27	25.35	24.67	25.67	26.67	28.37
FAIRHAVEN		Bulkhead/Seawall	Private	2.52	3.43	4.39	6.69	7.12	7.69	8.69	10.83	13.10	12.66	13.47	15.23	17.59	18.87	18.22	20.02	19.42	20.56	21.52	23.22
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Revetment	Private	2.12	3.02	4.02	6.14	6.81	6.72	8.32	9.71	12.01	12.32	13.20	14.92	15.10	16.58	17.91	19.40	19.12	20.39	21.12	22.81
FAIRHAVEN		Revetment	Private	3.92	4.83	5.83	7.94	8.62	9.82	10.72	12.22	13.61	14.12	15.01	16.72	17.61	18.70	19.71	21.52	20.92	22.20	22.93	24.62
FAIRHAVEN		Bulkhead/Seawall	Private	1.60	2.50	3.50	5.60	6.30	6.90	7.80	11.32	10.70	11.80	12.70	14.40	16.72	17.81	17.40	20.62	18.60	19.90	20.60	22.30

Coastal Protection Structures

Municipality	Location	Primary Type	Property Type	Category 1				Category 2				Category 3				Category 4				Category 4 Extreme			
Water Level Rise				0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft
FAIRHAVEN		Bulkhead/Seawall	Private	5.43	6.32	7.33	9.43	10.13	10.52	11.42	13.52	14.53	15.63	16.53	18.23	18.92	20.02	21.23	22.83	22.43	23.73	24.43	26.13
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	7.43	8.25	9.34	11.44	12.13	12.65	13.55	15.65	16.89	17.64	18.53	20.24	21.05	22.14	23.24	25.39	24.44	25.73	26.44	28.14
FAIRHAVEN		Revetment	Private	0.00	5.63	6.63	0.00	0.00	9.96	10.93	13.03	0.00	0.00	0.00	0.00	18.43	19.53	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Revetment	Private	4.14	5.04	6.04	8.14	8.84	9.09	10.34	12.09	13.24	14.34	15.24	16.94	17.49	18.59	19.94	21.40	21.14	22.44	23.14	24.84
FAIRHAVEN		Revetment	Private	3.52	4.42	5.42	7.52	8.22	8.82	9.72	11.82	12.62	13.72	14.62	16.32	17.22	18.32	19.32	21.12	20.52	21.82	22.52	24.22
FAIRHAVEN		Revetment	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Revetment	Private	5.69	7.57	8.56	9.70	10.39	11.97	12.86	13.99	15.76	15.89	16.78	18.49	20.35	21.46	21.49	24.27	22.70	23.98	24.70	26.40
FAIRHAVEN		Groin/Jetty	Private	7.69	8.59	9.59	11.69	12.39	12.99	13.89	15.99	16.78	17.89	18.78	20.49	21.38	22.48	23.49	25.29	24.69	25.98	26.69	28.39
FAIRHAVEN		Bulkhead/Seawall	Private	4.99	5.89	5.95	9.00	9.69	9.35	11.19	12.35	14.09	15.19	16.09	17.80	18.82	18.84	20.79	22.73	22.00	23.28	24.00	25.70
FAIRHAVEN		Revetment	Private	6.21	6.92	7.92	10.22	10.91	11.39	12.29	14.32	15.19	16.41	17.31	19.02	19.79	20.89	22.01	23.70	23.22	24.51	25.22	26.92
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	1.43	2.42	3.42	5.72	6.16	6.10	7.01	9.01	9.73	11.74	12.55	14.34	14.44	15.14	17.24	19.06	18.46	19.64	20.54	22.22
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.32	1.33	3.57	4.02	4.83	5.68	7.69	8.46	9.60	10.41	12.20	12.97	14.01	15.09	16.96	16.32	17.49	18.40	20.08
FAIRHAVEN		Bulkhead/Seawall	Private	1.36	2.13	3.73	5.64	6.09	7.23	7.75	9.75	10.27	11.66	12.47	14.26	15.37	16.08	17.15	19.36	18.38	19.55	20.46	22.13
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	0.99	1.68	2.69	5.26	5.70	6.18	7.08	9.08	9.80	11.26	12.08	13.86	14.60	15.40	16.75	18.58	17.98	19.15	20.06	21.73
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	7.17	8.07	9.07	11.07	11.87	11.10	13.27	15.57	14.91	17.47	18.17	20.07	21.07	22.17	23.17	25.17	24.67	25.57	26.47	28.17
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	1.16	3.15	4.16	5.38	5.80	6.92	8.08	9.42	11.15	11.26	12.13	13.86	14.64	15.67	16.70	18.57	17.98	19.09	20.06	21.68
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	4.16	5.06	6.07	8.37	8.78	9.48	10.39	12.38	13.02	14.21	15.10	16.81	17.61	18.62	19.62	21.52	20.92	22.02	23.00	24.62
FAIRHAVEN		Bulkhead/Seawall	Private	3.70	4.61	5.61	7.91	8.32	9.02	9.93	11.92	12.56	13.75	14.63	16.35	17.15	18.15	19.16	21.05	20.46	21.56	22.54	24.15
FAIRHAVEN		Revetment	Private	0.98	3.76	4.76	5.18	5.59	8.17	9.08	9.19	11.70	11.01	11.90	13.62	16.29	17.30	16.43	20.20	17.72	18.82	19.81	21.42
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.40	1.41	3.70	4.12	4.81	5.84	7.71	8.34	9.53	10.42	12.13	13.05	14.05	14.94	16.84	16.24	17.34	18.33	19.93
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Revetment	Private	0.00	1.99	1.78	4.07	4.49	6.39	7.30	8.08	9.91	9.89	10.79	12.50	13.29	14.29	15.30	17.20	16.60	17.70	18.69	20.30
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.04	0.93	3.31	3.73	4.43	5.31	7.43	7.96	9.25	10.06	11.83	12.44	13.71	14.81	16.54	16.01	17.14	18.11	19.82
FAIRHAVEN		Bulkhead/Seawall	Private	1.53	2.28	3.23	5.72	6.13	6.83	7.72	9.64	10.35	11.64	12.44	14.23	14.85	16.10	17.19	18.96	18.39	19.50	20.49	22.19
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	3.72	4.66	5.61	7.91	8.32	9.68	10.57	12.02	12.62	13.83	14.63	16.42	17.08	18.33	19.38	21.18	20.58	21.69	22.68	24.38
FAIRHAVEN		Groin/Jetty	Private	5.80	6.75	7.69	9.99	10.41	11.10	11.99	14.10	14.71	15.91	16.72	18.51	19.16	20.40	21.46	23.26	22.66	23.77	24.76	26.46
FAIRHAVEN		Groin/Jetty	Private	6.75	7.77	8.72	10.95	11.35	11.66	12.48	15.05	15.26	16.86	17.66	19.45	20.10	21.34	22.40	24.27	23.60	24.71	25.70	27.40
FAIRHAVEN		Bulkhead/Seawall	Private	1.99	2.94	3.89	6.19	6.59	7.29	8.19	10.29	10.89	12.10	12.90	14.69	15.34	16.59	17.64	19.50	18.84	19.95	20.94	22.65
FAIRHAVEN		Groin/Jetty	Private	2.96	3.77	4.72	7.16	7.56	8.12	9.16	11.39	11.72	13.07	13.87	15.67	16.44	17.68	18.62	20.28	19.82	20.92	21.92	23.62
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Revetment	Private	2.04	2.99	4.61	6.21	6.74	8.07	8.35	10.39	11.14	12.30	13.14	14.90	15.68	16.78	17.83	19.65	19.05	20.27	21.10	22.79
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	2.72	3.68	4.68	6.93	7.42	8.15	9.05	11.08	11.98	13.00	13.82	15.59	16.35	17.70	18.52	20.33	19.73	20.94	21.80	23.48
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Revetment	Private	1.02	2.00	3.26	5.28	5.73	6.49	7.39	9.41	10.13	11.32	12.12	13.91	14.64	15.62	16.82	18.64	18.03	19.23	20.12	21.81
FAIRHAVEN		Bulkhead/Seawall	Private	2.57	3.44	4.43	6.83	7.27	7.93	8.94	10.95	11.68	12.87	13.67	15.46	16.19	17.10	18.37	20.08	19.59	20.78	21.67	23.35
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	2.98	3.81	4.81	7.24	7.68	8.44	9.38	11.39	12.08	13.27	14.08	15.87	16.59	17.69	18.78	20.59	19.99	21.19	22.08	23.76
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Coastal Protection Structures

Municipality	Location	Primary Type	Property Type	Category 1				Category 2				Category 3				Category 4				Category 4 Extreme			
Water Level Rise				0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft
FAIRHAVEN		Revetment	Private	0.94	1.40	2.79	5.09	5.55	5.80	7.09	9.25	9.85	11.11	11.91	13.65	14.34	15.62	16.64	17.99	17.84	19.00	19.94	21.64
FAIRHAVEN		Revetment	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Revetment	Private	0.00	0.00	0.00	0.36	0.85	1.55	2.37	4.72	5.16	6.45	7.25	8.96	9.66	11.09	11.95	13.75	13.15	14.35	15.25	16.95
FAIRHAVEN		Revetment	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Revetment	Private	4.08	4.99	5.90	8.20	8.70	9.40	10.21	12.12	13.01	14.29	15.09	16.80	17.51	18.78	19.79	21.59	20.99	22.20	23.09	24.79
FAIRHAVEN		Revetment	Private	1.63	2.54	3.45	5.75	6.25	6.95	7.77	9.94	10.56	11.84	12.64	14.36	15.06	16.33	17.34	19.14	18.54	19.75	20.64	22.34
FAIRHAVEN		Revetment	Private	1.32	2.23	3.14	5.44	5.94	6.64	7.46	9.63	10.25	11.53	12.33	14.05	14.75	16.02	17.03	18.83	18.24	19.44	20.33	22.03
FAIRHAVEN		Bulkhead/Seawall	Private	5.22	5.86	7.16	9.37	9.91	10.61	11.20	13.56	14.00	15.47	16.31	18.06	18.85	19.96	21.01	22.82	22.22	23.45	24.27	25.97
FAIRHAVEN		Groin/Jetty	Private	7.36	8.28	9.27	11.44	12.04	12.70	13.59	15.67	16.68	17.58	18.44	20.17	21.24	22.36	23.14	24.95	24.35	25.60	26.38	28.07
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	6.36	6.74	7.74	10.40	11.04	11.15	12.04	14.13	14.92	16.56	17.43	19.16	19.49	19.13	22.14	23.43	23.35	24.61	25.37	27.05
FAIRHAVEN		Bulkhead/Seawall	Private	4.59	5.52	6.51	8.69	9.28	9.98	10.88	12.95	13.83	14.82	15.68	17.42	18.39	19.50	20.38	22.23	21.59	22.84	23.63	25.32
FAIRHAVEN		Bulkhead/Seawall	Private	4.44	5.35	6.35	8.48	9.12	9.89	10.79	12.87	13.67	14.65	15.52	17.24	18.24	19.35	20.22	22.14	21.44	22.69	23.45	25.14
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Revetment	Private	4.19	5.10	6.10	8.23	8.88	9.50	10.40	12.49	13.90	14.40	15.27	17.00	17.86	19.58	19.98	21.79	21.19	22.45	23.20	24.89
FAIRHAVEN		Revetment	Private	3.41	4.31	5.31	7.44	8.09	8.73	9.63	11.71	12.51	13.61	14.49	16.21	17.09	18.19	19.19	21.01	20.40	21.67	22.41	24.10
FAIRHAVEN		Bulkhead/Seawall	Private	6.19	6.28	7.27	10.22	10.87	10.68	11.58	14.48	14.46	16.39	17.27	18.99	19.86	20.96	21.97	23.78	23.18	24.45	25.19	26.88
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	6.79	7.69	8.69	10.80	11.49	12.44	13.34	15.44	16.24	16.99	17.88	19.59	20.84	21.93	22.59	24.74	23.79	25.08	25.79	27.49
FAIRHAVEN		Bulkhead/Seawall	Private	4.75	5.53	6.53	8.76	9.45	9.93	10.83	12.92	13.73	14.95	15.85	17.55	18.32	19.41	20.55	22.23	21.75	23.04	23.76	25.45
FAIRHAVEN		Bulkhead/Seawall	Private	7.27	8.17	9.17	11.28	11.96	12.57	13.47	15.56	16.36	17.47	18.36	20.07	20.96	22.05	23.06	24.87	24.27	25.55	26.27	27.96
FAIRHAVEN		Bulkhead/Seawall	Private	4.56	5.53	6.53	8.57	9.25	10.18	11.08	12.93	13.98	14.76	15.65	17.36	18.32	19.34	20.35	22.16	21.56	22.84	23.56	25.26
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	2.72	3.68	4.62	6.93	7.32	7.97	8.87	11.03	11.57	12.83	13.63	15.42	16.07	17.31	18.37	20.17	19.57	20.67	21.67	23.37
FAIRHAVEN		Groin/Jetty	Private	7.19	7.55	8.41	11.39	11.79	12.49	13.39	14.90	16.08	17.29	18.10	19.89	20.54	21.19	22.84	24.63	24.04	25.14	26.14	27.84
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	4.90	5.86	6.81	9.11	9.50	10.42	11.32	13.21	13.80	15.00	15.81	17.60	18.25	19.49	20.55	22.35	21.75	22.85	23.85	25.55
FAIRHAVEN		Bulkhead/Seawall	Private	5.19	6.66	7.61	9.39	9.79	11.00	11.91	13.49	14.60	15.29	16.09	17.89	18.53	20.28	20.83	22.64	22.03	23.13	24.13	25.83
FAIRHAVEN		Groin/Jetty	Private	7.73	8.28	9.23	11.93	12.32	13.02	13.93	15.63	16.62	17.83	18.63	20.42	20.66	21.90	23.37	24.77	24.57	25.66	26.66	28.37
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	3.22	3.63	4.56	7.43	7.81	7.97	8.85	11.52	11.57	13.32	14.12	15.91	15.96	17.18	18.84	20.64	20.04	21.13	22.13	23.84
FAIRHAVEN		Revetment	Private	1.04	2.02	2.94	5.24	5.63	6.33	7.23	9.34	9.78	11.13	11.94	13.73	14.34	15.56	16.65	18.45	17.85	18.94	19.94	21.65
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.36	1.28	4.12	4.50	5.21	6.11	7.67	8.26	10.00	10.81	12.60	12.66	13.87	15.51	16.78	16.71	17.80	18.80	20.51
FAIRHAVEN		Bulkhead/Seawall	Private	1.04	1.86	2.79	5.24	5.63	8.47	7.24	9.34	12.06	11.13	11.94	13.73	14.34	15.39	16.64	18.45	17.84	18.94	19.94	21.64
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	7.78	8.76	9.71	11.98	12.38	13.11	14.01	0.00	16.71	17.89	18.69	20.48	0.00	0.00	23.43	25.26	24.63	25.73	26.73	28.43
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	4.85	5.75	6.75	8.86	9.55	10.15	11.05	13.15	13.57	15.05	15.95	17.65	18.55	19.64	20.65	22.07	21.85	23.15	23.86	25.55
FAIRHAVEN		Bulkhead/Seawall	Private	4.05	5.24	6.24	8.05	8.74	9.63	10.53	12.34	13.43	14.25	15.14	16.85	17.74	18.83	19.84	21.64	21.05	22.34	23.05	24.75
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Bulkhead/Seawall	Private	3.67	4.91	5.91	7.68	8.36	8.97	9.87	11.96	12.77	13.87	14.76	16.47	17.35	18.45	19.46	21.27	20.67	21.95	22.67	24.37
FAIRHAVEN		Bulkhead/Seawall	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAIRHAVEN		Groin/Jetty	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.56	12.37	14.05	17.80	20.30	21.15	22.44	23.56	25.52	25.22	26.06	26.74	28.58

Government Buildings

Object	Municipality	Owner	Location	Category 1				Category 2				Category 3				Category 4				Category 4 Extreme			
Water Level Rise				0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft
1	Fairhaven	Town of Fairhaven	Arsene St	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71	2.52	3.52	4.52	5.81	7.23	6.76	8.02	8.83	10.43
2	Fairhaven	Town of Fairhaven	Center St	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.73	9.02	10.34	11.60	12.56	14.79	14.36	15.09	16.19	18.13
3	Fairhaven	United States of America	Old Fort Rd.	1.21	2.10	3.11	5.51	6.09	6.89	7.70	9.92	10.49	11.60	12.02	14.62	15.52	16.83	17.82	19.52	19.42	20.32	21.02	22.72
4	Fairhaven	Town of Fairhaven	Causeway Rd	0.00	0.00	0.00	0.00	0.00	0.00	0.83	2.87	3.70	4.80	5.64	7.40	8.24	9.30	10.34	12.17	11.57	12.77	13.60	15.27
5	Acushnet	Town of Acushnet Selectmen	Main St	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	Acushnet	Town of Acushnet Historical Commission	South Main St	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	Acushnet	Town of Acushnet Selectmen	Main St	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Environmental Justice

Census Tract	Population	Category 1				Category 2				Category 3				Category 4				Category 4 Extreme			
Water Level Rise		0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft	0 ft	1 ft	2 ft	4 ft
650500	2142	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.80	0.00	0.00	6.90	0.00	8.06	8.55	8.79	9.00
654200	772	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.64	3.02	3.04	11.95	14.85	14.84	14.80	14.66	15.06	15.49	16.08	16.49	16.89
650400	1322	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	2.29	0.97	15.65	19.16	20.74	21.83	22.62	23.42	24.01	24.66	25.24	26.00
651700	1066	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28
650600	767	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.54	0.86	1.41
655200	720	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.34	2.10	1.52	14.10	17.53	18.45	18.99	19.36	19.60	19.81	19.96	20.23	24.09
651200	1119	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.29	2.26	2.32	13.17	17.27	19.21	20.64	21.69	22.68	23.27	24.18	24.94	26.63
650500	960	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.00	0.48	11.64	14.65	16.50	17.54	18.24	18.71	18.91	19.23	19.57	19.93
650900	923	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
650900	795	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
651200	1061	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.70	9.09	5.36	5.65	6.20	6.81	7.52	7.28	7.71	8.13	11.08
651002	1112	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
651200	733	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.49	2.43	1.38	12.92	18.11	19.52	20.72	21.70	22.64	22.74	23.41	24.04	27.60
650900	1863	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
652700	1548	4.66	4.82	5.05	7.18	6.40	6.75	7.32	7.44	8.30	8.89	10.05	11.64	12.55	13.88	14.79	16.40	16.30	17.20	18.00	19.75
651002	1041	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
651700	1011	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
651900	1160	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.83	3.19	3.35	3.92	5.01	5.76	6.98	7.82	9.34	9.24	10.10	10.86	12.47
654200	1178	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.12	4.99	5.82	6.68	7.34	7.99	8.40	8.86	9.23	11.12
653203	1044	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56
651700	843	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
651700	780	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
651800	1161	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.17	2.21	1.48	11.43	17.06	17.65	18.58	19.27	21.03	20.68	21.24	21.76	24.54
651900	683	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.98	5.13	5.72	11.54	13.47	14.48	15.85	16.76	18.50	18.36	19.26	19.97	21.89
652200	1279	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.53	1.68	1.85	2.62	3.00	3.19	3.36	4.22	4.17	4.69	5.10	5.97
651900	887	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.28	2.64	2.84	3.42	4.31	4.84	5.65	6.26	7.26	7.20	7.74	8.20	9.10
651200	1335	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.41	1.71	2.00	12.20	17.04	17.65	18.14	18.70	19.19	18.96	19.33	19.71	22.70
651700	564	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
650102	1364	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
651700	1037	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.13	0.15	1.79	8.82	11.96	11.58	12.52	13.15	14.62	14.36	14.89	15.23	16.48
650900	1151	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
651500	604	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
651700	609	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
650500	687	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.45	2.72	3.85	4.18	4.48	4.71	4.90	5.04	5.03	5.09
650900	1325	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
650900	799	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
650500	970	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
651900	708	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.27	1.65	2.77	11.71	14.61	15.23	16.37	17.27	19.61	19.03	19.80	20.54	22.38
650500	1316	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
650500	1142	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
650500	670	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.29	10.35	11.16	11.85	12.41	12.93	13.22	13.46	13.81	14.23
651500	737	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
651900	629	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.19	0.51	0.80	1.63
652400	1300	3.41	4.35	5.35	7.71	8.22	8.86	9.67	11.96	12.76	13.82	14.72	17.48	18.72	18.75	19.80	21.35	21.17	22.11	23.00	24.71
651500	701	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
652500	1410	3.00	4.00	4.88	6.84	7.21	7.83	8.60	9.06	10.00	10.60	11.57	13.45	14.53	15.42	16.35	17.96	17.82	18.72	19.55	21.28
650900	917	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
650900	935	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.34
653203	808	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
651900	1259	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.93	5.63	5.80	6.10	7.05	7.77	8.77	9.47	10.90	10.75	11.48	12.05	13.56
651002	906	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
651900	1179	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.24	7.30	7.67	8.71	10.28	11.29	12.61	13.52	15.12	15.02	15.92	16.72	18.43
652700	1295	2.83	3.89	4.70	6.40	6.82	7.41	8.18	6.84	7.58	7.94	8.59	9.81	10.56	11.57	12.35	13.79	13.69	14.55	15.36	17.15
652800	1027	1.35	2.01	2.64	4.01	4.10	4.38	4.37	5.05	5.37	6.12	6.60	7.70	8.34	9.39	10.23	11.68	11.46	12.29	13.03	14.43
652700	1070	4.83	5.18	5.44	7.66	6.46	6.67	7.03	7.31	7.79	8.58	9.16	10.18	10.59	11.56	12.26	13.36	13.24	13.83	14.39	15.47
652700	888	3.69	4.02	4.51	6.64	6.04	6.31	6.78	7.37	7.87	8.42	9.07	10.32	10.99	11.92	12.70	14.10	14.00	14.88	15.68	17.45
650900	2865	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
651700	1140	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
650900	951	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
650900	808	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
651500	1168	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
651200	1464	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	3.26	3.52	3.83	4.27	4.47	4.58	4.83	5.07	6.29
652000	1392	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.58	5.18	5.46	6.12	6.90	7.37	7.92	8.40	9.49	9.41	10.05	10.39	11.23
650201	1501	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
652700	777	3.54	2.59	3.03	4.27	4.76	5.30	5.86	7.22	8.01	8.44	9.01	10.07	10.71	11.57	12.21	13.34	13.24	13.83	14.34	15.48

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 1, 0-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	396,672	70.9%
Commercial	89,927	16.1%
Industrial	57,647	10.3%
Agricultural	8,824	1.6%
Religion	4,335	0.8%
Government	764	0.1%
Education	1,665	0.3%
Total	**559,834**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

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Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	456,043	73.1%
Commercial	92,424	14.8%
Industrial	58,168	9.3%
Agricultural	8,824	1.4%
Religion	4,335	0.7%
Government	764	0.1%
Education	3,195	0.5%
Total	**623,753**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Hazus Global Summary Report Category 1, 2-foot SLR

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 1, 2-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Hazus Global Summary Report Category 1, 2-foot SLR

Building Damage

General Building Stock Damage

Hazus estimates that about 313 buildings will be at least moderately damaged. This is over 52% of the total number of buildings in the scenario. There are an estimated 2 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	40	12.78	155	49.52	72	23.00	44	14.06	2	0.64
Total	**0**		**40**		**155**		**72**		**44**		**2**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	0	0.00	0	0.00	1	50.00	1	50.00	0	0.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	40	12.86	154	49.52	71	22.83	44	14.15	2	0.64

Hazus Global Summary Report Category 1, 2-foot SLR

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Hazus Global Summary Report Category 1, 2-foot SLR

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 12,469 tons of debris will be generated. Of the total amount, Finishes comprises 35% of the total, Structure comprises 40% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 499 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 583 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 1,124 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 57.47 million dollars, which represents 9.21 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 57.36 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 77.79% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	26.49	1.70	0.94	0.64	29.76
	Content	18.18	5.08	1.96	1.72	26.94
	Inventory	0.00	0.11	0.37	0.18	0.66
	Subtotal	**44.67**	**6.89**	**3.27**	**2.54**	**57.36**
Business Interruption						
	Income	0.00	0.03	0.00	0.00	0.03
	Relocation	0.04	0.00	0.00	0.00	0.04
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.03	0.00	0.01	0.04
	Subtotal	**0.04**	**0.05**	**0.00**	**0.01**	**0.11**
ALL	**Total**	**44.71**	**6.95**	**3.27**	**2.55**	**57.47**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 1, 4-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region .

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B .

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	519,768	74.7%
Commercial	97,884	14.1%
Industrial	58,845	8.5%
Agricultural	9,045	1.3%
Religion	4,843	0.7%
Government	2,142	0.3%
Education	3,195	0.5%
Total	**695,722**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 1, 4-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 481 buildings will be at least moderately damaged. This is over 66% of the total number of buildings in the scenario. There are an estimated 3 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	26	5.41	204	42.41	147	30.56	101	21.00	3	0.62
Total	**0**		**26**		**204**		**147**		**101**		**3**	

Table 4: Expected Building Damage by Building Type

	1-10		11-20		21-30		31-40		41-50		Substantially	
Building Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	0	0.00	0	0.00	2	50.00	1	25.00	1	25.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	26	5.45	202	42.35	146	30.61	100	20.96	3	0.63

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 24,150 tons of debris will be generated. Of the total amount, Finishes comprises 30% of the total, Structure comprises 43% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 966 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 711 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 1,435 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 94.07 million dollars, which represents 13.52 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 93.91 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 78.14% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	43.39	2.92	1.68	0.98	48.97
	Content	30.06	7.80	3.59	2.36	43.81
	Inventory	0.00	0.18	0.72	0.24	1.13
	Subtotal	**73.44**	**10.90**	**5.99**	**3.58**	**93.91**
Business Interruption						
	Income	0.00	0.03	0.00	0.00	0.04
	Relocation	0.06	0.00	0.00	0.00	0.07
	Rental Income	0.01	0.00	0.00	0.00	0.01
	Wage	0.00	0.04	0.00	0.01	0.05
	Subtotal	**0.07**	**0.07**	**0.00**	**0.02**	**0.16**
ALL	**Total**	**73.51**	**10.98**	**5.99**	**3.60**	**94.07**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 2, 0-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

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Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	532,058	75.1%
Commercial	98,355	13.9%
Industrial	58,845	8.3%
Agricultural	9,126	1.3%
Religion	4,843	0.7%
Government	2,142	0.3%
Education	3,195	0.5%
Total	**708,564**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 2, 0-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 524 buildings will be at least moderately damaged. This is over 69% of the total number of buildings in the scenario. There are an estimated 6 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	23	4.39	196	37.40	174	33.21	125	23.85	6	1.15
Total	**0**		**23**		**196**		**174**		**125**		**6**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00
Masonry	0	0.00	0	0.00	1	25.00	2	50.00	1	25.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	23	4.43	195	37.57	172	33.14	124	23.89	5	0.96

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 28,128 tons of debris will be generated. Of the total amount, Finishes comprises 29% of the total, Structure comprises 44% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 1,125 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 746 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 1,538 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 104.51 million dollars, which represents 14.75 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 104.33 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 77.92% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	48.07	3.30	1.91	1.15	54.44
	Content	33.29	8.55	4.14	2.63	48.61
	Inventory	0.00	0.20	0.83	0.26	1.29
	Subtotal	**81.36**	**12.05**	**6.89**	**4.04**	**104.33**
Business Interruption						
	Income	0.00	0.04	0.00	0.01	0.04
	Relocation	0.07	0.00	0.00	0.00	0.07
	Rental Income	0.01	0.00	0.00	0.00	0.01
	Wage	0.00	0.04	0.00	0.02	0.05
	Subtotal	**0.07**	**0.08**	**0.00**	**0.02**	**0.18**
ALL	**Total**	**81.43**	**12.13**	**6.89**	**4.06**	**104.51**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Hazus Global Summary Report Category 2, 0-foot SLR

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus Global Summary Report Category 2, 0-foot SLR

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 2, 1-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

Hazus Global Summary Report Category 2, 1-foot SLR

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Hazus Global Summary Report Category 2, 1-foot SLR

General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	545,478	75.4%
Commercial	99,540	13.8%
Industrial	58,922	8.1%
Agricultural	9,126	1.3%
Religion	4,843	0.7%
Government	2,142	0.3%
Education	3,195	0.4%
Total	**723,246**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 2, 1-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 583 buildings will be at least moderately damaged. This is over 73% of the total number of buildings in the scenario. There are an estimated 6 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	21	3.60	198	33.96	183	31.39	175	30.02	6	1.03
Total	**0**		**21**		**198**		**183**		**175**		**6**	

Table 4: Expected Building Damage by Building Type

Building	1-10		11-20		21-30		31-40		41-50		Substantially	
Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00
Masonry	0	0.00	0	0.00	1	20.00	2	40.00	2	40.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	21	3.64	197	34.14	181	31.37	173	29.98	5	0.87

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 32,522 tons of debris will be generated. Of the total amount, Finishes comprises 28% of the total, Structure comprises 44% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 1,301 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 786 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 1,632 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 117.23 million dollars, which represents 16.21 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 117.03 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 77.58% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	53.72	3.79	2.23	1.33	61.07
	Content	37.15	9.48	4.93	2.91	54.46
	Inventory	0.00	0.22	1.00	0.28	1.50
	Subtotal	**90.87**	**13.48**	**8.16**	**4.52**	**117.03**
Business Interruption						
	Income	0.00	0.04	0.00	0.01	0.05
	Relocation	0.08	0.00	0.00	0.00	0.08
	Rental Income	0.01	0.00	0.00	0.00	0.01
	Wage	0.00	0.04	0.00	0.02	0.06
	Subtotal	**0.08**	**0.09**	**0.00**	**0.03**	**0.20**
ALL	**Total**	**90.95**	**13.57**	**8.16**	**4.55**	**117.23**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 2, 2-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region .

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B .

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	558,055	75.7%
Commercial	100,270	13.6%
Industrial	59,084	8.0%
Agricultural	9,126	1.2%
Religion	4,843	0.7%
Government	2,142	0.3%
Education	3,195	0.4%
Total	**736,715**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 2, 2-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 658 buildings will be at least moderately damaged. This is over 76% of the total number of buildings in the scenario. There are an estimated 7 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	21	3.19	184	27.96	207	31.46	239	36.32	7	1.06
Total	**0**		**21**		**184**		**207**		**239**		**7**	

Table 4: Expected Building Damage by Building Type

Building	1-10		11-20		21-30		31-40		41-50		Substantially	
Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00
Masonry	0	0.00	0	0.00	1	14.29	2	28.57	4	57.14	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	21	3.23	183	28.15	205	31.54	235	36.15	6	0.92

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.
(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 37,969 tons of debris will be generated. Of the total amount, Finishes comprises 27% of the total, Structure comprises 45% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 1,519 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 837 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 1,769 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 132.79 million dollars, which represents 18.02 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 132.58 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 77.04% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	60.50	4.40	2.70	1.53	69.13
	Content	41.71	10.59	6.09	3.24	61.63
	Inventory	0.00	0.26	1.25	0.30	1.81
	Subtotal	**102.22**	**15.25**	**10.05**	**5.06**	**132.58**
Business Interruption						
	Income	0.00	0.04	0.00	0.01	0.05
	Relocation	0.08	0.00	0.00	0.00	0.09
	Rental Income	0.01	0.00	0.00	0.00	0.01
	Wage	0.00	0.04	0.00	0.02	0.06
	Subtotal	**0.09**	**0.09**	**0.00**	**0.03**	**0.22**
ALL	**Total**	**102.31**	**15.34**	**10.05**	**5.09**	**132.79**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 2, 4-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region .

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B .

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,409,507	63.2%
Commercial	513,925	23.0%
Industrial	254,935	11.4%
Agricultural	14,435	0.6%
Religion	21,979	1.0%
Government	4,241	0.2%
Education	12,182	0.5%
Total	**2,231,204**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 2, 4-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 1,508 buildings will be at least moderately damaged. This is over 74% of the total number of buildings in the scenario. There are an estimated 24 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	5	18.52	14	51.85	3	11.11	1	3.70	3	11.11	1	3.70
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	3	21.43	6	42.86	1	7.14	3	21.43	1	7.14	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	30	2.03	287	19.46	391	26.51	744	50.44	23	1.56
Total	**8**		**50**		**291**		**395**		**748**		**24**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	1	12.50	0	0.00	0	0.00	7	87.50	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00
Masonry	2	1.34	5	3.36	16	10.74	22	14.77	104	69.80	0	0.00
Steel	5	17.24	10	34.48	2	6.90	4	13.79	8	27.59	0	0.00
Wood	1	0.08	31	2.36	264	20.14	367	27.99	626	47.75	22	1.68

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	4	0	4

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 76,113 tons of debris will be generated. Of the total amount, Finishes comprises 39% of the total, Structure comprises 37% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 3,045 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 4,360 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 11,720 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 700.66 million dollars, which represents 31.40 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 698.18 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 48.48% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	204.38	72.20	26.34	3.71	306.62
	Content	135.04	157.06	68.47	13.80	374.37
	Inventory	0.00	5.28	11.44	0.48	17.19
	Subtotal	**339.43**	**234.53**	**106.24**	**17.98**	**698.18**
Business Interruption						
	Income	0.01	0.78	0.01	0.02	0.81
	Relocation	0.15	0.26	0.01	0.01	0.43
	Rental Income	0.11	0.19	0.00	0.00	0.30
	Wage	0.02	0.78	0.01	0.13	0.94
	Subtotal	**0.28**	**2.01**	**0.04**	**0.16**	**2.48**
ALL	**Total**	**339.71**	**236.54**	**106.28**	**18.14**	**700.66**

Hazus Global Summary Report Category 2, 4-foot SLR

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Hazus Global Summary Report Category 2, 4-foot SLR

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus Global Summary Report Category 2, 4-foot SLR

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 3, 0-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

Hazus Global Summary Report Category 3, 0-foot SLR

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,295,657	65.2%
Commercial	430,036	21.6%
Industrial	216,644	10.9%
Agricultural	12,765	0.6%
Religion	15,954	0.8%
Government	4,241	0.2%
Education	11,846	0.6%
Total	**1,987,143**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 3, 0-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 1,635 buildings will be at least moderately damaged. This is over 82% of the total number of buildings in the scenario. There are an estimated 44 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	6	33.33	4	22.22	2	11.11	4	22.22	2	11.11
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	1	12.50	2	25.00	1	12.50	1	12.50	3	37.50	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	24	1.49	254	15.78	386	23.98	904	56.15	42	2.61
Total	**1**		**32**		**259**		**389**		**911**		**44**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	10	100.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00
Masonry	0	0.00	1	0.60	13	7.74	23	13.69	129	76.79	2	1.19
Steel	1	3.85	7	26.92	3	11.54	3	11.54	11	42.31	1	3.85
Wood	0	0.00	24	1.69	241	16.98	362	25.51	753	53.07	39	2.75

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	4	0	4

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 87,273 tons of debris will be generated. Of the total amount, Finishes comprises 37% of the total, Structure comprises 39% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 3,491 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 4,229 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 11,517 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 699.46 million dollars, which represents 35.20 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 697.28 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 52.80% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	223.56	73.30	22.46	3.79	323.11
	Content	145.49	146.38	55.31	12.77	359.94
	Inventory	0.00	5.13	8.61	0.49	14.23
	Subtotal	**369.04**	**224.81**	**86.38**	**17.05**	**697.28**
Business Interruption						
	Income	0.00	0.71	0.00	0.02	0.73
	Relocation	0.16	0.23	0.01	0.00	0.41
	Rental Income	0.11	0.18	0.00	0.00	0.29
	Wage	0.00	0.65	0.01	0.11	0.76
	Subtotal	**0.28**	**1.76**	**0.02**	**0.13**	**2.19**
ALL	**Total**	**369.32**	**226.57**	**86.39**	**17.19**	**699.46**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 3, 1-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

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Note:
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There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,527,386	61.0%
Commercial	529,818	21.2%
Industrial	392,890	15.7%
Agricultural	14,684	0.6%
Religion	22,995	0.9%
Government	4,508	0.2%
Education	12,182	0.5%
Total	**2,504,463**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 3, 1-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 1,856 buildings will be at least moderately damaged. This is over 78% of the total number of buildings in the scenario. There are an estimated 88 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	6	16.22	18	48.65	4	10.81	2	5.41	4	10.81	3	8.11
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	2	13.33	7	46.67	1	6.67	2	13.33	3	20.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	31	1.71	250	13.80	387	21.36	1,059	58.44	85	4.69
Total	**8**		**56**		**255**		**391**		**1,066**		**88**	

Table 4: Expected Building Damage by Building Type

	1-10		11-20		21-30		31-40		41-50		Substantially	
Building Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	1	10.00	0	0.00	0	0.00	9	90.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00
Masonry	2	1.05	8	4.21	10	5.26	20	10.53	146	76.84	4	2.11
Steel	5	12.82	14	35.90	4	10.26	3	7.69	11	28.21	2	5.13
Wood	1	0.06	33	2.05	238	14.76	366	22.70	892	55.33	82	5.09

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	4	0	4

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 108,718 tons of debris will be generated. Of the total amount, Finishes comprises 35% of the total, Structure comprises 40% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 4,349 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 4,942 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 13,240 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 873.34 million dollars, which represents 34.87 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 870.45 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 48.65% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	256.81	90.60	33.69	5.03	386.13
	Content	167.76	190.44	86.48	18.10	462.78
	Inventory	0.00	6.54	14.42	0.58	21.54
	Subtotal	**424.57**	**287.58**	**134.59**	**23.71**	**870.45**
Business Interruption						
	Income	0.01	0.89	0.01	0.03	0.94
	Relocation	0.19	0.29	0.02	0.01	0.50
	Rental Income	0.13	0.22	0.00	0.00	0.35
	Wage	0.02	0.91	0.02	0.16	1.10
	Subtotal	**0.34**	**2.31**	**0.04**	**0.19**	**2.89**
ALL	**Total**	**424.91**	**289.89**	**134.63**	**23.91**	**873.34**

Appendix A: County Listing for the Region

Massachusetts

- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 3, 2-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region .

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B .

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,134,832	64.9%
Commercial	647,210	19.7%
Industrial	432,413	13.1%
Agricultural	17,893	0.5%
Religion	31,935	1.0%
Government	8,244	0.3%
Education	16,199	0.5%
Total	**3,288,726**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 3, 2-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 3,125 buildings will be at least moderately damaged. This is over 86% of the total number of buildings in the scenario. There are an estimated 850 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	4	8.51	4	8.51	8	17.02	17	36.17	14	29.79
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	1	4.55	1	4.55	3	13.64	17	77.27
Religion	0	0.00	1	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	37	1.21	275	9.00	488	15.97	1,436	47.00	819	26.81
Total	**0**		**42**		**280**		**497**		**1,456**		**850**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10 Count	1-10 (%)	11-20 Count	11-20 (%)	21-30 Count	21-30 (%)	31-40 Count	31-40 (%)	41-50 Count	41-50 (%)	Substantially Count	Substantially (%)
Concrete	0	0.00	1	7.14	0	0.00	0	0.00	11	78.57	2	14.29
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	4	100.00
Masonry	0	0.00	2	0.72	10	3.61	13	4.69	179	64.62	73	26.35
Steel	0	0.00	3	5.88	4	7.84	7	13.73	20	39.22	17	33.33
Wood	0	0.00	35	1.27	265	9.63	473	17.19	1,236	44.91	743	27.00

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	1	0	1
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	9	0	9

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 292,035 tons of debris will be generated. Of the total amount, Finishes comprises 25% of the total, Structure comprises 45% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 11,681 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 8,089 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 22,233 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 1,837.92 million dollars, which represents 55.89 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 1,832.69 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 45.45% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	517.43	194.72	102.50	12.80	827.44
	Content	317.22	366.96	231.98	40.95	957.11
	Inventory	0.00	12.41	34.75	0.99	48.14
	Subtotal	**834.65**	**574.09**	**369.22**	**54.73**	**1,832.69**
Business Interruption						
	Income	0.03	1.57	0.02	0.07	1.69
	Relocation	0.31	0.45	0.04	0.02	0.81
	Rental Income	0.23	0.32	0.00	0.00	0.55
	Wage	0.07	1.69	0.04	0.38	2.17
	Subtotal	**0.64**	**4.03**	**0.10**	**0.46**	**5.23**
ALL	**Total**	**835.29**	**578.12**	**369.32**	**55.20**	**1,837.92**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 3, 4-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region .

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B .

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,339,595	65.8%
Commercial	691,946	19.5%
Industrial	435,062	12.2%
Agricultural	18,205	0.5%
Religion	41,933	1.2%
Government	8,244	0.2%
Education	20,851	0.6%
Total	**3,555,836**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 3, 4-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 3,798 buildings will be at least moderately damaged. This is over 89% of the total number of buildings in the scenario. There are an estimated 1,399 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	2	3.33	6	10.00	7	11.67	2	3.33	10	16.67	33	55.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	1	3.45	5	17.24	23	79.31
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	35	0.94	252	6.79	470	12.67	1,611	43.41	1,343	36.19
Total	**2**		**41**		**259**		**473**		**1,626**		**1,399**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	1	6.67	0	0.00	0	0.00	11	73.33	3	20.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	9	100.00
Masonry	0	0.00	1	0.30	11	3.31	6	1.81	182	54.82	132	39.76
Steel	2	3.13	4	6.25	5	7.81	3	4.69	19	29.69	31	48.44
Wood	0	0.00	33	0.99	240	7.20	463	13.89	1,396	41.87	1,202	36.05

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	1	0	1
Hospitals	0	0	0	0
Police Stations	5	1	0	1
Schools	54	9	0	9

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 431,555 tons of debris will be generated. Of the total amount, Finishes comprises 22% of the total, Structure comprises 46% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 17,262 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 9,298 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 25,651 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 2,198.89 million dollars, which represents 61.84 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 2,192.78 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 47.12% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	651.98	249.30	116.96	18.81	1,037.04
	Content	383.28	418.06	254.81	46.95	1,103.08
	Inventory	0.00	13.76	37.80	1.10	52.66
	Subtotal	**1,035.25**	**681.12**	**409.56**	**66.85**	**2,192.78**
Business Interruption						
	Income	0.03	1.85	0.03	0.08	1.99
	Relocation	0.41	0.50	0.04	0.03	0.97
	Rental Income	0.28	0.36	0.00	0.00	0.65
	Wage	0.08	1.94	0.04	0.44	2.50
	Subtotal	**0.80**	**4.66**	**0.11**	**0.55**	**6.11**
ALL	**Total**	**1,036.05**	**685.77**	**409.66**	**67.40**	**2,198.89**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 4, 0-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

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Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,443,528	66.4%
Commercial	702,480	19.1%
Industrial	436,326	11.9%
Agricultural	18,285	0.5%
Religion	45,724	1.2%
Government	10,618	0.3%
Education	20,972	0.6%
Total	**3,677,933**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 4, 0-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 4,067 buildings will be at least moderately damaged. This is over 90% of the total number of buildings in the scenario. There are an estimated 1,718 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	2	3.28	3	4.92	6	9.84	4	6.56	5	8.20	41	67.21
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	1	3.13	4	12.50	27	84.38
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	27	0.68	232	5.84	445	11.19	1,622	40.79	1,650	41.50
Total	**2**		**30**		**238**		**450**		**1,631**		**1,718**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	11	78.57	3	21.43
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	14	100.00
Masonry	0	0.00	0	0.00	13	3.76	8	2.31	174	50.29	151	43.64
Steel	2	2.99	3	4.48	4	5.97	5	7.46	16	23.88	37	55.22
Wood	0	0.00	26	0.73	218	6.09	437	12.22	1,415	39.56	1,481	41.40

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	1	0	1
Hospitals	0	0	0	0
Police Stations	5	1	0	1
Schools	54	10	1	11

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 486,966 tons of debris will be generated. Of the total amount, Finishes comprises 22% of the total, Structure comprises 46% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 19,479 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 9,793 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 27,019 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 2,343.16 million dollars, which represents 63.71 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 2,336.77 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 48.12% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	**Area**	**Residential**	**Commercial**	**Industrial**	**Others**	**Total**
Building Loss						
	Building	715.73	267.58	121.91	21.26	1,126.48
	Content	410.96	433.13	262.95	49.09	1,156.13
	Inventory	0.00	14.14	38.88	1.14	54.16
	Subtotal	**1,126.69**	**714.85**	**423.74**	**71.49**	**2,336.77**
Business Interruption						
	Income	0.03	1.93	0.03	0.09	2.07
	Relocation	0.43	0.52	0.04	0.03	1.02
	Rental Income	0.31	0.37	0.00	0.00	0.69
	Wage	0.08	2.02	0.04	0.47	2.62
	Subtotal	**0.86**	**4.84**	**0.11**	**0.59**	**6.39**
ALL	**Total**	**1,127.55**	**719.69**	**423.85**	**72.08**	**2,343.16**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: mom_80mb1

Flood Scenario: Category 4, 1-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,482,489	66.5%
Commercial	706,666	18.9%
Industrial	444,572	11.9%
Agricultural	18,285	0.5%
Religion	46,768	1.3%
Government	10,618	0.3%
Education	20,972	0.6%
Total	**3,730,370**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 4, 1-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 4,291 buildings will be at least moderately damaged. This is over 91% of the total number of buildings in the scenario. There are an estimated 2,016 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	2	3.28	5	8.20	3	4.92	5	8.20	3	4.92	43	70.49
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	1	3.03	4	12.12	28	84.85
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	29	0.69	217	5.17	403	9.60	1,605	38.22	1,945	46.32
Total	**2**		**34**		**220**		**409**		**1,612**		**2,016**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	1	5.88	0	0.00	12	70.59	4	23.53
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	15	100.00
Masonry	0	0.00	0	0.00	10	2.79	9	2.51	156	43.45	184	51.25
Steel	2	2.94	3	4.41	2	2.94	5	7.35	13	19.12	43	63.24
Wood	0	0.00	29	0.77	207	5.48	394	10.44	1,416	37.52	1,728	45.79

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	1	0	1
Hospitals	0	0	0	0
Police Stations	5	1	0	1
Schools	54	10	1	11

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 542,153 tons of debris will be generated. Of the total amount, Finishes comprises 22% of the total, Structure comprises 46% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 21,686 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 10,203 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 28,219 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 2,473.23 million dollars, which represents 66.30 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 2,466.58 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 48.66% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	768.46	287.67	126.35	23.82	1,206.30
	Content	434.17	448.85	270.39	51.14	1,204.54
	Inventory	0.00	14.55	40.02	1.18	55.74
	Subtotal	**1,202.63**	**751.06**	**436.76**	**76.13**	**2,466.58**
Business Interruption						
	Income	0.03	2.00	0.03	0.10	2.16
	Relocation	0.46	0.54	0.04	0.03	1.07
	Rental Income	0.33	0.38	0.00	0.00	0.72
	Wage	0.08	2.09	0.04	0.49	2.71
	Subtotal	**0.91**	**5.01**	**0.11**	**0.62**	**6.65**
ALL	**Total**	**1,203.54**	**756.07**	**436.87**	**76.75**	**2,473.23**

Appendix A: County Listing for the Region

Massachusetts

- Bristol

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 4, 2-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

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The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region .

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B .

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,598,362	67.3%
Commercial	714,835	18.5%
Industrial	448,090	11.6%
Agricultural	18,520	0.5%
Religion	47,350	1.2%
Government	11,023	0.3%
Education	20,972	0.5%
Total	**3,859,152**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 4, 2-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 4,490 buildings will be at least moderately damaged. This is over 92% of the total number of buildings in the scenario. There are an estimated 2,308 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	2	2.90	6	8.70	2	2.90	4	5.80	5	7.25	50	72.46
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	1	2.94	3	8.82	30	88.24
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	26	0.59	211	4.81	369	8.41	1,555	35.43	2,228	50.76
Total	**2**		**32**		**213**		**374**		**1,563**		**2,308**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	1	5.56	0	0.00	8	44.44	9	50.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	16	100.00
Masonry	0	0.00	2	0.51	10	2.56	10	2.56	143	36.67	225	57.69
Steel	2	2.90	4	5.80	1	1.45	4	5.80	11	15.94	47	68.12
Wood	0	0.00	28	0.71	201	5.09	360	9.12	1,392	35.26	1,967	49.82

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	1	0	1
Hospitals	0	0	0	0
Police Stations	5	1	0	1
Schools	54	10	1	11

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.
(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 587,252 tons of debris will be generated. Of the total amount, Finishes comprises 21% of the total, Structure comprises 46% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 23,490 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 10,513 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 29,120 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 2,577.01 million dollars, which represents 66.78 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 2,570.16 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 49.04% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	810.41	303.37	130.03	26.09	1,269.90
	Content	452.40	461.04	276.95	52.75	1,243.13
	Inventory	0.00	14.88	41.04	1.22	57.13
	Subtotal	**1,262.81**	**779.28**	**448.02**	**80.05**	**2,570.16**
Business Interruption						
	Income	0.03	2.07	0.03	0.10	2.23
	Relocation	0.48	0.55	0.04	0.03	1.10
	Rental Income	0.34	0.40	0.00	0.00	0.74
	Wage	0.09	2.14	0.04	0.51	2.79
	Subtotal	**0.94**	**5.16**	**0.11**	**0.65**	**6.86**
ALL	**Total**	**1,263.75**	**784.44**	**448.13**	**80.70**	**2,577.01**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 4, 4-foot SLR

Print Date: Friday, June 06, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region .

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B .

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,632,545	67.5%
Commercial	720,472	18.5%
Industrial	448,458	11.5%
Agricultural	18,584	0.5%
Religion	47,788	1.2%
Government	11,023	0.3%
Education	20,972	0.5%
Total	**3,899,842**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 4, 4-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 5,672 buildings will be at least moderately damaged. This is over 99% of the total number of buildings in the scenario. There are an estimated 5,429 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	7	100.00
Commercial	0	0.00	2	1.08	0	0.00	0	0.00	0	0.00	183	98.92
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	100.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	3	100.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	5	7.81	59	92.19
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	10	100.00
Residential	0	0.00	1	0.02	16	0.30	37	0.69	182	3.37	5,165	95.63
Total	**0**		**3**		**16**		**37**		**187**		**5,429**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	30	100.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	23	100.00
Masonry	0	0.00	0	0.00	0	0.00	0	0.00	4	0.73	546	99.27
Steel	0	0.00	2	1.32	0	0.00	0	0.00	5	3.31	144	95.36
Wood	0	0.00	1	0.02	16	0.33	37	0.77	177	3.67	4,592	95.21

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	1	1
Hospitals	0	0	0	0
Police Stations	5	0	1	1
Schools	54	1	10	11

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 898,553 tons of debris will be generated. Of the total amount, Finishes comprises 20% of the total, Structure comprises 45% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 35,942 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 11,013 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 30,600 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 3,258.34 million dollars, which represents 83.55 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 3,250.63 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 51.48% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	1,135.25	428.13	154.10	51.62	1,769.10
	Content	540.93	508.96	309.38	59.48	1,418.75
	Inventory	0.00	15.84	45.57	1.38	62.79
	Subtotal	**1,676.18**	**952.93**	**509.04**	**112.48**	**3,250.63**
Business Interruption						
	Income	0.04	2.32	0.03	0.12	2.50
	Relocation	0.55	0.61	0.04	0.04	1.24
	Rental Income	0.39	0.43	0.00	0.00	0.83
	Wage	0.10	2.40	0.04	0.60	3.14
	Subtotal	**1.08**	**5.76**	**0.12**	**0.76**	**7.71**
ALL	**Total**	**1,677.26**	**958.68**	**509.16**	**113.24**	**3,258.34**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 4 (Extreme), 0-foot SLR

Print Date: Friday, June 06, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,641,471	67.6%
Commercial	722,026	18.5%
Industrial	448,473	11.5%
Agricultural	18,520	0.5%
Religion	47,564	1.2%
Government	11,023	0.3%
Education	20,972	0.5%
Total	**3,910,049**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 4 (Extreme), 0-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 4,765 buildings will be at least moderately damaged. This is over 92% of the total number of buildings in the scenario. There are an estimated 2,792 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	2	2.60	6	7.79	2	2.60	2	2.60	6	7.79	59	76.62
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	1	2.50	4	10.00	35	87.50
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	22	0.47	199	4.28	321	6.90	1,410	30.32	2,698	58.02
Total	**2**		**28**		**201**		**324**		**1,420**		**2,792**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	4	28.57	10	71.43
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	19	100.00
Masonry	0	0.00	2	0.49	8	1.96	7	1.72	109	26.72	282	69.12
Steel	2	2.63	4	5.26	1	1.32	2	2.63	9	11.84	58	76.32
Wood	0	0.00	24	0.57	191	4.57	314	7.51	1,286	30.74	2,368	56.61

Hazus Global Summary Report Category 4 (Extreme), 0-foot SLR

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	1	0	1
Hospitals	0	0	0	0
Police Stations	5	1	0	1
Schools	54	7	4	11

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Hazus Global Summary Report Category 4 (Extreme), 0-foot SLR

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 658,688 tons of debris will be generated. Of the total amount, Finishes comprises 21% of the total, Structure comprises 47% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 26,348 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 11,048 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 30,692 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Hazus Global Summary Report Category 4 (Extreme), 0-foot SLR

Economic Loss

The total economic loss estimated for the flood is 2,745.25 million dollars, which represents 70.21 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 2,738.04 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 49.64% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	**Area**	**Residential**	**Commercial**	**Industrial**	**Others**	**Total**
Building Loss						
	Building	880.48	328.50	136.15	30.19	1,375.32
	Content	481.28	479.61	287.29	55.45	1,303.64
	Inventory	0.00	15.28	42.53	1.28	59.08
	Subtotal	**1,361.77**	**823.39**	**465.97**	**86.92**	**2,738.04**
Business Interruption						
	Income	0.04	2.18	0.03	0.11	2.35
	Relocation	0.51	0.57	0.04	0.04	1.16
	Rental Income	0.36	0.41	0.00	0.00	0.77
	Wage	0.09	2.24	0.04	0.55	2.92
	Subtotal	**1.00**	**5.40**	**0.12**	**0.70**	**7.21**
ALL	**Total**	**1,362.77**	**828.79**	**466.08**	**87.61**	**2,745.25**

Hazus Global Summary Report Category 4 (Extreme), 0-foot SLR

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 4 (Extreme), 1-foot SLR

Print Date: Friday, June 06, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

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Note:
Appendix A contains a complete listing of the counties contained in the region.

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There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

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Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,688,948	67.7%
Commercial	729,659	18.4%
Industrial	450,184	11.3%
Agricultural	18,584	0.5%
Religion	49,971	1.3%
Government	11,023	0.3%
Education	20,972	0.5%
Total	**3,969,341**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 4 (Extreme), 1-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 4,962 buildings will be at least moderately damaged. This is over 92% of the total number of buildings in the scenario. There are an estimated 3,084 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	6	7.59	3	3.80	1	1.27	6	7.59	63	79.75
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	4	8.51	0	0.00	1	2.13	7	14.89	35	74.47
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	22	0.45	197	4.07	319	6.60	1,312	27.13	2,986	61.75
Total	**0**		**32**		**200**		**321**		**1,325**		**3,084**	

Table 4: Expected Building Damage by Building Type

Building	1-10		11-20		21-30		31-40		41-50		Substantially	
Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	1	7.69	12	92.31
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	20	100.00
Masonry	0	0.00	2	0.47	7	1.65	5	1.18	90	21.23	320	75.47
Steel	0	0.00	6	6.90	3	3.45	2	2.30	11	12.64	65	74.71
Wood	0	0.00	24	0.55	189	4.34	313	7.19	1,211	27.82	2,616	60.10

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	1	0	1
Hospitals	0	0	0	0
Police Stations	5	1	0	1
Schools	54	5	6	11

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 696,387 tons of debris will be generated. Of the total amount, Finishes comprises 21% of the total, Structure comprises 47% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 27,855 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 11,359 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 31,551 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 2,843.91 million dollars, which represents 71.65 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 2,836.53 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 49.92% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	920.41	341.90	140.46	32.55	1,435.32
	Content	498.11	489.43	295.78	57.23	1,340.54
	Inventory	0.00	15.47	43.89	1.32	60.67
	Subtotal	**1,418.52**	**846.80**	**480.13**	**91.09**	**2,836.53**
Business Interruption						
	Income	0.04	2.22	0.03	0.11	2.40
	Relocation	0.54	0.58	0.04	0.04	1.20
	Rental Income	0.37	0.42	0.00	0.00	0.79
	Wage	0.09	2.28	0.05	0.57	2.99
	Subtotal	**1.04**	**5.50**	**0.12**	**0.72**	**7.38**
ALL	**Total**	**1,419.55**	**852.30**	**480.25**	**91.81**	**2,843.91**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 4 (Extreme), 2-foot SLR

Print Date: Friday, June 06, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,726,340	67.6%
Commercial	746,119	18.5%
Industrial	452,022	11.2%
Agricultural	19,149	0.5%
Religion	49,971	1.2%
Government	11,821	0.3%
Education	27,087	0.7%
Total	**4,032,509**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 4 (Extreme), 2-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 5,083 buildings will be at least moderately damaged. This is over 92% of the total number of buildings in the scenario. There are an estimated 3,319 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	100.00
Commercial	0	0.00	6	7.50	2	2.50	1	1.25	4	5.00	67	83.75
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	4	9.09	0	0.00	1	2.27	5	11.36	34	77.27
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	24	0.48	193	3.89	311	6.27	1,213	24.47	3,216	64.88
Total	**0**		**34**		**195**		**313**		**1,222**		**3,319**	

Table 4: Expected Building Damage by Building Type

Building	1-10		11-20		21-30		31-40		41-50		Substantially	
Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	1	6.67	14	93.33
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	19	100.00
Masonry	0	0.00	2	0.46	5	1.15	6	1.38	71	16.36	350	80.65
Steel	0	0.00	6	7.06	2	2.35	2	2.35	8	9.41	67	78.82
Wood	0	0.00	26	0.58	186	4.17	304	6.82	1,131	25.36	2,813	63.07

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	1	0	1
Hospitals	0	0	0	0
Police Stations	5	1	0	1
Schools	54	5	6	11

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 726,714 tons of debris will be generated. Of the total amount, Finishes comprises 20% of the total, Structure comprises 47% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 29,069 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 11,636 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 32,330 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 2,926.33 million dollars, which represents 72.57 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 2,918.78 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 50.14% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	954.47	353.37	143.83	34.74	1,486.41
	Content	511.77	497.03	302.61	58.94	1,370.35
	Inventory	0.00	15.66	45.01	1.35	62.02
	Subtotal	**1,466.24**	**866.05**	**491.45**	**95.04**	**2,918.78**
Business Interruption						
	Income	0.04	2.25	0.03	0.12	2.44
	Relocation	0.56	0.59	0.05	0.04	1.23
	Rental Income	0.38	0.42	0.00	0.00	0.81
	Wage	0.10	2.32	0.05	0.61	3.07
	Subtotal	**1.08**	**5.58**	**0.13**	**0.76**	**7.54**
ALL	**Total**	**1,467.32**	**871.64**	**491.58**	**95.80**	**2,926.33**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 4 (Extreme), 4-foot SLR

Print Date: Friday, June 06, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region .

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B .

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,780,618	67.3%
Commercial	788,213	19.1%
Industrial	451,676	10.9%
Agricultural	19,295	0.5%
Religion	53,283	1.3%
Government	11,821	0.3%
Education	27,202	0.7%
Total	**4,132,108**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 4 (Extreme), 4-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 5,480 buildings will be at least moderately damaged. This is over 93% of the total number of buildings in the scenario. There are an estimated 3,830 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00
Commercial	0	0.00	4	4.26	3	3.19	2	2.13	2	2.13	83	88.30
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	4	6.78	6	10.17	2	3.39	0	0.00	6	10.17	41	69.49
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00
Residential	0	0.00	26	0.49	186	3.49	312	5.85	1,101	20.66	3,704	69.51
Total	**4**		**36**		**191**		**314**		**1,109**		**3,830**	

Table 4: Expected Building Damage by Building Type

	1-10		11-20		21-30		31-40		41-50		Substantially	
Building Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	15	100.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	15	100.00
Masonry	0	0.00	2	0.42	4	0.85	6	1.27	52	10.99	409	86.47
Steel	2	1.98	6	5.94	4	3.96	2	1.98	7	6.93	80	79.21
Wood	0	0.00	26	0.54	180	3.76	305	6.37	1,039	21.69	3,240	67.64

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	1	0	1
Hospitals	0	0	0	0
Police Stations	5	2	0	2
Schools	54	5	8	13

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 790,409 tons of debris will be generated. Of the total amount, Finishes comprises 20% of the total, Structure comprises 46% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 31,616 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 12,252 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 34,211 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 3,121.78 million dollars, which represents 75.55 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 3,113.77 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 50.48% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	1,030.80	381.31	152.28	39.00	1,603.39
	Content	543.90	518.45	319.30	63.40	1,445.04
	Inventory	0.00	15.99	47.95	1.41	65.34
	Subtotal	**1,574.69**	**915.75**	**519.53**	**103.81**	**3,113.77**
Business Interruption						
	Income	0.04	2.35	0.03	0.13	2.55
	Relocation	0.59	0.61	0.05	0.05	1.30
	Rental Income	0.41	0.44	0.01	0.00	0.86
	Wage	0.10	2.47	0.05	0.68	3.30
	Subtotal	**1.15**	**5.86**	**0.14**	**0.86**	**8.01**
ALL	**Total**	**1,575.84**	**921.61**	**519.66**	**104.66**	**3,121.78**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 1, 0-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

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Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	396,672	70.9%
Commercial	89,927	16.1%
Industrial	57,647	10.3%
Agricultural	8,824	1.6%
Religion	4,335	0.8%
Government	764	0.1%
Education	1,665	0.3%
Total	**559,834**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 1, 0-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 194 buildings will be at least moderately damaged. This is over 40% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	48	24.74	119	61.34	8	4.12	19	9.79	0	0.00
Total	**0**		**48**		**119**		**8**		**19**		**0**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	0	0.00	0	0.00	1	100.00	0	0.00	0	0.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	48	24.87	118	61.14	8	4.15	19	9.84	0	0.00

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 6,168 tons of debris will be generated. Of the total amount, Finishes comprises 40% of the total, Structure comprises 37% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 247 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 459 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 818 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 34.18 million dollars, which represents 6.11 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 34.11 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 76.44% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	15.61	0.97	0.57	0.40	17.54
	Content	10.50	3.22	1.23	1.20	16.15
	Inventory	0.00	0.06	0.22	0.13	0.42
	Subtotal	**26.11**	**4.25**	**2.03**	**1.73**	**34.11**
Business Interruption						
	Income	0.00	0.02	0.00	0.00	0.02
	Relocation	0.02	0.00	0.00	0.00	0.02
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.02	0.00	0.01	0.03
	Subtotal	**0.02**	**0.04**	**0.00**	**0.01**	**0.07**
ALL	**Total**	**26.13**	**4.29**	**2.03**	**1.74**	**34.18**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 1, 0-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	396,672	70.9%
Commercial	89,927	16.1%
Industrial	57,647	10.3%
Agricultural	8,824	1.6%
Religion	4,335	0.8%
Government	764	0.1%
Education	1,665	0.3%
Total	**559,834**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 1, 0-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 194 buildings will be at least moderately damaged. This is over 40% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	48	24.74	119	61.34	8	4.12	19	9.79	0	0.00
Total	**0**		**48**		**119**		**8**		**19**		**0**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	0	0.00	0	0.00	1	100.00	0	0.00	0	0.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	48	24.87	118	61.14	8	4.15	19	9.84	0	0.00

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

Classification	Total	# Facilities: At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Hazus Global Summary Report Category 1, 0-foot SLR

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 6,168 tons of debris will be generated. Of the total amount, Finishes comprises 40% of the total, Structure comprises 37% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 247 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 459 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 818 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Hazus Global Summary Report Category 1, 0-foot SLR

Economic Loss

The total economic loss estimated for the flood is 34.18 million dollars, which represents 6.11 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 34.11 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 76.44% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	15.61	0.97	0.57	0.40	17.54
	Content	10.50	3.22	1.23	1.20	16.15
	Inventory	0.00	0.06	0.22	0.13	0.42
	Subtotal	**26.11**	**4.25**	**2.03**	**1.73**	**34.11**
Business Interruption						
	Income	0.00	0.02	0.00	0.00	0.02
	Relocation	0.02	0.00	0.00	0.00	0.02
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.02	0.00	0.01	0.03
	Subtotal	**0.02**	**0.04**	**0.00**	**0.01**	**0.07**
ALL	**Total**	**26.13**	**4.29**	**2.03**	**1.74**	**34.18**

Hazus Global Summary Report Category 1, 0-foot SLR

Appendix A: County Listing for the Region

Massachusetts

- Bristol

Hazus Global Summary Report Category 1, 0-foot SLR

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 1, 1-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region .

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B .

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	424,734	72.2%
Commercial	90,414	15.4%
Industrial	57,935	9.8%
Agricultural	8,824	1.5%
Religion	4,335	0.7%
Government	764	0.1%
Education	1,665	0.3%
Total	**588,671**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Hazus Global Summary Report Category 1, 1-foot SLR

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 1, 1-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Hazus Global Summary Report Category 1, 1-foot SLR

Building Damage

General Building Stock Damage

Hazus estimates that about 247 buildings will be at least moderately damaged. This is over 45% of the total number of buildings in the scenario. There are an estimated 2 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	47	19.03	142	57.49	28	11.34	28	11.34	2	0.81
Total	**0**		**47**		**142**		**28**		**28**		**2**	

Table 4: Expected Building Damage by Building Type

	1-10		11-20		21-30		31-40		41-50		Substantially	
Building Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	0	0.00	0	0.00	1	100.00	0	0.00	0	0.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	47	19.11	141	57.32	28	11.38	28	11.38	2	0.81

Hazus Global Summary Report Category 1, 1-foot SLR

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.
(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Hazus Global Summary Report Category 1, 1-foot SLR

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 9,058 tons of debris will be generated. Of the total amount, Finishes comprises 37% of the total, Structure comprises 38% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 362 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 521 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 977 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 44.47 million dollars, which represents 7.55 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 44.38 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 76.97% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	20.34	1.28	0.76	0.50	22.88
	Content	13.86	4.06	1.61	1.44	20.97
	Inventory	0.00	0.08	0.30	0.16	0.53
	Subtotal	**34.20**	**5.42**	**2.67**	**2.10**	**44.38**
Business Interruption						
	Income	0.00	0.02	0.00	0.00	0.03
	Relocation	0.03	0.00	0.00	0.00	0.03
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.02	0.00	0.01	0.03
	Subtotal	**0.03**	**0.05**	**0.00**	**0.01**	**0.09**
ALL	**Total**	**34.23**	**5.47**	**2.67**	**2.10**	**44.47**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 1, 2-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	456,043	73.1%
Commercial	92,424	14.8%
Industrial	58,168	9.3%
Agricultural	8,824	1.4%
Religion	4,335	0.7%
Government	764	0.1%
Education	3,195	0.5%
Total	**623,753**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 1, 2-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 313 buildings will be at least moderately damaged. This is over 52% of the total number of buildings in the scenario. There are an estimated 2 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	40	12.78	155	49.52	72	23.00	44	14.06	2	0.64
Total	**0**		**40**		**155**		**72**		**44**		**2**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	0	0.00	0	0.00	1	50.00	1	50.00	0	0.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	40	12.86	154	49.52	71	22.83	44	14.15	2	0.64

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 12,469 tons of debris will be generated. Of the total amount, Finishes comprises 35% of the total, Structure comprises 40% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 499 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 583 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 1,124 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 57.47 million dollars, which represents 9.21 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 57.36 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 77.79% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	26.49	1.70	0.94	0.64	29.76
	Content	18.18	5.08	1.96	1.72	26.94
	Inventory	0.00	0.11	0.37	0.18	0.66
	Subtotal	**44.67**	**6.89**	**3.27**	**2.54**	**57.36**
Business Interruption						
	Income	0.00	0.03	0.00	0.00	0.03
	Relocation	0.04	0.00	0.00	0.00	0.04
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.03	0.00	0.01	0.04
	Subtotal	**0.04**	**0.05**	**0.00**	**0.01**	**0.11**
ALL	**Total**	**44.71**	**6.95**	**3.27**	**2.55**	**57.47**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 1, 4-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	519,768	74.7%
Commercial	97,884	14.1%
Industrial	58,845	8.5%
Agricultural	9,045	1.3%
Religion	4,843	0.7%
Government	2,142	0.3%
Education	3,195	0.5%
Total	**695,722**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 1, 4-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 481 buildings will be at least moderately damaged. This is over 66% of the total number of buildings in the scenario. There are an estimated 3 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	26	5.41	204	42.41	147	30.56	101	21.00	3	0.62
Total	**0**		**26**		**204**		**147**		**101**		**3**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	0	0.00	0	0.00	2	50.00	1	25.00	1	25.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	26	5.45	202	42.35	146	30.61	100	20.96	3	0.63

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 24,150 tons of debris will be generated. Of the total amount, Finishes comprises 30% of the total, Structure comprises 43% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 966 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 711 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 1,435 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 94.07 million dollars, which represents 13.52 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 93.91 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 78.14% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	**Area**	**Residential**	**Commercial**	**Industrial**	**Others**	**Total**
Building Loss						
	Building	43.39	2.92	1.68	0.98	48.97
	Content	30.06	7.80	3.59	2.36	43.81
	Inventory	0.00	0.18	0.72	0.24	1.13
	Subtotal	**73.44**	**10.90**	**5.99**	**3.58**	**93.91**
Business Interruption						
	Income	0.00	0.03	0.00	0.00	0.04
	Relocation	0.06	0.00	0.00	0.00	0.07
	Rental Income	0.01	0.00	0.00	0.00	0.01
	Wage	0.00	0.04	0.00	0.01	0.05
	Subtotal	**0.07**	**0.07**	**0.00**	**0.02**	**0.16**
ALL	**Total**	**73.51**	**10.98**	**5.99**	**3.60**	**94.07**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 2, 0-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	532,058	75.1%
Commercial	98,355	13.9%
Industrial	58,845	8.3%
Agricultural	9,126	1.3%
Religion	4,843	0.7%
Government	2,142	0.3%
Education	3,195	0.5%
Total	**708,564**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 2, 0-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 524 buildings will be at least moderately damaged. This is over 69% of the total number of buildings in the scenario. There are an estimated 6 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	23	4.39	196	37.40	174	33.21	125	23.85	6	1.15
Total	**0**		**23**		**196**		**174**		**125**		**6**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00
Masonry	0	0.00	0	0.00	1	25.00	2	50.00	1	25.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	23	4.43	195	37.57	172	33.14	124	23.89	5	0.96

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Hazus Global Summary Report Category 2, 0-foot SLR

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 28,128 tons of debris will be generated. Of the total amount, Finishes comprises 29% of the total, Structure comprises 44% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 1,125 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 746 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 1,538 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Hazus Global Summary Report Category 2, 0-foot SLR

Economic Loss

The total economic loss estimated for the flood is 104.51 million dollars, which represents 14.75 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 104.33 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 77.92% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	48.07	3.30	1.91	1.15	54.44
	Content	33.29	8.55	4.14	2.63	48.61
	Inventory	0.00	0.20	0.83	0.26	1.29
	Subtotal	**81.36**	**12.05**	**6.89**	**4.04**	**104.33**
Business Interruption						
	Income	0.00	0.04	0.00	0.01	0.04
	Relocation	0.07	0.00	0.00	0.00	0.07
	Rental Income	0.01	0.00	0.00	0.00	0.01
	Wage	0.00	0.04	0.00	0.02	0.05
	Subtotal	**0.07**	**0.08**	**0.00**	**0.02**	**0.18**
ALL	**Total**	**81.43**	**12.13**	**6.89**	**4.06**	**104.51**

Hazus Global Summary Report Category 2, 0-foot SLR

Appendix A: County Listing for the Region

Massachusetts

- Bristol

Hazus Global Summary Report Category 2, 0-foot SLR

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 2, 1-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region .

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B .

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	545,478	75.4%
Commercial	99,540	13.8%
Industrial	58,922	8.1%
Agricultural	9,126	1.3%
Religion	4,843	0.7%
Government	2,142	0.3%
Education	3,195	0.4%
Total	**723,246**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	40mb_1_meters
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 583 buildings will be at least moderately damaged. This is over 73% of the total number of buildings in the scenario. There are an estimated 6 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	21	3.60	198	33.96	183	31.39	175	30.02	6	1.03
Total	**0**		**21**		**198**		**183**		**175**		**6**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00
Masonry	0	0.00	0	0.00	1	20.00	2	40.00	2	40.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	21	3.64	197	34.14	181	31.37	173	29.98	5	0.87

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.
(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 32,522 tons of debris will be generated. Of the total amount, Finishes comprises 28% of the total, Structure comprises 44% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 1,301 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 786 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 1,632 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 117.23 million dollars, which represents 16.21 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 117.03 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 77.58% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	53.72	3.79	2.23	1.33	61.07
	Content	37.15	9.48	4.93	2.91	54.46
	Inventory	0.00	0.22	1.00	0.28	1.50
	Subtotal	**90.87**	**13.48**	**8.16**	**4.52**	**117.03**
Business Interruption						
	Income	0.00	0.04	0.00	0.01	0.05
	Relocation	0.08	0.00	0.00	0.00	0.08
	Rental Income	0.01	0.00	0.00	0.00	0.01
	Wage	0.00	0.04	0.00	0.02	0.06
	Subtotal	**0.08**	**0.09**	**0.00**	**0.03**	**0.20**
ALL	**Total**	**90.95**	**13.57**	**8.16**	**4.55**	**117.23**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: 40mb_2_meters

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

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Hazus Global Summary Report Category 2, 2-foot SLR

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Hazus Global Summary Report Category 2, 2-foot SLR

General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region .

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B .

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Hazus Global Summary Report Category 2, 2-foot SLR

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	558,055	75.7%
Commercial	100,270	13.6%
Industrial	59,084	8.0%
Agricultural	9,126	1.2%
Religion	4,843	0.7%
Government	2,142	0.3%
Education	3,195	0.4%
Total	**736,715**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Hazus Global Summary Report Category 2, 2-foot SLR

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 2, 2-foot SLR
Return Period Analyzed:	Mix0 No What-Ifs
Analysis Options Analyzed:	

Building Damage

General Building Stock Damage

Hazus estimates that about 658 buildings will be at least moderately damaged. This is over 76% of the total number of buildings in the scenario. There are an estimated 7 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	21	3.19	184	27.96	207	31.46	239	36.32	7	1.06
Total	**0**		**21**		**184**		**207**		**239**		**7**	

Table 4: Expected Building Damage by Building Type

	1-10		11-20		21-30		31-40		41-50		Substantially	
Building Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00
Masonry	0	0.00	0	0.00	1	14.29	2	28.57	4	57.14	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	21	3.23	183	28.15	205	31.54	235	36.15	6	0.92

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 37,969 tons of debris will be generated. Of the total amount, Finishes comprises 27% of the total, Structure comprises 45% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 1,519 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 837 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 1,769 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 132.79 million dollars, which represents 18.02 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 132.58 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 77.04% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	60.50	4.40	2.70	1.53	69.13
	Content	41.71	10.59	6.09	3.24	61.63
	Inventory	0.00	0.26	1.25	0.30	1.81
	Subtotal	**102.22**	**15.25**	**10.05**	**5.06**	**132.58**
Business Interruption						
	Income	0.00	0.04	0.00	0.01	0.05
	Relocation	0.08	0.00	0.00	0.00	0.09
	Rental Income	0.01	0.00	0.00	0.00	0.01
	Wage	0.00	0.04	0.00	0.02	0.06
	Subtotal	**0.09**	**0.09**	**0.00**	**0.03**	**0.22**
ALL	**Total**	**102.31**	**15.34**	**10.05**	**5.09**	**132.79**

Hazus Global Summary Report Category 2, 2-foot SLR

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Hazus Global Summary Report Category 2, 2-foot SLR

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus Global Summary Report Category 2, 2-foot SLR

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 2, 4-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

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Hazus Global Summary Report Category 2, 4-foot SLR

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,409,507	63.2%
Commercial	513,925	23.0%
Industrial	254,935	11.4%
Agricultural	14,435	0.6%
Religion	21,979	1.0%
Government	4,241	0.2%
Education	12,182	0.5%
Total	**2,231,204**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 2, 4-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 1,508 buildings will be at least moderately damaged. This is over 74% of the total number of buildings in the scenario. There are an estimated 24 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	5	18.52	14	51.85	3	11.11	1	3.70	3	11.11	1	3.70
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	3	21.43	6	42.86	1	7.14	3	21.43	1	7.14	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	30	2.03	287	19.46	391	26.51	744	50.44	23	1.56
Total	**8**		**50**		**291**		**395**		**748**		**24**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	1	12.50	0	0.00	0	0.00	7	87.50	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00
Masonry	2	1.34	5	3.36	16	10.74	22	14.77	104	69.80	0	0.00
Steel	5	17.24	10	34.48	2	6.90	4	13.79	8	27.59	0	0.00
Wood	1	0.08	31	2.36	264	20.14	367	27.99	626	47.75	22	1.68

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	4	0	4

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 76,113 tons of debris will be generated. Of the total amount, Finishes comprises 39% of the total, Structure comprises 37% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 3,045 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 4,360 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 11,720 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 700.66 million dollars, which represents 31.40 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 698.18 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 48.48% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	204.38	72.20	26.34	3.71	306.62
	Content	135.04	157.06	68.47	13.80	374.37
	Inventory	0.00	5.28	11.44	0.48	17.19
	Subtotal	**339.43**	**234.53**	**106.24**	**17.98**	**698.18**
Business Interruption						
	Income	0.01	0.78	0.01	0.02	0.81
	Relocation	0.15	0.26	0.01	0.01	0.43
	Rental Income	0.11	0.19	0.00	0.00	0.30
	Wage	0.02	0.78	0.01	0.13	0.94
	Subtotal	**0.28**	**2.01**	**0.04**	**0.16**	**2.48**
ALL	**Total**	**339.71**	**236.54**	**106.28**	**18.14**	**700.66**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 3, 0-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Hazus Global Summary Report Category 3, 0-foot SLR

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,295,657	65.2%
Commercial	430,036	21.6%
Industrial	216,644	10.9%
Agricultural	12,765	0.6%
Religion	15,954	0.8%
Government	4,241	0.2%
Education	11,846	0.6%
Total	**1,987,143**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Hazus Global Summary Report Category 3, 0-foot SLR

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 3, 0-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Hazus Global Summary Report Category 3, 0-foot SLR

Building Damage

General Building Stock Damage

Hazus estimates that about 1,635 buildings will be at least moderately damaged. This is over 82% of the total number of buildings in the scenario. There are an estimated 44 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	6	33.33	4	22.22	2	11.11	4	22.22	2	11.11
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	1	12.50	2	25.00	1	12.50	1	12.50	3	37.50	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	24	1.49	254	15.78	386	23.98	904	56.15	42	2.61
Total	**1**		**32**		**259**		**389**		**911**		**44**	

Table 4: Expected Building Damage by Building Type

Building	1-10		11-20		21-30		31-40		41-50		Substantially	
Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	10	100.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00
Masonry	0	0.00	1	0.60	13	7.74	23	13.69	129	76.79	2	1.19
Steel	1	3.85	7	26.92	3	11.54	3	11.54	11	42.31	1	3.85
Wood	0	0.00	24	1.69	241	16.98	362	25.51	753	53.07	39	2.75

Hazus Global Summary Report Category 3, 0-foot SLR

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	4	0	4

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 87,273 tons of debris will be generated. Of the total amount, Finishes comprises 37% of the total, Structure comprises 39% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 3,491 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 4,229 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 11,517 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 699.46 million dollars, which represents 35.20 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 697.28 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 52.80% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	223.56	73.30	22.46	3.79	323.11
	Content	145.49	146.38	55.31	12.77	359.94
	Inventory	0.00	5.13	8.61	0.49	14.23
	Subtotal	**369.04**	**224.81**	**86.38**	**17.05**	**697.28**
Business Interruption						
	Income	0.00	0.71	0.00	0.02	0.73
	Relocation	0.16	0.23	0.01	0.00	0.41
	Rental Income	0.11	0.18	0.00	0.00	0.29
	Wage	0.00	0.65	0.01	0.11	0.76
	Subtotal	**0.28**	**1.76**	**0.02**	**0.13**	**2.19**
ALL	**Total**	**369.32**	**226.57**	**86.39**	**17.19**	**699.46**

Appendix A: County Listing for the Region

Massachusetts

- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 3, 1-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region .

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B .

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,527,386	61.0%
Commercial	529,818	21.2%
Industrial	392,890	15.7%
Agricultural	14,684	0.6%
Religion	22,995	0.9%
Government	4,508	0.2%
Education	12,182	0.5%
Total	**2,504,463**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name: New Bedford, Fairhaven and Acushnet
Scenario Name: Category 3, 1-foot SLR
Return Period Analyzed: Mix0
Analysis Options Analyzed: No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 1,856 buildings will be at least moderately damaged. This is over 78% of the total number of buildings in the scenario. There are an estimated 88 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	6	16.22	18	48.65	4	10.81	2	5.41	4	10.81	3	8.11
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	2	13.33	7	46.67	1	6.67	2	13.33	3	20.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	31	1.71	250	13.80	387	21.36	1,059	58.44	85	4.69
Total	**8**		**56**		**255**		**391**		**1,066**		**88**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	1	10.00	0	0.00	0	0.00	9	90.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00
Masonry	2	1.05	8	4.21	10	5.26	20	10.53	146	76.84	4	2.11
Steel	5	12.82	14	35.90	4	10.26	3	7.69	11	28.21	2	5.13
Wood	1	0.06	33	2.05	238	14.76	366	22.70	892	55.33	82	5.09

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	4	0	4

If this report displays all zeros or is blank, two possibilities can explain this.
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.
(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 108,718 tons of debris will be generated. Of the total amount, Finishes comprises 35% of the total, Structure comprises 40% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 4,349 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 4,942 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 13,240 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 873.34 million dollars, which represents 34.87 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 870.45 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 48.65% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	256.81	90.60	33.69	5.03	386.13
	Content	167.76	190.44	86.48	18.10	462.78
	Inventory	0.00	6.54	14.42	0.58	21.54
	Subtotal	**424.57**	**287.58**	**134.59**	**23.71**	**870.45**
Business Interruption						
	Income	0.01	0.89	0.01	0.03	0.94
	Relocation	0.19	0.29	0.02	0.01	0.50
	Rental Income	0.13	0.22	0.00	0.00	0.35
	Wage	0.02	0.91	0.02	0.16	1.10
	Subtotal	**0.34**	**2.31**	**0.04**	**0.19**	**2.89**
ALL	**Total**	**424.91**	**289.89**	**134.63**	**23.91**	**873.34**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 3, 2-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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Note:
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The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B .

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

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Building Exposure by Occupancy Type for the Study Region

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Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,134,832	64.9%
Commercial	647,210	19.7%
Industrial	432,413	13.1%
Agricultural	17,893	0.5%
Religion	31,935	1.0%
Government	8,244	0.3%
Education	16,199	0.5%
Total	**3,288,726**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 3, 2-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 3,125 buildings will be at least moderately damaged. This is over 86% of the total number of buildings in the scenario. There are an estimated 850 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	4	8.51	4	8.51	8	17.02	17	36.17	14	29.79
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	1	4.55	1	4.55	3	13.64	17	77.27
Religion	0	0.00	1	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	37	1.21	275	9.00	488	15.97	1,436	47.00	819	26.81
Total	**0**		**42**		**280**		**497**		**1,456**		**850**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	1	7.14	0	0.00	0	0.00	11	78.57	2	14.29
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	4	100.00
Masonry	0	0.00	2	0.72	10	3.61	13	4.69	179	64.62	73	26.35
Steel	0	0.00	3	5.88	4	7.84	7	13.73	20	39.22	17	33.33
Wood	0	0.00	35	1.27	265	9.63	473	17.19	1,236	44.91	743	27.00

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	1	0	1
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	9	0	9

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 292,035 tons of debris will be generated. Of the total amount, Finishes comprises 25% of the total, Structure comprises 45% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 11,681 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 8,089 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 22,233 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 1,837.92 million dollars, which represents 55.89 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 1,832.69 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 45.45% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	517.43	194.72	102.50	12.80	827.44
	Content	317.22	366.96	231.98	40.95	957.11
	Inventory	0.00	12.41	34.75	0.99	48.14
	Subtotal	**834.65**	**574.09**	**369.22**	**54.73**	**1,832.69**
Business Interruption						
	Income	0.03	1.57	0.02	0.07	1.69
	Relocation	0.31	0.45	0.04	0.02	0.81
	Rental Income	0.23	0.32	0.00	0.00	0.55
	Wage	0.07	1.69	0.04	0.38	2.17
	Subtotal	**0.64**	**4.03**	**0.10**	**0.46**	**5.23**
ALL	**Total**	**835.29**	**578.12**	**369.32**	**55.20**	**1,837.92**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 3, 4-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,339,595	65.8%
Commercial	691,946	19.5%
Industrial	435,062	12.2%
Agricultural	18,205	0.5%
Religion	41,933	1.2%
Government	8,244	0.2%
Education	20,851	0.6%
Total	**3,555,836**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 3, 4-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 3,798 buildings will be at least moderately damaged. This is over 89% of the total number of buildings in the scenario. There are an estimated 1,399 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	2	3.33	6	10.00	7	11.67	2	3.33	10	16.67	33	55.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	1	3.45	5	17.24	23	79.31
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	35	0.94	252	6.79	470	12.67	1,611	43.41	1,343	36.19
Total	**2**		**41**		**259**		**473**		**1,626**		**1,399**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	1	6.67	0	0.00	0	0.00	11	73.33	3	20.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	9	100.00
Masonry	0	0.00	1	0.30	11	3.31	6	1.81	182	54.82	132	39.76
Steel	2	3.13	4	6.25	5	7.81	3	4.69	19	29.69	31	48.44
Wood	0	0.00	33	0.99	240	7.20	463	13.89	1,396	41.87	1,202	36.05

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	1	0	1
Hospitals	0	0	0	0
Police Stations	5	1	0	1
Schools	54	9	0	9

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 431,555 tons of debris will be generated. Of the total amount, Finishes comprises 22% of the total, Structure comprises 46% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 17,262 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 9,298 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 25,651 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 2,198.89 million dollars, which represents 61.84 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 2,192.78 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 47.12% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	**Area**	**Residential**	**Commercial**	**Industrial**	**Others**	**Total**
Building Loss						
	Building	651.98	249.30	116.96	18.81	1,037.04
	Content	383.28	418.06	254.81	46.95	1,103.08
	Inventory	0.00	13.76	37.80	1.10	52.66
	Subtotal	**1,035.25**	**681.12**	**409.56**	**66.85**	**2,192.78**
Business Interruption						
	Income	0.03	1.85	0.03	0.08	1.99
	Relocation	0.41	0.50	0.04	0.03	0.97
	Rental Income	0.28	0.36	0.00	0.00	0.65
	Wage	0.08	1.94	0.04	0.44	2.50
	Subtotal	**0.80**	**4.66**	**0.11**	**0.55**	**6.11**
ALL	**Total**	**1,036.05**	**685.77**	**409.66**	**67.40**	**2,198.89**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 4, 0-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,443,528	66.4%
Commercial	702,480	19.1%
Industrial	436,326	11.9%
Agricultural	18,285	0.5%
Religion	45,724	1.2%
Government	10,618	0.3%
Education	20,972	0.6%
Total	**3,677,933**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 4, 0-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 4,067 buildings will be at least moderately damaged. This is over 90% of the total number of buildings in the scenario. There are an estimated 1,718 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	2	3.28	3	4.92	6	9.84	4	6.56	5	8.20	41	67.21
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	1	3.13	4	12.50	27	84.38
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	27	0.68	232	5.84	445	11.19	1,622	40.79	1,650	41.50
Total	**2**		**30**		**238**		**450**		**1,631**		**1,718**	

Table 4: Expected Building Damage by Building Type

Building	1-10		11-20		21-30		31-40		41-50		Substantially	
Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	11	78.57	3	21.43
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	14	100.00
Masonry	0	0.00	0	0.00	13	3.76	8	2.31	174	50.29	151	43.64
Steel	2	2.99	3	4.48	4	5.97	5	7.46	16	23.88	37	55.22
Wood	0	0.00	26	0.73	218	6.09	437	12.22	1,415	39.56	1,481	41.40

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	1	0	1
Hospitals	0	0	0	0
Police Stations	5	1	0	1
Schools	54	10	1	11

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 486,966 tons of debris will be generated. Of the total amount, Finishes comprises 22% of the total, Structure comprises 46% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 19,479 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 9,793 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 27,019 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 2,343.16 million dollars, which represents 63.71 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 2,336.77 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 48.12% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	715.73	267.58	121.91	21.26	1,126.48
	Content	410.96	433.13	262.95	49.09	1,156.13
	Inventory	0.00	14.14	38.88	1.14	54.16
	Subtotal	**1,126.69**	**714.85**	**423.74**	**71.49**	**2,336.77**
Business Interruption						
	Income	0.03	1.93	0.03	0.09	2.07
	Relocation	0.43	0.52	0.04	0.03	1.02
	Rental Income	0.31	0.37	0.00	0.00	0.69
	Wage	0.08	2.02	0.04	0.47	2.62
	Subtotal	**0.86**	**4.84**	**0.11**	**0.59**	**6.39**
ALL	**Total**	**1,127.55**	**719.69**	**423.85**	**72.08**	**2,343.16**

Appendix A: County Listing for the Region

Massachusetts

- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 4, 1-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

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Building Exposure by Occupancy Type for the Study Region

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Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,482,489	66.5%
Commercial	706,666	18.9%
Industrial	444,572	11.9%
Agricultural	18,285	0.5%
Religion	46,768	1.3%
Government	10,618	0.3%
Education	20,972	0.6%
Total	**3,730,370**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 4, 1-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 4,291 buildings will be at least moderately damaged. This is over 91% of the total number of buildings in the scenario. There are an estimated 2,016 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	2	3.28	5	8.20	3	4.92	5	8.20	3	4.92	43	70.49
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	1	3.03	4	12.12	28	84.85
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	29	0.69	217	5.17	403	9.60	1,605	38.22	1,945	46.32
Total	**2**		**34**		**220**		**409**		**1,612**		**2,016**	

Table 4: Expected Building Damage by Building Type

Building	1-10		11-20		21-30		31-40		41-50		Substantially	
Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	1	5.88	0	0.00	12	70.59	4	23.53
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	15	100.00
Masonry	0	0.00	0	0.00	10	2.79	9	2.51	156	43.45	184	51.25
Steel	2	2.94	3	4.41	2	2.94	5	7.35	13	19.12	43	63.24
Wood	0	0.00	29	0.77	207	5.48	394	10.44	1,416	37.52	1,728	45.79

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	1	0	1
Hospitals	0	0	0	0
Police Stations	5	1	0	1
Schools	54	10	1	11

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.
(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 542,153 tons of debris will be generated. Of the total amount, Finishes comprises 22% of the total, Structure comprises 46% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 21,686 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 10,203 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 28,219 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 2,473.23 million dollars, which represents 66.30 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 2,466.58 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 48.66% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	768.46	287.67	126.35	23.82	1,206.30
	Content	434.17	448.85	270.39	51.14	1,204.54
	Inventory	0.00	14.55	40.02	1.18	55.74
	Subtotal	**1,202.63**	**751.06**	**436.76**	**76.13**	**2,466.58**
Business Interruption						
	Income	0.03	2.00	0.03	0.10	2.16
	Relocation	0.46	0.54	0.04	0.03	1.07
	Rental Income	0.33	0.38	0.00	0.00	0.72
	Wage	0.08	2.09	0.04	0.49	2.71
	Subtotal	**0.91**	**5.01**	**0.11**	**0.62**	**6.65**
ALL	**Total**	**1,203.54**	**756.07**	**436.87**	**76.75**	**2,473.23**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 4, 2-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region .

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B .

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,598,362	67.3%
Commercial	714,835	18.5%
Industrial	448,090	11.6%
Agricultural	18,520	0.5%
Religion	47,350	1.2%
Government	11,023	0.3%
Education	20,972	0.5%
Total	**3,859,152**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 4, 2-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 4,490 buildings will be at least moderately damaged. This is over 92% of the total number of buildings in the scenario. There are an estimated 2,308 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	2	2.90	6	8.70	2	2.90	4	5.80	5	7.25	50	72.46
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	1	2.94	3	8.82	30	88.24
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	26	0.59	211	4.81	369	8.41	1,555	35.43	2,228	50.76
Total	**2**		**32**		**213**		**374**		**1,563**		**2,308**	

Table 4: Expected Building Damage by Building Type

	1-10		11-20		21-30		31-40		41-50		Substantially	
Building Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	1	5.56	0	0.00	8	44.44	9	50.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	16	100.00
Masonry	0	0.00	2	0.51	10	2.56	10	2.56	143	36.67	225	57.69
Steel	2	2.90	4	5.80	1	1.45	4	5.80	11	15.94	47	68.12
Wood	0	0.00	28	0.71	201	5.09	360	9.12	1,392	35.26	1,967	49.82

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	1	0	1
Hospitals	0	0	0	0
Police Stations	5	1	0	1
Schools	54	10	1	11

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 587,252 tons of debris will be generated. Of the total amount, Finishes comprises 21% of the total, Structure comprises 46% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 23,490 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 10,513 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 29,120 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 2,577.01 million dollars, which represents 66.78 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 2,570.16 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 49.04% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	810.41	303.37	130.03	26.09	1,269.90
	Content	452.40	461.04	276.95	52.75	1,243.13
	Inventory	0.00	14.88	41.04	1.22	57.13
	Subtotal	**1,262.81**	**779.28**	**448.02**	**80.05**	**2,570.16**
Business Interruption						
	Income	0.03	2.07	0.03	0.10	2.23
	Relocation	0.48	0.55	0.04	0.03	1.10
	Rental Income	0.34	0.40	0.00	0.00	0.74
	Wage	0.09	2.14	0.04	0.51	2.79
	Subtotal	**0.94**	**5.16**	**0.11**	**0.65**	**6.86**
ALL	**Total**	**1,263.75**	**784.44**	**448.13**	**80.70**	**2,577.01**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 4, 4-foot SLR

Print Date: Friday, June 06, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region .

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B .

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,632,545	67.5%
Commercial	720,472	18.5%
Industrial	448,458	11.5%
Agricultural	18,584	0.5%
Religion	47,788	1.2%
Government	11,023	0.3%
Education	20,972	0.5%
Total	**3,899,842**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 4, 4-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 5,672 buildings will be at least moderately damaged. This is over 99% of the total number of buildings in the scenario. There are an estimated 5,429 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	7	100.00
Commercial	0	0.00	2	1.08	0	0.00	0	0.00	0	0.00	183	98.92
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	100.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	3	100.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	5	7.81	59	92.19
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	10	100.00
Residential	0	0.00	1	0.02	16	0.30	37	0.69	182	3.37	5,165	95.63
Total	**0**		**3**		**16**		**37**		**187**		**5,429**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	30	100.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	23	100.00
Masonry	0	0.00	0	0.00	0	0.00	0	0.00	4	0.73	546	99.27
Steel	0	0.00	2	1.32	0	0.00	0	0.00	5	3.31	144	95.36
Wood	0	0.00	1	0.02	16	0.33	37	0.77	177	3.67	4,592	95.21

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	1	1
Hospitals	0	0	0	0
Police Stations	5	0	1	1
Schools	54	1	10	11

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 898,553 tons of debris will be generated. Of the total amount, Finishes comprises 20% of the total, Structure comprises 45% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 35,942 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 11,013 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 30,600 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 3,258.34 million dollars, which represents 83.55 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 3,250.63 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 51.48% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	1,135.25	428.13	154.10	51.62	1,769.10
	Content	540.93	508.96	309.38	59.48	1,418.75
	Inventory	0.00	15.84	45.57	1.38	62.79
	Subtotal	**1,676.18**	**952.93**	**509.04**	**112.48**	**3,250.63**
Business Interruption						
	Income	0.04	2.32	0.03	0.12	2.50
	Relocation	0.55	0.61	0.04	0.04	1.24
	Rental Income	0.39	0.43	0.00	0.00	0.83
	Wage	0.10	2.40	0.04	0.60	3.14
	Subtotal	**1.08**	**5.76**	**0.12**	**0.76**	**7.71**
ALL	**Total**	**1,677.26**	**958.68**	**509.16**	**113.24**	**3,258.34**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 4 (Extreme), 0-foot SLR

Print Date: Friday, June 06, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,641,471	67.6%
Commercial	722,026	18.5%
Industrial	448,473	11.5%
Agricultural	18,520	0.5%
Religion	47,564	1.2%
Government	11,023	0.3%
Education	20,972	0.5%
Total	**3,910,049**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 4 (Extreme), 0-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 4,765 buildings will be at least moderately damaged. This is over 92% of the total number of buildings in the scenario. There are an estimated 2,792 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	2	2.60	6	7.79	2	2.60	2	2.60	6	7.79	59	76.62
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	1	2.50	4	10.00	35	87.50
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	22	0.47	199	4.28	321	6.90	1,410	30.32	2,698	58.02
Total	**2**		**28**		**201**		**324**		**1,420**		**2,792**	

Table 4: Expected Building Damage by Building Type

Building	1-10		11-20		21-30		31-40		41-50		Substantially	
Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	4	28.57	10	71.43
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	19	100.00
Masonry	0	0.00	2	0.49	8	1.96	7	1.72	109	26.72	282	69.12
Steel	2	2.63	4	5.26	1	1.32	2	2.63	9	11.84	58	76.32
Wood	0	0.00	24	0.57	191	4.57	314	7.51	1,286	30.74	2,368	56.61

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	1	0	1
Hospitals	0	0	0	0
Police Stations	5	1	0	1
Schools	54	7	4	11

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 658,688 tons of debris will be generated. Of the total amount, Finishes comprises 21% of the total, Structure comprises 47% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 26,348 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 11,048 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 30,692 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 2,745.25 million dollars, which represents 70.21 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 2,738.04 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 49.64% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	880.48	328.50	136.15	30.19	1,375.32
	Content	481.28	479.61	287.29	55.45	1,303.64
	Inventory	0.00	15.28	42.53	1.28	59.08
	Subtotal	**1,361.77**	**823.39**	**465.97**	**86.92**	**2,738.04**
Business Interruption						
	Income	0.04	2.18	0.03	0.11	2.35
	Relocation	0.51	0.57	0.04	0.04	1.16
	Rental Income	0.36	0.41	0.00	0.00	0.77
	Wage	0.09	2.24	0.04	0.55	2.92
	Subtotal	**1.00**	**5.40**	**0.12**	**0.70**	**7.21**
ALL	**Total**	**1,362.77**	**828.79**	**466.08**	**87.61**	**2,745.25**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 4 (Extreme), 1-foot SLR

Print Date: Friday, June 06, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,688,948	67.7%
Commercial	729,659	18.4%
Industrial	450,184	11.3%
Agricultural	18,584	0.5%
Religion	49,971	1.3%
Government	11,023	0.3%
Education	20,972	0.5%
Total	**3,969,341**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 4 (Extreme), 1-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 4,962 buildings will be at least moderately damaged. This is over 92% of the total number of buildings in the scenario. There are an estimated 3,084 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	6	7.59	3	3.80	1	1.27	6	7.59	63	79.75
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	4	8.51	0	0.00	1	2.13	7	14.89	35	74.47
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	22	0.45	197	4.07	319	6.60	1,312	27.13	2,986	61.75
Total	**0**		**32**		**200**		**321**		**1,325**		**3,084**	

Table 4: Expected Building Damage by Building Type

Building	1-10		11-20		21-30		31-40		41-50		Substantially	
Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	1	7.69	12	92.31
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	20	100.00
Masonry	0	0.00	2	0.47	7	1.65	5	1.18	90	21.23	320	75.47
Steel	0	0.00	6	6.90	3	3.45	2	2.30	11	12.64	65	74.71
Wood	0	0.00	24	0.55	189	4.34	313	7.19	1,211	27.82	2,616	60.10

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	1	0	1
Hospitals	0	0	0	0
Police Stations	5	1	0	1
Schools	54	5	6	11

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.
(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 696,387 tons of debris will be generated. Of the total amount, Finishes comprises 21% of the total, Structure comprises 47% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 27,855 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 11,359 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 31,551 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 2,843.91 million dollars, which represents 71.65 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 2,836.53 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 49.92% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	920.41	341.90	140.46	32.55	1,435.32
	Content	498.11	489.43	295.78	57.23	1,340.54
	Inventory	0.00	15.47	43.89	1.32	60.67
	Subtotal	**1,418.52**	**846.80**	**480.13**	**91.09**	**2,836.53**
Business Interruption						
	Income	0.04	2.22	0.03	0.11	2.40
	Relocation	0.54	0.58	0.04	0.04	1.20
	Rental Income	0.37	0.42	0.00	0.00	0.79
	Wage	0.09	2.28	0.05	0.57	2.99
	Subtotal	**1.04**	**5.50**	**0.12**	**0.72**	**7.38**
ALL	**Total**	**1,419.55**	**852.30**	**480.25**	**91.81**	**2,843.91**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 4 (Extreme), 2-foot SLR

Print Date: Friday, June 06, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

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There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

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Building Exposure by Occupancy Type for the Study Region

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Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,726,340	67.6%
Commercial	746,119	18.5%
Industrial	452,022	11.2%
Agricultural	19,149	0.5%
Religion	49,971	1.2%
Government	11,821	0.3%
Education	27,087	0.7%
Total	**4,032,509**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 4 (Extreme), 2-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 5,083 buildings will be at least moderately damaged. This is over 92% of the total number of buildings in the scenario. There are an estimated 3,319 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	100.00
Commercial	0	0.00	6	7.50	2	2.50	1	1.25	4	5.00	67	83.75
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	4	9.09	0	0.00	1	2.27	5	11.36	34	77.27
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	24	0.48	193	3.89	311	6.27	1,213	24.47	3,216	64.88
Total	**0**		**34**		**195**		**313**		**1,222**		**3,319**	

Table 4: Expected Building Damage by Building Type

	1-10		11-20		21-30		31-40		41-50		Substantially	
Building Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	1	6.67	14	93.33
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	19	100.00
Masonry	0	0.00	2	0.46	5	1.15	6	1.38	71	16.36	350	80.65
Steel	0	0.00	6	7.06	2	2.35	2	2.35	8	9.41	67	78.82
Wood	0	0.00	26	0.58	186	4.17	304	6.82	1,131	25.36	2,813	63.07

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	1	0	1
Hospitals	0	0	0	0
Police Stations	5	1	0	1
Schools	54	5	6	11

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 726,714 tons of debris will be generated. Of the total amount, Finishes comprises 20% of the total, Structure comprises 47% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 29,069 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 11,636 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 32,330 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 2,926.33 million dollars, which represents 72.57 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 2,918.78 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 50.14% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	954.47	353.37	143.83	34.74	1,486.41
	Content	511.77	497.03	302.61	58.94	1,370.35
	Inventory	0.00	15.66	45.01	1.35	62.02
	Subtotal	**1,466.24**	**866.05**	**491.45**	**95.04**	**2,918.78**
Business Interruption						
	Income	0.04	2.25	0.03	0.12	2.44
	Relocation	0.56	0.59	0.05	0.04	1.23
	Rental Income	0.38	0.42	0.00	0.00	0.81
	Wage	0.10	2.32	0.05	0.61	3.07
	Subtotal	**1.08**	**5.58**	**0.13**	**0.76**	**7.54**
ALL	**Total**	**1,467.32**	**871.64**	**491.58**	**95.80**	**2,926.33**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 4 (Extreme), 4-foot SLR

Print Date: Friday, June 06, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,780,618	67.3%
Commercial	788,213	19.1%
Industrial	451,676	10.9%
Agricultural	19,295	0.5%
Religion	53,283	1.3%
Government	11,821	0.3%
Education	27,202	0.7%
Total	**4,132,108**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 4 (Extreme), 4-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 5,480 buildings will be at least moderately damaged. This is over 93% of the total number of buildings in the scenario. There are an estimated 3,830 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00
Commercial	0	0.00	4	4.26	3	3.19	2	2.13	2	2.13	83	88.30
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	4	6.78	6	10.17	2	3.39	0	0.00	6	10.17	41	69.49
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00
Residential	0	0.00	26	0.49	186	3.49	312	5.85	1,101	20.66	3,704	69.51
Total	**4**		**36**		**191**		**314**		**1,109**		**3,830**	

Table 4: Expected Building Damage by Building Type

	1-10		11-20		21-30		31-40		41-50		Substantially	
Building Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	15	100.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	15	100.00
Masonry	0	0.00	2	0.42	4	0.85	6	1.27	52	10.99	409	86.47
Steel	2	1.98	6	5.94	4	3.96	2	1.98	7	6.93	80	79.21
Wood	0	0.00	26	0.54	180	3.76	305	6.37	1,039	21.69	3,240	67.64

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	1	0	1
Hospitals	0	0	0	0
Police Stations	5	2	0	2
Schools	54	5	8	13

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 790,409 tons of debris will be generated. Of the total amount, Finishes comprises 20% of the total, Structure comprises 46% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 31,616 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 12,252 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 34,211 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 3,121.78 million dollars, which represents 75.55 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 3,113.77 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 50.48% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	1,030.80	381.31	152.28	39.00	1,603.39
	Content	543.90	518.45	319.30	63.40	1,445.04
	Inventory	0.00	15.99	47.95	1.41	65.34
	Subtotal	**1,574.69**	**915.75**	**519.53**	**103.81**	**3,113.77**
Business Interruption						
	Income	0.04	2.35	0.03	0.13	2.55
	Relocation	0.59	0.61	0.05	0.05	1.30
	Rental Income	0.41	0.44	0.01	0.00	0.86
	Wage	0.10	2.47	0.05	0.68	3.30
	Subtotal	**1.15**	**5.86**	**0.14**	**0.86**	**8.01**
ALL	**Total**	**1,575.84**	**921.61**	**519.66**	**104.66**	**3,121.78**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Hazus Global Summary Report Category 4 (Extreme), 4-foot SLR

Flood Event Summary Report Page 10 of 11

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	**Residential**	**Non-Residential**	**Total**
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus Global Summary Report Category 4 (Extreme), 4-foot SLR

Flood Event Summary Report Page 11 of 11

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name: New Bedford, Fairhaven and Acushnet
Scenario Name: Category 1, 0-foot SLR
Return Period Analyzed: Mix0
Analysis Options Analyzed: No What-Ifs

Hazus Global Summary Report Category 1, 0-foot SLR

Building Damage

General Building Stock Damage

Hazus estimates that about 194 buildings will be at least moderately damaged. This is over 40% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	48	24.74	119	61.34	8	4.12	19	9.79	0	0.00
Total	**0**		**48**		**119**		**8**		**19**		**0**	

Table 4: Expected Building Damage by Building Type

	1-10		11-20		21-30		31-40		41-50		Substantially	
Building Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	0	0.00	0	0.00	1	100.00	0	0.00	0	0.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	48	24.87	118	61.14	8	4.15	19	9.84	0	0.00

Hazus Global Summary Report Category 1, 0-foot SLR

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Hazus Global Summary Report Category 1, 0-foot SLR

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 6,168 tons of debris will be generated. Of the total amount, Finishes comprises 40% of the total, Structure comprises 37% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 247 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 459 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 818 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Hazus Global Summary Report Category 1, 0-foot SLR

Economic Loss

The total economic loss estimated for the flood is 34.18 million dollars, which represents 6.11 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 34.11 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 76.44% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	15.61	0.97	0.57	0.40	17.54
	Content	10.50	3.22	1.23	1.20	16.15
	Inventory	0.00	0.06	0.22	0.13	0.42
	Subtotal	**26.11**	**4.25**	**2.03**	**1.73**	**34.11**
Business Interruption						
	Income	0.00	0.02	0.00	0.00	0.02
	Relocation	0.02	0.00	0.00	0.00	0.02
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.02	0.00	0.01	0.03
	Subtotal	**0.02**	**0.04**	**0.00**	**0.01**	**0.07**
ALL	**Total**	**26.13**	**4.29**	**2.03**	**1.74**	**34.18**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 1, 0-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

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Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	396,672	70.9%
Commercial	89,927	16.1%
Industrial	57,647	10.3%
Agricultural	8,824	1.6%
Religion	4,335	0.8%
Government	764	0.1%
Education	1,665	0.3%
Total	**559,834**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 1, 0-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 194 buildings will be at least moderately damaged. This is over 40% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	48	24.74	119	61.34	8	4.12	19	9.79	0	0.00
Total	**0**		**48**		**119**		**8**		**19**		**0**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	0	0.00	0	0.00	1	100.00	0	0.00	0	0.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	48	24.87	118	61.14	8	4.15	19	9.84	0	0.00

Hazus Global Summary Report Category 1, 0-foot SLR

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Hazus Global Summary Report Category 1, 0-foot SLR

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 6,168 tons of debris will be generated. Of the total amount, Finishes comprises 40% of the total, Structure comprises 37% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 247 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 459 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 818 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Hazus Global Summary Report Category 1, 0-foot SLR

Economic Loss

The total economic loss estimated for the flood is 34.18 million dollars, which represents 6.11 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 34.11 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 76.44% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	**Area**	**Residential**	**Commercial**	**Industrial**	**Others**	**Total**
Building Loss						
	Building	15.61	0.97	0.57	0.40	17.54
	Content	10.50	3.22	1.23	1.20	16.15
	Inventory	0.00	0.06	0.22	0.13	0.42
	Subtotal	**26.11**	**4.25**	**2.03**	**1.73**	**34.11**
Business Interruption						
	Income	0.00	0.02	0.00	0.00	0.02
	Relocation	0.02	0.00	0.00	0.00	0.02
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.02	0.00	0.01	0.03
	Subtotal	**0.02**	**0.04**	**0.00**	**0.01**	**0.07**
ALL	**Total**	**26.13**	**4.29**	**2.03**	**1.74**	**34.18**

Hazus Global Summary Report Category 1, 0-foot SLR

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Hazus Global Summary Report Category 1, 0-foot SLR

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus Global Summary Report Category 1, 0-foot SLR

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 1, 1-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

Hazus Global Summary Report Category 1, 1-foot SLR

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Hazus Global Summary Report Category 1, 1-foot SLR

General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 38,601 buildings in the region which have an aggregate total replacement value of 9,268 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	6,754,711	72.9%
Commercial	1,606,696	17.3%
Industrial	661,541	7.1%
Agricultural	31,872	0.3%
Religion	115,972	1.3%
Government	47,795	0.5%
Education	49,602	0.5%
Total	**9,268,189**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	424,734	72.2%
Commercial	90,414	15.4%
Industrial	57,935	9.8%
Agricultural	8,824	1.5%
Religion	4,335	0.7%
Government	764	0.1%
Education	1,665	0.3%
Total	**588,671**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 54 schools, 3 fire stations, 5 police stations and 3 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	New Bedford, Fairhaven and Acushnet
Scenario Name:	Category 1, 1-foot SLR
Return Period Analyzed:	Mix0
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 247 buildings will be at least moderately damaged. This is over 45% of the total number of buildings in the scenario. There are an estimated 2 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	47	19.03	142	57.49	28	11.34	28	11.34	2	0.81
Total	**0**		**47**		**142**		**28**		**28**		**2**	

Table 4: Expected Building Damage by Building Type

	1-10		11-20		21-30		31-40		41-50		Substantially	
Building Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	0	0.00	0	0.00	1	100.00	0	0.00	0	0.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	47	19.11	141	57.32	28	11.38	28	11.38	2	0.81

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

Classification	Total	# Facilities At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	3	0	0	0
Hospitals	0	0	0	0
Police Stations	5	0	0	0
Schools	54	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 9,058 tons of debris will be generated. Of the total amount, Finishes comprises 37% of the total, Structure comprises 38% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 362 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 521 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 977 people (out of a total population of 120,088) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 44.47 million dollars, which represents 7.55 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 44.38 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 76.97% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	20.34	1.28	0.76	0.50	22.88
	Content	13.86	4.06	1.61	1.44	20.97
	Inventory	0.00	0.08	0.30	0.16	0.53
	Subtotal	**34.20**	**5.42**	**2.67**	**2.10**	**44.38**
Business Interruption						
	Income	0.00	0.02	0.00	0.00	0.03
	Relocation	0.03	0.00	0.00	0.00	0.03
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.02	0.00	0.01	0.03
	Subtotal	**0.03**	**0.05**	**0.00**	**0.01**	**0.09**
ALL	**Total**	**34.23**	**5.47**	**2.67**	**2.10**	**44.47**

Appendix A: County Listing for the Region

Massachusetts
- Bristol

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Bristol	120,088	6,754,711	2,513,478	9,268,189
Total	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**
Total Study Region	**120,088**	**6,754,711**	**2,513,478**	**9,268,189**

Hazus-MH: Flood Event Report

Region Name: New Bedford, Fairhaven and Acushnet

Flood Scenario: Category 1, 2-foot SLR

Print Date: Thursday, June 05, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 51 square miles and contains 2,267 census blocks. The region contains over 49 thousand households and has a total population of 120,088 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 38,601 buildings in the region with a total building replacement value (excluding contents) of 9,268 million dollars (2006 dollars). Approximately 90.49% of the buildings (and 72.88% of the building value) are associated with residential housing.

Summary Recommendations for the City of New Bedford

The following is a summary of recommendations that describe potential climate adaptation actions for the City of New Bedford in order to better address vulnerabilities to combined sewer outfalls (CSOs), wastewater treatment plant, and pump station infrastructures The assessed vulnerabilities and recommendations are based on the results of the Climate Change Vulnerability Assessment and Adaptation Planning Study for Water Quality Infrastructure in New Bedford, Fairhaven, and Acushnet, which assessed the potential for damage and loss of function from modeled inundation scenarios using a combination of hurricane parameters and sea level rise projections.

The project team developed recommendations for CSOs, wastewater treatment facilities, and pump stations based on two inundation scenarios.

Typical wastewater design recommendations are to protect wastewater infrastructure against the 500-year flood. Furthermore, FEMA guidance provides an additional benchmark for quantifying risk to critical facilities, such as water quality infrastructure:

> *Under Executive Order 11988, Floodplain Management, Federal agencies funding and/or permitting critical facilities are required to avoid the 0.2% (500-year) floodplain or protect the facilities to the 0.2% chance flood level.*

Following the standard of protecting critical facilities against damages from a 500-year storm, we chose the two scenarios based on the 2009 FEMA floodplain projections for a 500-year storm. The inundation scenario from the team's modeling approach that most closely resembled the FEMA 500-year storm floodplain was the Category 3 hurricane with baseline (no SLR) water level scenario. We used this scenario, as well as the Category 3 hurricane with 4-foot (SLR) scenario to evaluate vulnerability for each CSO, wastewater treatment facility, and pump station, and to make recommendations based on each feature's vulnerability.

After meeting with town officials and reviewing site-specific studies, we assessed the vulnerability of the water quality infrastructure based on information provided to the team. We also performed a visual evaluation of each pump station using Google Earth imagery to assess whether there were structural features or characteristics that put them at higher or lower risk of damage from inundation. This provided only a cursory engineering review that does not replace a more detailed site specific inspection and evaluation that will be required to be conducted in a future phase of this project.

CSOs

The City of New Bedford has 23 CSOs. CSO discharges are controlled by regulators, many of which are already below MSL (mean sea level) and MHW (mean high water) (Figure 27). This means that there are likely to be additional regulators, sets of controls and/or storage available that would prevent the system from flooding during normal operation. Additionally, 15 of these outfalls have a tide gate that would preserve system storage. The project team understands that several regulators currently flood with water from the river and/or bay during storms and other extreme tide events resulting in in situ river/bay water draining to the treatment plant. This inflow into the system unnecessarily impacts the system hydraulic loads and likely negatively impacts the waste water treatment system performance. Sea level rise will only exacerbate these flooding issues. However, it is not currently possible to quantify the extent of these impacts beyond understanding that increased sea level rise will add backflow to the existing CSO outfalls and reduce their hydraulic performance.

In the short-term, the team recommends that the City of New Bedford pursue smaller adjustments and repairs to CSOs, where possible; however, more information is needed as to whether increased water levels at discharge locations would prevent regulators from functioning properly. As such, we suggest that assessing the impacts of storm surges will require hydraulic modeling of the system, which answers questions about the storage capacity of the system and its ability to drain. In general, the hydraulic modeling would need to assess the ability of the system to temporarily store water during target evaluation storms and then release that water as tides recede for sea level rise scenarios. In terms of priority study activities, we recommend that CSO hydraulics should be modeled for those CSOs where regulator weir elevations are below sea level rise elevations for specific sea level rise scenarios (Table 8). This study modeled flooding from hurricane events, however, in the long term, if there is more than 1 – 2 feet of SLR, there will be limited abilities to make any changes to individual CSOs that will prevent overflows. Under these projected SLR scenarios, dramatic and costly changes will have to be made to sewer infrastructure to prevent saltwater intrusion and to eliminate CSOs due to seawater intrusion into the system. Once these sea levels are reached, it will be necessary to devote substantial resources to increase overall sewer capacity.

Pump stations

The City of New Bedford has 26 pump stations, 4 of which are in the flood plain in a Category 3 storm with no SLR. These are given a high risk ranking in the table below. 5 additional pump stations are located in the floodplain when 4-foot SLR is added to the Category 3 storm scenario. These are given a medium risk ranking in the table below. The infrastructure housed at pump stations, including motors, electrical service and electronic controls, generators, buried compressors and fuel tanks, and manholes can all influence a pump station's ability to operate during flooding events. In addition, access to many structures will not be possible except by boat during the inundation scenarios evaluated. Generally the pump stations are above ground on level ground near the shoreline and are very exposed. A few are below ground.

Adaptation actions should prioritize structures that fall within the Category 3 floodplain at current water levels, and focus secondarily on those which are at risk during Category 3 storms with 4-foot SLR. In the table below, we rank priority sites and provide specific recommendations based on information provided by the City of New Bedford; however, this does not replace the need for site-specific evaluations. In general, site-specific evaluations should be performed to make a detailed assessment of potential risks to a facility. Individual assessments of each structure should be performed to determine the following:

- Whether the structure has already been floodproofed
- To confirm elevations of possible points of entry for water (e.g. vents, door sills, windows)
- The vulnerability of critical infrastructure within each pump station
- What would be required to flood-proof

– Whether the facility is currently able to operate during flood conditions (e.g. equipped with generator, ability to remote operate)

Once potential risks to a facility are understood, potential mitigation measures should be identified and more accurate opinions of costs can be developed to retrofit existing facilities.

Wastewater treatment plants

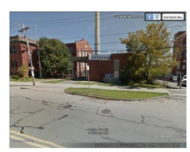
The City of New Bedford has one wastewater treatment facility. The Category 3 storms at both baseline water levels and 4-foot SLR levels show over ground flooding of the wastewater treatment plant location. Future studies should assess the storm scenarios that the treatment facility should be protected from and focus on thorough evaluations of the flood control system and critical infrastructure for those scenarios to ensure they are protected during these flood events. Ideally, flood controls should keep the entire site dry for the specified inundation scenario but some limited flooding could be acceptable if the site can be kept operational throughout these events.

The New Bedford facility is protected by an existing levee; however, there is the potential for inundation around this levee in the Category 3 storm scenarios. The ability to enhance the existing flood control system around these structures should be assessed as part of any consideration to providing further flood protection for this structure.

The team recommends a detailed, site-specific assessment of the facility's vulnerability to flooding. This would include a site visit to determine point of entry and where flood waters could damage equipment/structures and a survey to identify actual elevations of critical points to compare with target flood elevations. Once potential risks to a facility are understood, potential mitigation measures should be identified and more accurate opinions of costs can be developed to retrofit existing facilities.

Summary Table of Vulnerability and Recommendations

We have assessed risk based on the point location of each pump station and treatment plant, and the water levels at that point for the two inundation scenarios described above and categorized these risks in the table below. Facilities that are not in the floodplain in either scenario are colored in green (low risk). Facilities that are in the floodplain in the Category 3, 4-foot SLR scenario only are colored in orange (medium risk), and facilities that are in the floodplain for both Category 3 scenarios are colored in red (high risk). This table contains recommendations based on available information; however, we recommend that site-specific evaluations be performed for each feature to further determine vulnerability and refine adaptation measures.

Structure Location in New Bedford	Inundation depth (NAVD88 ft) for Category 3 Hurricane with no SLR	Inundation depth (NAVD 88 ft) for Category 3 Hurricane with 4-ft SLR	Preliminary Recommendations	Comments
Belleville Avenue	0	17.73	Require floodproof doors for entries and loading dock as well as floodproofing electrical vault and air intakes. Also, incoming sewer manholes will need to have covers bolted and gasketed. Controlling water levels above roof line likely not feasible. Potential cost range is $25,000 to $200,000.	 Above ground brick structure. Door and loading dock landing is about 3.3' above ground. Air intake or exhaust is about 3' above ground. Below grade electrical vault will be vulnerable to flooding. Equipped with SCADA and telemetry so can be remote operated. Generator is located on-site.
MacArthur Drive	0	13.27	Potentially require floodproof door, generator and floodproofing of vaults that could be points of entry. Potential buoyancy of building should also be assessed. Controlling water levels above roof line likely not feasible. Potential cost range is $100,000 to $250,000	 Above ground brick structure. First floor is at about 3.1' above ground at entry door landing. Several buried concrete vaults are adjacent or nearby the structure. Contents of those vaults are not known but likely points of entry into pump station. The vaults may be inlet works, wet wells or electrical vaults.Site is not equipped with a generator and pigtail connection is at door sill elevation. Some electrical service enters building from ground. Facility will be equipped with SCADA and telemetry to allow remote operation.

Structure Location in New Bedford	Inundation depth (NAVD88 ft) for Category 3 Hurricane with no SLR	Inundation depth (NAVD 88 ft) for Category 3 Hurricane with 4-ft SLR	Preliminary Recommendations	Comments
Wamsutta Street	0	23.53	Potentially require floodproof doors as well as floodproofing at-grade entryway and building penetrations. Generator will also need to be protected likely with wall system. Potential buoyancy of building should also be assessed. Controlling water levels above roof line likely not feasible. Potential cost range is $75,000 to $250,000.	 Above ground structure with brick construction. Door sill is close to ground. No generator, likely pigtail
Rowe Street	0	0		

Structure Location in New Bedford	Inundation depth (NAVD88 ft) for Category 3 Hurricane with no SLR	Inundation depth (NAVD 88 ft) for Category 3 Hurricane with 4-ft SLR	Preliminary Recommendations	Comments
Coggeshall Street	0	16.66	Floodproofing of doors, windows and vaults will be required. Existing vents will need to be raised. Electrical infrastructure such as services, generators and transformers will either need to be raised or protected with floodwall system with flashboards for access. Structure and vaults should be checked for buoancy. Controlling water levels above roof line likely not feasible. Potential cost range is $150,000 to $350,000.	 Above ground brick structure with brick construction. Door sill is about 0.8' above ground. Window sills are about 4.7' above ground. Several concrete vaults with hatches or accessways exist below grade that likely provide pathway for flooding inside of building. A vent to one of the vaults also has a low point at about the same elevation of the window sills. Two other vents also exist at a lower elevation. Building electrical service is below inundation levels. A transformer adjacent to the site and generator is on right at grade.
Peckham Road	0	0		
Sassaquin Avenue	0	0		
Pequot Street	0	0		

Structure Location in New Bedford	Inundation depth (NAVD88 ft) for Category 3 Hurricane with no SLR	Inundation depth (NAVD 88 ft) for Category 3 Hurricane with 4-ft SLR	Preliminary Recommendations	Comments
Phillips Road	0	0		
Marlborough Street	0	0		
Forbes Street	0	0		
Hanover Street	0	0		
Welby Road	0	0		
Church Street	0	0		
Joyce Street	0	0		
Aviation Way	0	0		
Shawmut Avenue	0	0		
Howard Avenue	0.53	23.44	Require floodproof doors and windows including accessways to below grade vaults. Above ground tank will have to be anchored and vaults checked for buoyancy. Generator should be provided for site. Controlling water levels above roof line likely not feasible. Potential cost range is $150,000 to $350,000.	 Above ground structure with brick construction. Two stainless steel doors have sills at grade. Window sills are as low as 2.7' above ground. Below grade vaults exist with hatches or grates providing access to the vaults. Above ground storage tank exists at grade. Generator transfer switch and connection are located about 3.2' above grade. A below grade electrical vault also exists on this site. bove ground structure with brick construction. Two stainless steel doors have sills at grade. Window sills are as low as 2.7' above ground. Below grade vaults exist with hatches or grates providing access to the vaults. Above ground storage tank exists at grade.

Structure Location in New Bedford	Inundation depth (NAVD88 ft) for Category 3 Hurricane with no SLR	Inundation depth (NAVD 88 ft) for Category 3 Hurricane with 4-ft SLR	Preliminary Recommendations	Comments
Valley View Drive	0	0		
Joy Street	0	0		
Hathaway Road	0	0		
Apple Tree Lane	0	0		
Merrimac Street	0	0		
Popes Island	0	16.69	Access hatch to pump station will need to be floodproofed. Electrical service and control panels will need to be raised and floodproofed. Ability to operate pump station remotely will need to be confirmed. Generator should also be provided that will need to be protected as well. Potential cost range is $100,000 to $250,000.	 Below ground pump station. Electrical service and control panels are at about 2.8' above grade. Vent is about 4.25' above grade. No generator
South Water Street	6.82	15.12	Potentially require floodproof door and flood proof windows. Generator and electrical service will likely need to be raised or protected. Little information available for this site to identify other needs. Potential cost range is $100,000 to $250,000.	 Above ground structure. Door sill is just above ground. Generator is reportedly located on site

Structure Location in New Bedford	Inundation depth (NAVD88 ft) for Category 3 Hurricane with no SLR	Inundation depth (NAVD 88 ft) for Category 3 Hurricane with 4-ft SLR	Preliminary Recommendations	Comments
East Rodney French Boulevard	11.39	15.74	Floodproof doors and windows. Vents will need to be protected with cutoff wall. Electrical service will need to be raised and gas service needs to be evaluated. Controlling water levels above roof line likely not feasible. Potential cost range is $25,000 to $150,000.	 One door sill and vent are located 3.6' above grade. One door sill is 1.8' above grade. Ground elevations vary at both doors. Electrical service meter box located 2.3' above grade. Electrical junction boxes appear to be as low as 0.8' above grade. Intake/exhaust vents for generator are about 1.8' above grade. Gas service is at grade for backup generator.
Cove Road	11.89	15.12	Floodproof existing doors. Electrical service should be raised and floodproofed with transformer protected as well. Generator vent should be protected with cut off wall. Gas service needs to be assessed. Controlling water levels above roof line likely not feasible. Potential cost range is $50,000 to $250,000.	 Protected by existing levee; The ability to enhance the existing flood control system around this structure should be assessed as part of any consideration to providing further flood protection for this structure. First floor 4' above grade with two stainless steel doors providing access. Electrical box is located 3' above grade. Transformer is located at grade. Gas service is also located at grade. Generator intake/exhaust vents is located 4.4' above grade. Odor control system is located outdoors but is not critical to system operation and would not be required to be protected. Generator is on site in building.

Structure Location in New Bedford	Inundation depth (NAVD88 ft) for Category 3 Hurricane with no SLR	Inundation depth (NAVD 88 ft) for Category 3 Hurricane with 4-ft SLR	Preliminary Recommendations	Comments
Wastewater Treatment Plant				
South Rodney French Boulevard	1.38	5.40		Protected by existing levee; The ability to enhance the existing flood control system around these structure should be assessed as part of any consideration to providing further flood protection for this structure.

Summary Recommendations for the Town of Acushnet

The following is a summary of recommendations that describe potential climate adaptation actions for the Town of Acushnet in order to better address vulnerabilities to wastewater treatment plant, and pump station infrastructures. The assessed vulnerabilities and recommendations are based on the results of the Climate Change Vulnerability Assessment and Adaptation Planning Study for Water Quality Infrastructure in New Bedford, Fairhaven, and Acushnet, which evaluated the potential for damage and loss of function from modeled inundation scenarios using a combination of hurricane parameters and sea level rise (SLR) projections.

Typical wastewater design recommendations are to protect wastewater infrastructure against the 500-year flood. Furthermore, FEMA guidance provides an additional benchmark for quantifying risk to critical facilities, such as water quality infrastructure:

> *Under Executive Order 11988, Floodplain Management, Federal agencies funding and/or permitting critical facilities are required to avoid the 0.2% (500-year) floodplain or protect the facilities to the 0.2% chance flood level.*

Following the standard of protecting critical facilities against damages from a 500-year storm, we chose two modeled hurricane inundation scenarios based on the 2009 FEMA floodplain projections for a 500-year storm. The inundation scenario from the team's modeling approach that most closely resembled the FEMA 500-year storm floodplain was the Category 3 hurricane with baseline water levels (no SLR). We used this scenario, as well as the Category 3 hurricane with 4-foot SLR scenario to evaluate water quality infrastructure, and to make recommendations for individual water quality infrastructure features where possible.

After meeting with town officials and reviewing site-specific studies, we assessed the vulnerability of the water quality infrastructure based on information provided to the team. We also performed a visual evaluation of each pump station using Google Earth imagery to assess whether there were structural features or characteristics that put them at higher or lower risk of damage from inundation. This provided only a cursory engineering review that does not replace a more detailed site specific inspection and evaluation that will be required to be conducted in a future phase of this project. The following paragraphs summarize findings and general recommendations for pump stations. The summary table ranks individual pump station vulnerability and provides preliminary, site-specific recommendations.

Pump station recommendations

The Town of Acushnet has 3 pump stations, 1 of which is in the floodplain of the Category 3 scenario with no SLR. This is given a high risk ranking in the table below. An additional pump station is in the floodplain when 4-foot SLR is added to the Category 3 scenario. This is given a medium risk ranking in the table. The infrastructure housed at pump stations, including motors, electrical service and electronic controls, generators, buried compressors and fuel tanks, and manholes can all influence a pump station's ability to operate during flooding events. In addition, access to many structures will not be possible except by boat during the inundation scenarios evaluated. Generally the pump stations are above ground on level ground near the shoreline and are very exposed. A few are below ground.

Adaptation actions should prioritize structures that fall within the Category 3 floodplain at current water levels, and focus secondarily on those which are at risk during Category 3 storms with 4-foot SLR. In the table below, we identify priority sites and provide specific recommendations based on information provided by the Town of Acushnet; however, this does not replace the need for site-specific evaluations. In general, site-specific evaluations should be performed to make a detailed assessment of potential risks to a facility. Individual assessments of each structure should be performed to determine the following:

- Whether the structure has already been floodproofed
- To confirm elevations of possible points of entry for water (e.g. vents, door sills, windows)
- The vulnerability of critical infrastructure within each pump station
- What would be required to flood-proof
- Whether the facility is currently able to operate during flood conditions (e.g. equipped with generator, ability to remote operate)

Once potential risks to a facility are understood, potential mitigation measures should be identified and more accurate opinions of costs can be developed to retrofit existing facilities.

Summary Table of Vulnerability and Recommendations

We have assessed risk based on the point location of each pump station and the water levels at that point for the two inundation scenarios described above and categorized these risks in the table below. Facilities that are not in the floodplain in either scenario are colored in green (low risk). Facilities that are in the floodplain in the Category 3, 4-foot SLR scenario only are colored in orange (medium risk), and facilities that are in the floodplain both scenarios are colored in red (high risk). This table contains recommendations based on available information; however, we recommend that site-specific evaluations be performed for each feature to further evaluate vulnerability and refine adaptation measures.

Structure Location in Acushnet	Inundation depth (NAVD88 ft) for Category 3 Hurricane with no SLR	Inundation depth (NAVD88 ft) for Category 3 Hurricane with 4-ft SLR	Preliminary Recommendations	Comments
Blueberry Drive	0	0	None	
Allen Street	0	4.74	Consider berm or wall with weir boards for access. Need for generator is unknown. Potential cost range is $25,000 to $75,000	 Above ground structure type unknown, likely pre-manufactured housing for pump station. If so, likely cannot be floodproofed and earthen berm will be required.
Slocum Street	.85	23.84	Add flood proof door and extend vents. Potential cost range is $10,000 to $25,000. On-site generator will be expensive and not included in these costs. Controlling water levels above roof line likely not feasible.	 Below ground structure. Vents likely could be flooded with SLR scenario.

Summary Recommendations for the Town of Fairhaven

The following is a summary of recommendations that describe potential climate adaptation actions for the Town of Fairhaven in order to better address vulnerabilities to wastewater treatment plant, and pump station infrastructures. The assessed vulnerabilities and recommendations are based on the results of the Climate Change Vulnerability Assessment and Adaptation Planning Study for Water Quality Infrastructure in New Bedford, Fairhaven, and Acushnet, which evaluated the potential for damage and loss of function from modeled inundation scenarios using a combination of hurricane parameters and sea level rise (SLR) projections.

Typical wastewater design recommendations are to protect wastewater infrastructure against the 500-year flood. Furthermore, FEMA guidance provides an additional benchmark for quantifying risk to critical facilities, such as water quality infrastructure:

> *Under Executive Order 11988, Floodplain Management, Federal agencies funding and/or permitting critical facilities are required to avoid the 0.2% (500-year) floodplain or protect the facilities to the 0.2% chance flood level.*

Following the standard of protecting critical facilities against damages from a 500-year storm, we chose two modeled hurricane inundation scenarios based on the 2009 FEMA floodplain projections for a 500-year storm. The inundation scenario from the team's modeling approach that most closely resembled the FEMA 500-year storm floodplain was the Category 3 hurricane with baseline (no SLR) water level scenario. We used this scenario, as well as the Category 3 hurricane with 4-foot SLR scenario to evaluate water quality infrastructure, and to make recommendations for individual water quality infrastructure features where possible.

After meeting with town officials and reviewing site-specific studies, we assessed the vulnerability of the water quality infrastructure based on information provided to the team. We also performed a visual evaluation of each pump station using Google Earth imagery to assess whether there were structural features or characteristics that put them at higher or lower risk of damage from inundation. This provided only a cursory engineering review that does not replace a more detailed site-specific inspection and evaluation that will be required to be conducted in a future phase of this project. The following paragraphs summarize findings and general recommendations for pump stations and wastewater treatment facilities. The summary table ranks individual water quality infrastructure feature vulnerability and provides preliminary, site-specific recommendations.

Pump stations

The Town of Fairhaven has 19 pump stations, 10 of which are in the floodplain during the Category 3 scenario with no SLR. These are given a high risk ranking in the table below. 5 additional pump stations are in the floodplain when 4-foot SLR is added to the Category 3 scenario. These are given a medium risk ranking in the table below. The pump stations at Causeway Rd., Bernese St., and South St. pump water from upstream pump stations. These require additional consideration as they would render the other pump stations useless if they were to malfunction. Because these and some additional pump stations are reportedly not operated during flooding events, adaptations to allow pump station to operate during the flood events are likely not required. However, adaptations to these structures may still be required in order to protect key infrastructure in the facilities (e.g. motors and electrical service) and allow the facilities to be able to operate after the storm. The infrastructure housed at pump stations, including motors, electrical service and electronic controls, generators, buried compressors and fuel tanks, and manholes can all influence a pump station's ability to operate during flooding events. In addition, access to many structures will not be possible except by boat during the inundation scenarios evaluated. Generally the pump stations are above ground on level ground near the shoreline and are very exposed. A few are below ground. Older structures which fall behind the hurricane barrier may be more vulnerable to flooding events as they may not have been built using current standards. These structures will also require further evaluation.

Adaptation actions should prioritize structures that fall within the Category 3 floodplain at current water levels, and focus secondarily on those which are at risk during Category 3 storms with 4-foot SLR. In the table below, we rank priority sites and provide specific recommendations based on information provided by the Town of Fairhaven; however, this does not replace the need for site-specific evaluations. In general, site-specific evaluations should be performed to make a detailed assessment of potential risks to a facility. Individual assessments of each structure should be performed to determine the following:

- Whether the structure has already been floodproofed
- To confirm elevations of possible points of entry for water (e.g. vents, door sills, windows)
- The vulnerability of critical infrastructure within each pump station
- What would be required to flood-proof
- Whether the facility is currently able to operate during flood conditions (e.g. equipped with generator, ability to remote operate)

Once potential risks to a facility are understood, potential mitigation measures should be identified and more accurate opinions of costs can be developed to retrofit existing facilities.

Wastewater treatment plants

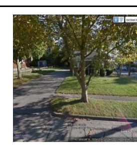
The Town of Fairhaven has two wastewater treatment facilities; however, neither facility is at risk from flooding during either of these scenarios. Future studies should assess the storm scenarios that the treatment facility should be protected from and focus on thorough evaluations of the flood control system and critical infrastructure for those scenarios to ensure they are protected during these flood events. Ideally, flood controls should keep the entire site dry for the specified inundation scenario but some limited flooding could be acceptable if the site can be kept operational throughout these events.

Summary Table of Vulnerability and Recommendations

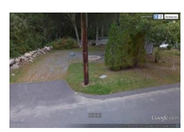
We have assessed risk based on the point location of each pump station and treatment plants, and the water levels at that point for the two inundation scenarios described above and categorized these risks in the table below. Facilities that are not in the floodplain in either scenario are colored in green (low

risk). Facilities that are in the floodplain in the Category 3, 4-foot SLR scenario only are colored in orange (medium risk), and facilities that are in the floodplain for both Category 3 scenarios are colored in red (high risk). This table contains recommendations based on available information; however, we recommend that site-specific evaluations be performed for each feature to further evaluate vulnerability and refine adaptation measures.

Structure Location in Fairhaven	Inundation depth (NAVD88 ft) for Category 3 Hurricane with no SLR	Inundation depth (NAVD 88 ft) for Category 3 Hurricane with 4-ft SLR	Preliminary Recommendations	Comments
Taber Street*	0	20.73	Potentially require flood proof door. Potential cost range is $10,000 to $250,000.	 Above ground structure with brick construction. Door sill is close to ground.
Pilgrim Avenue*	0	20.65	Potentially require flood proof door as remote controls. Structure should be checked for buoyancy. Potential cost range is $10,000 to $250,000.	 Above ground brick structure, first floor within 2-3 ft of ground. Generator on site

Structure Location in Fairhaven	Inundation depth (NAVD88 ft) for Category 3 Hurricane with no SLR	Inundation depth (NAVD 88 ft) for Category 3 Hurricane with 4-ft SLR	Preliminary Recommendations	Comments
Bridge Street*	0	18.05	Potentially require floodproof door as well as generator and remote controls. Structure should be checked for buoyancy. Potential cost range is $10,000 to $250,000.	 Above ground brick structure, first floor within 2-3 ft of ground. No longer a pump station; used for odor control only
Arsene Street	0	0		Unknown
South Street	0	11.74	Potentially require floodproof door as well as generator and remote controls. Structure should be checked for buoyancy. Potential cost range is $10,000 to $250,000.	 Above ground structure with brick construction. Door sill is close to ground. Pumps water from downstream pump stations.
Rivard Street	0	0		
Marguerite Street	0	0		
Pine Grove Road	0	0		

Structure Location in Fairhaven	Inundation depth (NAVD88 ft) for Category 3 Hurricane with no SLR	Inundation depth (NAVD 88 ft) for Category 3 Hurricane with 4-ft SLR	Preliminary Recommendations	Comments
Middle Street*	0	18.82	This is a drainage (not sewer) pump station and therefore should be assessed to determine how essential it is to operate during coastal floods. Potential cost range is $10,000 to $50,000.	 Above ground structure. Door sill is 1 to 2 feet above ground.
Causeway Road**	3.93	7.66	Structure would require complete reconstruction. Potential cost range is $200,000 to $500,000	 Above ground wood structure. Door sill is just above ground. Generator onsite. Pumps water from upstream pump stations.
Rocky Point Road**	7.44	11.25		No image available

Structure Location in Fairhaven	Inundation depth (NAVD88 ft) for Category 3 Hurricane with no SLR	Inundation depth (NAVD 88 ft) for Category 3 Hurricane with 4-ft SLR	Preliminary Recommendations	Comments
Camel Street**	8.04	11.66	Below ground pump station. Flood door for vault required and on site generator should be considered. Potential cost range is $50,000 - $250,000	 Town has indicated that a portable generator is used during storms; however, access to site would be limited during projected inundation scenarios.
Manhattan Avenue**	8.71	12.49	Minimum likely requirement is flood-proofing doors. Potential cost range is $10,000 to $250,000	 Above ground structure with pump station on site. Doors are elevated 15 feet.

Structure Location in Fairhaven	Inundation depth (NAVD88 ft) for Category 3 Hurricane with no SLR	Inundation depth (NAVD 88 ft) for Category 3 Hurricane with 4-ft SLR	Preliminary Recommendations	Comments
Bernese Street**	8.73	12.59	None	 Generator on-site with elevated doors. Pumps water from upstream pump stations.
Shore Drive**	12.18	15.98	Floodproof access hatch and provide on-site generator. Potential cost range is $100,000 - $250,000	 Below grade pump station with no generator

Structure Location in Fairhaven	Inundation depth (NAVD88 ft) for Category 3 Hurricane with no SLR	Inundation depth (NAVD 88 ft) for Category 3 Hurricane with 4-ft SLR	Preliminary Recommendations	Comments
Abbey Street**	12.50	16.75	None	 Has on-site generator
Waybridge Road**	12.59	16.40	On-site generator recommended. Potential cost range is $10,000 to $250,000	 Aboveground pump station with elevated first floor, which is 10-12" above grade. Town has indicated that a portable generator is used during storms; however, access to site would be limited during projected inundation scenarios.
Seaview Avenue**	12.81	16.59	On-site with above ground structure. Potential cost range is $10,000 to $250,000	

Structure Location in Fairhaven	Inundation depth (NAVD88 ft) for Category 3 Hurricane with no SLR	Inundation depth (NAVD 88 ft) for Category 3 Hurricane with 4-ft SLR	Preliminary Recommendations	Comments
Boulder Park**	13.20	17.33	Needs elevation	
Treatment Plants				
Arsene Street	0	0	None	
West Island	0	0	None	

* Town has indicated that these pump stations, which are behind the hurricane barrier, may be older structures therefore more vulnerable in the event of flooding at that location.
** This facility reportedly is not operated during flooding events. As a result, adaptations to allow pump station to operate during the flood events are likely not required. However, adaptations to these structures may still be required in order to protect key infrastructure in the facilities (e.g. motors and electrical service) and allow the facilities to be able to operate after the storm.

Appendix C: Battelle Climate Change Vulnerabilities Scoping Report Excerpts

EPA Contract Number EP-C-14-017

Work Assignment 1-14

Climate Change Vulnerabilities Scoping Report: Risks to Clean Water Act Goals in the Northeast

Prepared for:

U.S. Environmental Protection Agency, OWOW

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Originally Submitted: October 19, 2015

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The Business of Innovation

1 Purpose

The purpose of this scoping study is to raise awareness of risks to U.S. Environmental Protection Agency (EPA) Clean Water Act goals associated with climate change and indicate where more analysis might be needed. This study reviewed and analyzed existing information to create a risk-based climate change vulnerability assessment to inform those managing coastal watersheds in the Northeast Study Area. The Northeast (NE) Study Area includes Long Island, NY to southern Maine. The vulnerability assessment resulted in consequence/probability (C/P) matrices for four EPA goal areas: pollution control; habitat; fish, wildlife, and plants; recreation and public water supplies. C/P matrices were produced for two future time periods, 2050 and 2100, for which climate change projections were available.

2 Scope and Limitations of Study

Potential climate change risks to the Clean Water act goals in the NE Study Area were identified or inferred from sources specified by the EPA: the National Climate Assessment (NCA) (Melillo et al., 2014), and NOAA (2013). As summarized in Table 1, expert knowledge and judgment supplemented by a review by the experts of the information in the specified sources were applied to an analysis of all four risk identification checklists for Clean Water Act goals (pollution control; habitat; fish, wildlife, and plants; recreation and public water supplies) of EPA (2014). The experts made judgments as to the consequence (severity of impact) and likelihood (probability of occurrence) based on the sources of information listed in Section 3. It is important to note that no other literature sources were reviewed as part of this study. A C/P matrix was prepared for each checklist for both 2050 and 2100 and vetted by the team of experts to ensure logical consistency and consensus on the ratings of the matrices.

3 Sources of Information Used

Per direction from EPA, only the following data sources were reviewed and used to inform expert judgment in the development of the C/P matrices. Per EPA direction, information was not sought outside of these sources:

EPA. 2014. Being Prepared for Climate Change: A Workbook for Developing Risk-Based Adaptation Plans. Climate Ready Estuaries, EPA Office of Water (http://www2.epa.gov/sites/production/files/2014-09/documents/being_prepared_workbook_508.pdf).

Melillo, J.M., T. Richmond, and G.W. Yohe, Eds. 2014. Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program, 841 pp. (http://nca2014.globalchange.gov/downloads)

NOAA. 2013. NOAA Technical Report NESDIS 142-1, Regional Climate Trends and Scenarios for the U.S. National Climate Assessment, Part 1. Climate of the Northeast U.S. U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), National Environmental Satellite, Data, and Information Service (NESDIS), Washington, D.C. (http://www.nesdis.noaa.gov/technical_reports/NOAA_NESDIS_Tech_Report_142-1-Climate_of_the_Northeast_U.S.pdf).

Table 1. Summary of Checklists, EPA Goals, Stressors, and Time Frames within Study Scope

Potential Climate Change Risks (Checklist)	Clean Water Act Goals	Climate Change Stressors	Time Frames (Years)
Pollution Control	• Controlling point sources of pollution and cleaning up pollution • Controlling nonpoint sources of pollution	• Warmer summers • Warmer winters • Warmer water • Increasing drought • Increasing storminess • Sea level rise • Ocean acidification	• 2050 • 2100
Habitat	• Restoring and protecting physical and hydrologic features • Constructing reefs to promote fish and shellfish	• Warmer summers • Warmer winters • Warmer water • Increasing drought • Increasing storminess • Sea level rise • Ocean acidification	• 2050 • 2100
Fish, Wildlife, and Plants	• Protecting and propagating fish, shellfish, and wildlife • Controlling nonnative and invasive species • Maintaining biological integrity and reintroducing native species	• Warmer summers • Warmer winters • Warmer water • Increasing drought • Increasing storminess • Sea level rise • Ocean acidification	• 2050 • 2100
Recreation and Public Water Supplies	• Restoring and maintaining recreational activities, in and on the water • Protecting public water supplies	• Warmer summers • Warmer winters • Warmer water • Increasing drought • Increasing storminess • Sea level rise • Ocean acidification	• 2050 • 2100

4 Interpreting Findings

Professional judgment is useful for analysis where complex problems exist for which empirical estimation is not feasible, as well as detailed research is unavailable. Professional judgment as applied in this NE Study area meant: (1) persons involved in making the judgment had scientific and / engineering credentials and academic and / or professional experience necessary to support a claim of “expert”; (2) persons involved in making the judgment had thorough knowledge of the relevant literature essential for interpretation of facts; and (3) concurrence existed among more than one expert to provide scientifically-valid and defendable conclusions.

The experts who contributed to the NE Study Area vulnerability analysis included:

Dr. Kurt Philipp, Ph.D., Marine Sciences (Avatar Environmental). Credentials include being a Professional Wetland Scientist and former Professional Certification Board President. He has over 30 years of experience conducting wetlands investigations, particularly in wetlands restoration and creation, as well as delineation, mapping and the impact of hazardous waste. Dr. Philipp conducted his doctoral graduate research in salt and water relations of tidal marsh plants at the University of Delaware and conducted research in tidal marshes throughout the estuary. He has also provided historical and ecological characterizations in *Estuarine Profiles - Delaware National Estuarine Research Reserve, Comprehensive Conservation and Management Plan for Delaware's Tidal Wetlands*, "The ecology of freshwater tidal wetlands, History of Delaware and New Jersey salt marsh restoration sites, *Phragmites australis* expansion in Delaware Bay salt marshes". He has presented at conferences such as the Society of Wetland Scientists.

Siva Sangameswaran, Ph.D., P.E., C.F.M. (Dewberry). A Senior Water Resources Engineer, Dr. Sangameswaran has extensive knowledge and experience solving complex engineering problems and environmental issues using context sensitive modeling and sustainable, natural systems based approaches. His expertise includes 1-D and 2-D hydrodynamic modeling; hydraulic and hydrologic modeling; coastal engineering and wave modeling; and sediment transport modeling in riverine and coastal systems. He has experience with stream restoration; drainage design for flood protection; green infrastructure design; and TMDL development.

Kaveh Zomorodi, Ph.D., P.E., C.F.M. (Dewberry). A Senior Hydrologist and Water Resources Engineer, Dr. Zomorodi has over 27 years of work experience in academic and consulting engineering work dealing with surface water hydrology and hydraulics, groundwater, water resources planning and management and hazard mitigation. Dr. Zomorodi has published over 45 technical papers in various journals and conference proceedings and numerous R&D and project reports. Consulting and research work experience includes hydrological studies and modeling; floodplain modeling; benefit-cost analysis of hazard mitigation; modeling the impact of climate change on design peak discharges and coastal design flood elevations; highway hydraulic modeling and bridge scour analysis; management and operation of water resources networks; groundwater modeling and management; and artificial groundwater recharge.

Harry Stone, Ph.D. (ecology), M.S. (plant physiology), M.B.A. (Battelle). Dr. Stone is a Senior Research Scientist. He is a Certified Senior Ecologist (Ecological Society of America) with more than 25 years of project management experience. Recent work includes leading a team of experts in the evaluation of models applicable to prediction of algal blooms in Lake Erie on an EPA project and modeling the likelihood of observing pollution intolerant fish communities in the Ohio Interior Low Plateau Ecoregion. Recently for the US Army Corps of Engineers, he provided technical leadership for the evaluation of climate change impacts on ecosystem services in the Ohio River Basin and corresponding adaptation strategies.

Chuck Dobroski, M.S., Marine Biology (Avatar Environmental). He is a co-founder and Principal of Avatar Environmental, and provides the technical direction and oversight of ecological programs as well as ecological and human health risk assessments for Avatar. He has over 35 years of providing ecological services in marine and estuarine environments for the government and private sector. Activities have included the technical development, management and performance of a diverse array of coastal and estuarine projects throughout the United States as well as overseas. Mr. Dobroski provides consulting support for biological monitoring of marine/estuarine fisheries; marine construction and dredging impacts; ocean outfalls; salt marsh, beach and dune restoration; submerged aquatic vegetation evaluations; intertidal and benthic ecology; blue water biology; and tropical/subtropical ecology. Water/sediment quality and hydrographic investigations in marine and estuarine habitats have included evaluation of thermal plumes using standard techniques as well as remote sensing, tracer studies for ocean outfalls; nutrient chemistry and evaluation, chemical contaminant characterization; and dissolved oxygen reduction in poorly circulating marinas and embayments.

John Licsko, M.Sc., Water Resource Engineering (Dewberry). During his 20-year career, Mr. Licsko has been a technical and management lead for the application and review of hydrologic & hydraulic procedures for floodplain, interior drainage, dam, transportation and stream restoration studies and designs, across the U.S., including New York, New Jersey, Virginia, and Maryland. Currently, he serves as a senior engineer and project manager with Dewberry's joint venture with URS Corporation for the Production and Technical Services contract with FEMA, which includes development of floodplain studies in FEMA Regions II, III, and IV. His work has included the development and review of engineering models, such as HEC-HMS, HEC-RAS (Steady and Unsteady State), XP-SWMM (1D & 2D), EPA SWMM, and FLO-2D in support of flood insurance studies, appeals, and Letter Of Map Change (LOMC) requests. Prior to 2009, John worked within Dewberry's Water Resources Department developing and managing water quality monitoring programs to meet National Pollutant Discharge Elimination System (NPDES) requirements for local municipalities and agencies. John also completed hydrologic and hydraulic models for dam, transportation, and stream restoration projects, primarily in Virginia and Maryland.

Krista Rand, M.S. Civil Engineering, E.I.T., C.F.M (Dewberry). Ms. Rand's expertise is projects of national significance related to water resources and climate change, especially riverine flooding and transportation systems. Certified Floodplain Manager (2012 – 2014). Expertise include hydrology and hydraulics, climate vulnerability assessments, natural hazard mitigation and climate change adaptation, transportation systems, and natural resources management and policy.

4.1 Assumptions and Guidelines

An analysis was performed to elucidate the likelihood of risk using a "future without action" or "business as usual" scenario for two time periods (the years 2050 and 2100). Planned actions were not considered in the risk analysis.

Outcomes that were judged to be zero risk, per EPA direction, were categorized as low consequence and low probability. Only coral reef impacts were not evaluated because there are no coral reefs in the NE Study Area.

The criteria for selecting high, medium, and low risk values were vetted by the team of experts prior to beginning the analysis. Consensus was reached with the team of experts during a teleconference on September 10, 2015 establishing the following orders of magnitude rating guide for assigning risk.

The probability (likelihood) of occurrence was rated using the following guideline:

- If confidence level is "Very High (strong evidence and scientific consensus)" or "High" (moderate evidence from multiple sources, medium consensus) – probability (likelihood) of occurrence is rated "high".
- If confidence level is "Medium" (suggestive evidence, limited consensus, competing schools of thought) – probability (likelihood) of occurrence is rated "medium".
- If confidence level is "Low" (inconclusive, limited evidence, disagreement or lack of opinions among experts) – probability (likelihood) of occurrence is rated "low".

The original criteria definition for consequence of impact was as follows:

High if:

- Spatial extent is large and/or
- More than roughly 1 million people impacted and/or
- More than roughly $1 billion impact and/or

Medium if:

- Spatial extent is place or region and/or
- More than roughly 10,000 people impacted and/or
- More than roughly $1 million impact and/or

Low if:

- Spatial extent is one or a few sites and/or
- Less than roughly 1,000 people impacted and/or
- Less than roughly $1 million impact.

During the study, it was found that the above quantitative criteria were not directly usable for numerous situations owing to lack of data. For multiple situations, data was not available / complete. To assign a scientifically-informed consequence for the above, engineering judgement was used to assign a rank higher than low, if appropriate, following discussions between the experts of related disciplines.

For this assessment, ecological consequences were rated based the implied effect on the specific Clean Water Goals to be achieved and the severity of the effect:

Habitat:

- Severity - loss of habitat, modification of habitat, or shifting of habitat,
- Sensitivity or ecological importance of habitat,
- Spatial Scale - regional/sub-regional vs local,
- Potential for recovery – permanent loss or temporary loss, restoration possible,
- others

Fish, Wildlife, and Plants:

- Level of biological organization – Community, population, individual (threatened/endangered species)
- Spatial scale of effect regional versus sub-regional versus local
- Effect on survival, maintenance, reproductive capacity of species
- Effect on trophic structure
- Commercial fishery
- Others

All values should be considered approximate order of magnitude, not absolutes.

4.2 Consequence/Probability (C/P) Matrix

The C/P matrix is a risk management tool for sorting risks based on their likelihoods and consequences of the occurrence of a specific impact. The approach used to develop the C/P matrices is found in EPA's *Being Prepared for Climate Change Workbook* – Step 5 (EPA 2014).

After reviewing the specified sources of information, expert judgment was used to assign a likelihood and a consequence rating for each potential impact. The potential impact was added to the appropriate cell in the corresponding C/P matrix. Figure 1 provides an example of a C/P matrix with a single impact ("Jellyfish may be more common") added to the matrix. In this example, a medium consequence and a low probability rating [for illustration of approach only] assigns this impact to a "green" cell, i.e. a cell with a low risk. Any combinations of low and medium ratings for consequence and likelihood results in an overall low risk rating. Any combination of medium/medium or low/high ratings for consequence and likelihood results in a "yellow" or overall medium risk rating. Any combination of medium/high or high/high ratings for consequence and likelihood results in a "red" or overall high risk rating.

Probability (Likelihood) of Occurrence		Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
	High	Yellow (Medium Risk)	Red (High Risk)	Red (High Risk)
	Medium	Green (Low Risk)	Yellow (Medium Risk)	Red (High Risk)
	Low	Green (Low Risk)	Jellyfish may be more common Green (Low Risk)	Yellow (Medium Risk)

Figure 1. Consequence/probability matrix with illustrative example.

The experts applied their knowledge and judgment and the existing information specified in the Quality Assurance Project Plan (QAPP) to analyze all four risk identification checklists (pollution control; habitat; fish, wildlife, and plants; recreation and public water supplies) of the NCA. Each checklist contains two to three Clean Water Act goals that may be affected by seven listed climate change stressors. Overall each checklist contains approximately 30 items that were assessed with regard to consequence (severity of impact) and likelihood (probability of occurrence). High/medium/low consequence rating and high/medium/low probability rating was applied to each potential impact in the checklists. Spreadsheets developed by the expert team were used to capture the ratings, sources of information supporting the ratings, and to generate the C/P matrices. An example of the spreadsheets is attached as Appendix A.

[EPA is developing an online tool that can be used in conjunction with *Being Prepared for Climate Change: A Workbook for Developing Risk-Based Adaptation Plans* to generate C/P matrices. The beta version of the tool was considered for use in this study. EPA provided training on the tool to the team of experts. However, because the tool was expected to be unavailable during critical times in the study, the beta version of the tool was not used. Battelle’s team developed a simplified tool directly to meet the needs of this project. This spreadsheet tool enabled the assignment of individual and combined risk category rating after the expert(s) assigns the literature and judgment-based consequence and likelihood ratings. This tool helped expedite and standardize the analysis and rating process. Experts of interrelated disciplines (for example pollution control, habitat, and wetlands) discussed and finalized ratings to ensure consistency in ratings due to a mutually impacting stressor.]

5 Results

The following sections provide the C/P matrices that were generated as described above.

5.1 Pollution Control

The risks to EPA goals associated with pollution control in the NE Study Area by 2050 are shown in the matrix in Figure 2. The potential inadequacy of flood control facilities allowing flooding impacts appear to be the highest risk by 2050 to EPA goals associated with pollution control. There is also a high risk that water temperature may impact cooling water discharges that could impact energy production during peak demand periods (hot summers).

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High	1. Warmer Winters - Longer growing season can lead to more lawn maintenance with fertilizers and pesticides 2. Warmer Water - Greater algae growth may occur 3. Warmer Winters - Loss of melting winter snows may reduce spring or summer flow volume and raise pollutant concentration in receiving waters	1. Warmer Water - Water may hold less dissolved oxygen	1. Increasing Storminess - Flood control facilities (e.g., detention basins, manure management) may be inadequate
Medium	1. Increasing Storminess - High rainfall may cause septic systems to fail 2. Ocean Acidification - Decomposing organic matter releases carbon dioxide, which may exacerbate the ocean acidification problem in coastal waters 3. Warmer Summers - Wildfires may lead to soil erosion 4. Warmer Water - Higher surface temperatures may lead to stratification 5. Sea Level Rise - Sewage may mix with seawater in combined sewer systems	1. Increasing Drought - Pollution sources may build up on land, followed by high-intensity flushes 2. Increasing Storminess - Streams may see greater erosion and scour 3. Sea Level Rise - Tidal flooding may extend to new areas, leading to additional sources of pollution 4. Warmer Water - Higher solubility may lead to higher concentrations of pollutants 5. Warmer Water - Parasites, bacteria may have greater survival or transmission 6. Increasing Drought - Critical-low-flow criteria for discharging may not be met 7. Increasing Drought - Pollutant concentrations may increase if sources stay the same and flow diminishes 8. Increasing Storminess - Combined sewer overflows may increase 9. Warmer Water - Temperature criteria increase toxicity of pollutants	1. Increasing Storminess - Urban areas may be subject to more floods 2. Increasing Storminess - Treatment plants may go offline during intense floods 3. Sea Level Rise - Treatment plants may not be able to discharge via gravity at higher water levels 4. Sea Level Rise - Treatment infrastructure may be susceptible to flooding 5. Sea Level Rise - Contaminated sites may flood or have shoreline erosion 6. Sea Level Rise - Sewer pipes may have more inflow (floods) or infiltration (higher water table) 7. Warmer Water - Temperature criteria for discharges may be exceeded (thermal pollution)
Low			

Figure 2. Northeast Region 2050 Pollution Control Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

The risks to EPA goals associated with pollution control in the NE Study Area by 2100 are shown in the matrix in Figure 3. Problems associated with low flows and eutrophication join flooding as high risk challenges to EPA pollution control goals by 2100. Restrictions on discharges are also high risk that can impact operation of businesses and public services.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High	1. Warmer Winters - Longer growing season can lead to more lawn maintenance with fertilizers and pesticides	1. Increasing Drought - Critical-low-flow criteria for discharging may not be met 2. Sea Level Rise - Sewage may mix with seawater in combined sewer systems 3. Sea Level Rise - Tidal flooding may extend to new areas, leading to additional sources of pollution 4. Warmer Winters - Loss of melting winter snows may reduce spring or summer flow volume and raise pollutant concentration in receiving waters 5. Warmer Water - Water may hold less dissolved oxygen 6. Warmer Water - Greater algae growth may occur	1. Increasing Storminess - Flood control facilities (e.g., detention basins, manure management) may be inadequate 2. Sea Level Rise - Treatment plants may not be able to discharge via gravity at higher water levels 3. Sea Level Rise - Treatment infrastructure may be susceptible to flooding 4. Sea Level Rise - Sewer pipes may have more inflow (floods) or infiltration (higher water table)
Medium	1. Increasing Storminess - High rainfall may cause septic systems to fail 2. Ocean Acidification - Decomposing organic matter releases carbon dioxide, which may exacerbate the ocean acidification problem in coastal waters 3. Warmer Summers - Wildfires may lead to soil erosion 4. Warmer Water - Higher surface temperatures may lead to stratification	1. Increasing Drought - Pollutant concentrations may increase if sources stay the same and flow diminishes 2. Increasing Drought - Pollution sources may build up on land, followed by high-intensity, flushes 3. Increasing Storminess - Combined sewer overflows may increase 4. Increasing Storminess - Streams may see greater erosion and scour 5. Warmer Water - Temperature criteria increase toxicity of pollutants 6. Warmer Water - Higher solubility may lead to higher concentrations of pollutants 7. Warmer Water - Parasites, bacteria may have greater survival or transmission	1. Increasing Storminess - Treatment plants may go offline during intense floods 2. Increasing Storminess - Urban areas may be subject to more floods 3. Sea Level Rise - Contaminated sites may flood or have shoreline erosion 4. Warmer Water - Temperature criteria for discharges may be exceeded (thermal pollution)
Low			

Figure 3. Northeast Region 2100 Pollution Control Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

5.2 Habitat

The risks to EPA goals associated with habitat in the NE Study Area by 2050 are shown in the matrix in Figure 4. Habitat damage or loss caused by sea level rise and warmer water, supplemented by increasing turbidity and sedimentation from increased storms, are the high risk concerns by 2050.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High	1. Warmer Winters - Warmer winters may lead to less snow, more rain may change the runoff/infiltration balance; base flow in streams may change	1. Increasing Drought - An increase in long-term and seasonal short term drought may decrease base flows in streams 2. Increasing Drought -An increase in long-term and seasonal short term drought may cause groundwater tables to drop 3. Increasing Drought - Stream water may become warmer 4. Increasing Storminess - Stronger storms may cause more intense flooding and runoff 5. Increasing Storminess - The number of storms reaching an intensity that causes problems may increase 6. Increasing Storminess - Turbidity of surface waters may increase	1. Increasing Storminess - Coastal overwash or island breaching may occur 2. Sea Level Rise - Ability of tidal marsh elevation to match rate of sea level rise 3. Sea Level Rise - Ability of tidal marsh to migrate landward 4. Sea Level Rise - Higher salinity may kill targeted species 5. Sea Level Rise - Shoreline erosion may lead to loss of beaches, wetlands and salt marshes 6. Warmer Water - Warm water may promote invasive species or disease 7. Warmer Water - Warmer water is likely to increase incidence of marine and estuarine disease 8. Warmer Water - Warmer water is likely to lead to an expansion of invasive species
Medium	1. Increasing Storminess - Increased intensity of precipitation may yield less infiltration 2. Warmer Summers - Warmer summers may lead to greater electricity demand may affect operation decisions at hydropower dams 3. Warmer Summers - Warmer summers may result in the switching between surface and groundwater sources for public water supplies may affect the integrity of water bodies 4. Warmer Winters - Rivers may no longer freeze; a spring thaw would be obsolete 5. Warmer Winters - Marshes and beaches may erode from loss of protecting ice	1. Warmer Summers - Warmer summers are expected to result in higher temperatures which may lead to greater evaporation and lower groundwater tables 2. Warmer Water - Desired fish may no longer be present 3. Warmer Water - Warmer water is likely to lead to greater likelihood of stratification 4. Increasing Storminess - Turbidity of surface waters may increase	1. Increasing Storminess - Stream erosion may lead to high turbidity and greater sedimentation 2. Sea Level Rise - Bulkheads, sea walls and revetments may become more widespread 3. Sea Level Rise - Saline water may move farther upstream and freshwater habitat may become brackish 4. Sea Level Rise - Salinization of non-tidal freshwater coastal marshes 5. Sea Level Rise - Tidal influence may move farther upstream 6. Warmer Water - Warmer water may result in the loss of SAV habitat
Low	1. Increasing Drought - Increased human use of groundwater during drought may reduce stream baseflow 2. Increasing Drought - New water supply reservoirs may affect the integrity of freshwater streams 3. Increasing Storminess - Lower pH for NPS pollution may affect target species 4. Ocean Acidification - Long term shellfish sustainability may be an open question 5. Warmer Winters - A spring runoff pulse may disappear along with the snow	1. Sea Level Rise - Light may not penetrate through deeper water 2. Ocean Acidification - Fish may be adversely affected during development stages	

Figure 4. Northeast Region 2050 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

The risks to EPA goals associated with habitat in the NE Study Area by 2100 are shown in the matrix in Figure 5. Expanded habitat damage or loss caused by sea level rise and warmer water, supplemented by increasing turbidity and sedimentation from increased storms, are the high risk concerns by 2100.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High		1. Increasing Drought - An increase in long-term and seasonal short term drought may decrease base flows in streams 2. Increasing Drought - Stream water may become warmer 3. Increasing Storminess - The number of storms reaching an intensity that causes problems may increase 4. Increasing Storminess - Turbidity of surface waters may increase 5. Warmer Summers - Warmer summers are expected to result in higher temperatures which may lead to greater evaporation and lower groundwater tables 6. Warmer Summers - Warmer summers may lead to greater electricity demand may affect operation decisions at hydropower dams 7. Warmer Summers - Warmer summers may result in the switching between surface and groundwater sources for public water supplies may affect the integrity of water bodies 8. Warmer Winters - Warmer winters may lead to less snow, more rain may change the runoff/infiltration balance; base flow in streams may change	1. Increasing Drought - An increase in long-term and seasonal short term drought may cause groundwater tables to drop 2. Increasing Storminess - Coastal overwash or island breaching may occur 3. Increasing Storminess - Stream erosion may lead to high turbidity and greater sedimentation 4. Increasing Storminess - Stronger storms may cause more intense flooding and runoff 5. Sea Level Rise - Ability of tidal marsh elevation to match rate of sea level rise 6. Sea Level Rise - Ability of tidal marsh to migrate landward 7. Sea Level Rise - Bulkheads, sea walls and revetments may become more widespread 8. Sea Level Rise - Higher salinity may kill targeted species 9. Sea Level Rise - Saline water may move farther upstream and freshwater habitat may become brackish 10. Sea Level Rise - Salinization of non-tidal freshwater coastal marshes 11. Sea Level Rise - Shoreline erosion may lead to loss of beaches, wetlands and salt marshes 12. Sea Level Rise - Tidal influence may move farther upstream 13. Warmer Water - Warm water may promote invasive species or disease 14. Warmer Water - Warmer water is likely to Increase incidence of marine and estuarine disease 15. Warmer Water - Warmer water is likely to lead to an expansion of invasive species
Medium	1. Increasing Storminess - Increased intensity of precipitation may yield less infiltration 2. Increasing Storminess - Lower pH for NPS pollution may affect target species 3. Warmer Winters - A spring runoff pulse may disappear along with the snow 4. Warmer Winters - Marshes and beaches may erode from loss of protecting ice 5. Warmer Winters - Rivers may no longer freeze; a spring thaw would be obsolete	1. Increasing Drought - Increased human use of groundwater during drought may reduce stream baseflow 2. Increasing Drought - New water supply reservoirs may affect the integrity of freshwater streams 3. Ocean Acidification - Fish may be adversely affected during development stages 4. Ocean Acidification - Long term shellfish sustainability may be an open question 5. Warmer Water - Desired fish may no longer be present 6. Warmer Water - Warmer Water is likely to lead to greater likelihood of stratification	1. Warmer Water - Warmer water may result in the loss of SAV habitat
Low		1. Sea Level Rise - Light may not penetrate through deeper water	

Figure 5. Northeast Region 2100 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

5.3 Fish, Wildlife and Plants

The risks to EPA goals associated with fish, wildlife and plants in the NE Study Area by 2050 are shown in the matrix in Figure 6. These results are similar to those observed for habitat loss with damage caused by sea level rise, warmer weather, and warmer water, supplemented by increasing turbidity and sedimentation from increased storms, as the high risk concerns by 2050.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High		1. Increasing Storminess - Greater soil erosion may increase sediment deposition in estuaries, with consequences for benthic species 2. Warmer Summers - Species may need to consume more water as temperature rises 3. Warmer Summers - Species that won't tolerate warmer summers may die/migrate; biota at the southern limit of their range may disappear from ecosystems 4. Warmer Water - Heat may stress immobile biota 5. Warmer Water - Some fish reproduction may require cold temperatures; other reproductive cycles are tied to water temperature	1. Increasing Drought - Changing freshwater inputs may affect salinity distribution in estuaries (especially of interest with regard to shellfish habitat 2. Warmer Water - Parasites and diseases are enhanced by warmer water 3. Sea Level Rise - Ability of tidal marsh elevation to match rate of sea level rise 4. Sea Level Rise - Ability of tidal marsh to migrate landward 5. Sea Level Rise - Greater coastal wetland losses may occur 6. Warmer Water - Dissolved oxygen capacity of water may drop 7. Warmer Water - Habitat may become unsuitably warm, for a species or its food 8. Warmer Water - Newly invasive species may appear 9. Warmer Winters - Invasive species may move into places that used to be too cold 10. Warmer Winters - Pests may survive winters that used to kill them
Medium		1. Increasing Drought - Species may not tolerate a new drought regime 2. Warmer Summers - Essential food sources may die off or disappear, affecting the food web 3. Warmer Winters - Food supplies and bird migrations may be mistimed 4. Warmer Winters - Some plants may need a "setting" cold temperature 5. Warmer Winters - Species that once migrated through may stop and stay 6. Warmer Winters - Species that used to migrate away may stay all winter	1. Increasing Drought - Native habitat may be affected if freshwater flow in streams is diminished or eliminated 2. Increasing Storminess - Greater soil erosion may increase turbidity and decrease water clarity 3. Sea Level Rise - Sea level may push saltier water farther upstream (especially of interest with regard to shellfish habitat) 4. Sea Level Rise - Salinization of non-tidal freshwater coastal marshes
Low	1. Warmer Summers - Species may be weakened by heat and become out- competed 2. Ocean Acidification - Corrosive waters may impact shellfish development 3. Ocean Acidification - Shellfish predators may not survive the disappearance of shellfish 4. Ocean Acidification - Fish may be adversely affected during development stages by changes to water chemistry 5. Ocean Acidification - The effect of ocean acidification on calcifying plankton may lead to cascading effects in the food chain	1. Sea Level Rise - Light may not penetrate through the full depth of deeper water 2. Warmer Winters - A longer growing season may lead to an extra reproductive cycle	

Figure 6. Northeast Region 2050 Fish, Wildlife, and Plant Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

The risks to EPA goals associated with fish, wildlife and plants in the NE Study Area by 2100 are shown in the matrix in Figure 7. Expanded impacts on fish, wildlife and plants caused by sea level rise, warmer weather, and warmer water, supplemented by increasing turbidity and sedimentation from increased storms, are the high risk concerns by 2100.

Likelihood of Occurrence \ Consequence of Impact	Low	Medium	High
High		1. Increasing Drought - Species may not tolerate a new drought regime 2. Increasing Storminess - Greater soil erosion may increase sediment deposition in estuaries, with consequences for benthic species 3. Warmer Summers - Essential food sources may die off or disappear, affecting the food web 4. Warmer Summers - Species may need to consume more water as temperature rises 5. Warmer Summers - Species that won't tolerate warmer summers may die/migrate; biota at the southern limit of their range may disappear from ecosystems 6. Warmer Water - Heat may stress immobile biota 7. Warmer Water - Some fish reproduction may require cold temperatures; other reproductive cycles are tied to water temperature 8. Warmer Winters - Food supplies and bird migrations may be mistimed 9. Warmer Winters - Some plants may need a "setting" cold temperature	1. Increasing Drought - Changing freshwater inputs may affect salinity distribution in estuaries (especially of interest with regard to shellfish habitat 2. Increasing Storminess - Greater soil erosion may increase turbidity and decrease water clarity 3. Sea Level Rise - Ability of tidal marsh elevation to match rate of sea level rise 4. Sea Level Rise - Ability of tidal marsh to migrate landward 5. Sea Level Rise - Greater coastal wetland losses may occur 6. Sea Level Rise - Salinization of non-tidal freshwater coastal marshes 7. Sea Level Rise - Sea level may push saltier water farther upstream (especially of interest with regard to shellfish habitat) 8. Warmer Water - Dissolved oxygen capacity of water may drop 9. Warmer Water - Habitat may become unsuitably warm, for a species or its food 10. Warmer Water - Newly invasive species may appear 11. Warmer Water - Parasites and diseases are enhanced by warmer water 12. Warmer Winters - Invasive species may move into places that used to be too cold 13. Warmer Winters - Pests may survive winters that used to kill them
Medium	1. Warmer Summers - Species may be weakened by heat and become out- competed	1. Ocean Acidification - Corrosive waters may impact shellfish development 2. Ocean Acidification - Fish may be adversely affected during development stages by changes to water chemistry 3. Ocean Acidification - Shellfish predators may not survive the disappearance of shellfish 4. Ocean Acidification - The effect of ocean acidification on calcifying plankton may lead to cascading effects in the food chain 5. Warmer Winters - A longer growing season may lead to an extra reproductive cycle 6. Warmer Winters - Species that once migrated through may stop and stay 7. Warmer Winters - Species that used to migrate away may stay all winter	1. Increasing Drought - Native habitat may be affected if freshwater flow in streams is diminished or eliminated
Low		1. Sea Level Rise - Light may not penetrate through the full depth of deeper water	

Figure 7. Northeast Region 2100 Fish, Wildlife, and Plant Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

5.4 Recreation and Public Water Supplies

The risks to EPA goals associated recreation and public water supplies in the NE Study Area by 2050 are shown in the matrix in Figure 8. No high risk impacts to recreation and public water supplies were identified for 2050. However, medium risk concerns were identified associated with flooding, eutrophication, and impacts on fish and shellfish.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High	1. Sea Level Rise - Clearance under bridges may decrease 2. Warmer Water - Harmful algal blooms may be more likely		
Medium	1. Increasing Storminess - Greater NPS pollution may impair recreation 2. Ocean Acidification - Eco-tourism resource or attractions (e.g., birding, diving, fishing) may be degraded 3. Sea Level Rise - Saltwater intrusion into groundwater may be more likely 4. Warmer Summers - Warmer temperatures may drive greater water demand 5. Warmer Summers - Evaporation losses from reservoirs and groundwater may increase 6. Warmer Water - Jellyfish may be more common 7. Warmer Water - Increased growth of algae and microbes may affect drinking water quality	1. Increasing Storminess - Water infrastructure may be vulnerable to flooding 2. Sea Level Rise - Water infrastructure may be vulnerable to inundation or erosion 3. Sea Level Rise - Beaches or public access sites may be lost to coastal erosion or inundation 4. Warmer Water - Fishing seasons and fish may become misaligned 5. Warmer Water - Desired recreational fish may no longer be present 6. Warmer Winters - Summer water supplies that depend on winter snow pack may disappear 7. Warmer Water – Invasive plants may clog creeks and waterways 8. Ocean Acidification - Recreational shellfish harvesting may be lost	
Low	1. Increasing Drought - Freshwater flows in streams may not support recreational uses 2. Increasing Drought - Increased estuary salinity may drive away targeted recreational fish 3. Increasing Drought - Lower freshwater flows may not keep saltwater downstream of intakes 4. Increasing Drought - Groundwater tables may drop 5. Increasing Drought - Coastal aquifers may be salinized from insufficient freshwater input 6. Increasing Drought - Coastal aquifers may be salinized from higher demand on groundwater 7. Increasing Drought - Maintaining passing flows at diversions may be difficult 8. Increasing Storminess - More frequent or more intense storms may decrease recreational opportunities 9. Increasing Storminess - Flood waters may raise downstream turbidity and affect water quality 10. Warmer Summers - More people using water for recreation may raise the potential for pathogen exposure 11. Warmer Water - Changes in treatment processes may be required 12. Warmer Winters - Cold places may see more freeze/thaw cycles that can affect infrastructure	1. Sea Level Rise - Sea level may push salt fronts upstream past water diversion	

Figure 8. Northeast Region 2050 Recreation and Water Supply Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

The risks to EPA goals associated recreation and public water supplies in the NE Study Area by 2100 are shown in the matrix in Figure 9. High risk impacts to recreation and public water supplies were identified for 2100. These concerns are associated loss of recreational areas and infrastructure to flooding, erosion, and inundation; loss of species that support recreation; eutrophication; and the emergence of undesirable species.

Likelihood of Occurrence				
	High		1. Increasing Storminess - Greater NPS pollution may impair recreation 2. Ocean Acidification - Eco-tourism resource or attractions (e.g., birding, diving, fishing) may be degraded 3. Ocean Acidification - Recreational shellfish harvesting may be lost 4. Sea Level Rise - Clearance under bridges may decrease 5. Sea Level Rise - Saltwater intrusion into groundwater may be more likely 6. Warmer Summers - Warmer temperatures may drive greater water demand 7. Warmer Summers - Evaporation losses from reservoirs and groundwater may increase 8. Warmer Water - Harmful algal blooms may be more likely 9. Warmer Water - Jellyfish may be more common 10. Warmer Water - Desired recreational fish may no longer be present 11. Warmer Water - Invasive plants may clog creeks and waterways 12. Warmer Water - Increased growth of algae and microbes may affect drinking water quality 13. Warmer Winters - Summer water supplies that depend on winter snow pack may disappear	1. Increasing Storminess - Water infrastructure may be vulnerable to flooding 2. Sea Level Rise - Water infrastructure may be vulnerable to inundation or erosion 3. Sea Level Rise - Beaches or public access sites may be lost to coastal erosion or inundation 4. Warmer Water - Fishing seasons and fish may become misaligned
	Medium	1. Increasing Drought - Increased estuary salinity may drive away targeted recreational fish 2. Warmer Water - Changes in treatment processes may be required	1. Increasing Drought - Freshwater flows in streams may not support recreational uses 2. Increasing Drought - Lower freshwater flows may not keep saltwater downstream of intakes 3. Increasing Drought - Groundwater tables may drop 4. Increasing Drought - Coastal aquifers may be salinized from insufficient freshwater input 5. Increasing Drought - Coastal aquifers may be salinized from higher demand on groundwater 6. Increasing Drought - Maintaining passing flows at diversions may be difficult 7. Increasing Storminess - More frequent or more intense storms may decrease recreational opportunities 8. Increasing Storminess - Flood waters may raise downstream turbidity and affect water quality 9. Sea Level Rise - Sea level may push salt fronts upstream past water diversion 10. Warmer Summers - More people using water for recreation may raise the potential for pathogen exposure 11. Warmer Winters - Cold places may see more freeze/thaw cycles that can affect infrastructure	
	Low			
		Low	**Medium**	**High**
		Consequence of Impact		

Figure 9. Northeast Region 2100 Recreation and Water Supply Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

6 Conclusions and Comments

This scoping study provides a climate change vulnerability assessment for the NE Study Area from Long Island, NY to southern Maine. C/P matrices for four EPA goal areas (pollution control; habitat; fish, wildlife, and plants; recreation and public water supplies) for 2050 and 2100 indicate that risks to EPA Clean Water Act goals associated with climate change exist in the near term for most EPA goals and become substantially greater for all EPA goals by 2100.

Because these results represent expert judgment of a very limited number of individuals, the results should be considered preliminary and communicated and used with appropriate disclaimers and due caution. Owing to the nature of data available and reviewed, high levels of uncertainty exist in the complexities of climate change applied to any potential impact, particularly ecological impacts. For example, there is certainty that increased carbon dioxide in the atmosphere will increase the pH of the oceans. The sources reviewed indicated that empirical data from aquaculture and from laboratory experiments show that pH changes negatively impact species of economic interest. What was less certain is the extent of acidification and the impacts over time. The uncertainties were prevalent and enhanced the uncertainty in rank assignment based on spatial extents of the risk item.

The estimation of risk produced in this scoping study can be can be improved by ensuring that the breadth of understanding is available. No small group of experts will possess that breadth of knowledge. A full vetting of the scoping study vulnerability assessment results with a broad range of experts is strongly recommended.

7 References

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Task 3 Results

Work Assignment 1-14

Climate Change Vulnerabilities Scoping Report: Risks to Clean Water Act Goals in Northeast Sub-regions

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The Business *of* Innovation

1 Purpose

The purpose of this scoping study is to raise awareness of risks to the U.S. Environmental Protection Agency (EPA) Clean Water Act goals associated with climate change and indicate where more analysis might be needed. This study reviewed and analyzed existing information to create a risk-based climate change vulnerability assessment to inform those managing coastal watersheds in sub-regions in the Northeast Study Area. The study examined climate change risks to sub-regions, including estuaries and coastal watersheds, for six study regions within the Northeast (NE) Study Area:

1. Southern Maine concentrating on the Casco Bay Area
2. New Hampshire
3. Massachusetts Bay and environs
4. Buzzards Bay
5. Rhode Island
6. Long Island Sound (Connecticut and New York)

The vulnerability assessment produced separate consequence/probability (C/P) matrices for each of the six NE sub-regions based on each of the four risk identification checklists (pollution control; habitat; fish, wildlife, and plants; recreation and public water supplies) and two time periods (2050 and 2100) for a total of 48 C/P matrices.

2 Scope and Limitations of Study

In a companion study, potential climate change risks to the NE Study Area (Long Island to southern Maine) were identified or inferred from sources specified by the EPA: the National Climate Assessment (NCA) (Melillo et al., 2014) and NOAA (2013). Here, the same approach was applied to focus on sub-regions and define differences in climate change risk at this finer scale as it compares to the NE Study Area, summarized in Table 1. Expert knowledge and judgment supplemented by a review of the information in the specified sources were applied to an analysis of all four risk identification checklists (pollution control; habitat; fish, wildlife, and plants; recreation and public water supplies) of EPA (2014). Each checklist contains two to three Clean Water Act goals that may be affected by seven listed climate change stressors. Each checklist contains approximately 30 items that were assessed by individuals with relevant regional expertise in pollution control, habitats, biota, and water supplies. The experts made judgments as to the consequence (severity of impact) and likelihood (probability of occurrence) based on the sources of information listed in Section 3. It is important to note that no other literature sources were reviewed as part of this study. A C/P matrix was prepared for each checklist for both 2050 and 2100 and vetted by the team of experts to ensure logical consistency and consensus on the ratings of the matrices.

Table 1. Summary of Checklists, EPA Goals, Stressors, and Time Frames within Study Scope

Potential Climate Change Risks (Checklist)	Clean Water Act Goals	Climate Change Stressors	Time Frames (Years)
Pollution Control	• Controlling point sources of pollution and cleaning up pollution • Controlling nonpoint sources of pollution	• Warmer summers • Warmer winters • Warmer water • Increasing drought • Increasing storminess • Sea level rise • Ocean acidification	• 2050 • 2100
Habitat	• Restoring and protecting physical and hydrologic features • Constructing reefs to promote fish and shellfish	• Warmer summers • Warmer winters • Warmer water • Increasing drought • Increasing storminess • Sea level rise • Ocean acidification	• 2050 • 2100
Fish, Wildlife, and Plants	• Protecting and propagating fish, shellfish, and wildlife • Controlling nonnative and invasive species • Maintaining biological integrity and reintroducing native species	• Warmer summers • Warmer winters • Warmer water • Increasing drought • Increasing storminess • Sea level rise • Ocean acidification	• 2050 • 2100
Recreation and Public Water Supplies	• Restoring and maintaining recreational activities, in and on the water • Protecting public water supplies	• Warmer summers • Warmer winters • Warmer water • Increasing drought • Increasing storminess • Sea level rise • Ocean acidification	• 2050 • 2100

3 Sources of Information Used

For each sub-region, the results of the Northeast analysis (Climate Change Vulnerabilities Scoping Report: Risks to Clean Water Act Goals in Northeast) was compared with the respective state climate change reports. Per EPA direction, information was not sought outside of these sources:

Adaptation Subcommittee to the Governor's Steering Committee on Climate Change. 2010. The Impacts of Climate change on Connecticut Agriculture, Infrastructure, Natural Resources, and Public Health. http://www.ct.gov/deep/lib/deep/climatechange/impactsofclimatechange.pdf.

Executive Office of Energy and Environmental Affairs and the Adaptation Advisory Committee. 2011. Chapter 2: Changing Climate and Its Impact. Massachusetts Climate change Adaptation Report. (http://www.mass.gov/eea/docs/eea/energy/cca/eea-climate-adaptation-report.pdf).

New York State Climate Action Council. 2010. Climate Action Plan Interim Report. (http://www.dec.ny.gov/docs/administration_pdf/irpart1.pdf).

Rhode Island Climate Change Commission. 2012. Adapting to Climate Change in the Ocean State: A Starting Point: 2012 Progress Report. (http://www.rilin.state.ri.us/Reports/Climate%20Change%20Commission%20Prog%20Report%20Final%2011%2015%2012%20final%202.pdf.)

Wake, C., E. Burakowski, K. Hayhoe, C. Watson, E. Douglas, J. VanDorn, V. Naik, C. Keating. 2009. Climate change in the Casco Bay Watershed: Past, Present, Future. Casco Bay Estuary Partnership. (http://www.seagrant.umaine.edu/files/chg/Climate_Change_in_Casco_Bay.pdf).

Wake, C., E. Burakowski, P. Wilkinson, K. Hayhoe, A. Stoner, C. Keeley, J. LaBranche. 2014. Climate Change in Southern New Hampshire: Past, Present, and Future. Climate Solutions New England. (http://nhblog.stormsmart.org/links-to-resources-for-adaptation-to-climate-change/).

Wake, C., E. Burakowski, K. Hayhoe, A. Stoner, C. Watson, and W. Douglas. 2011. Climate Change in the Piscataqua/Great Bay Region: Past, Present, Future. Carbon Solutions New England, Great Bay Stewards, and University of New Hampshire. http://nhblog.stormsmart.org/links-to-resources-for-adaptation-to-climate-change/

4 Interpreting Findings

Professional judgment is useful for analysis where complex problems exist for which empirical estimation is not feasible, as well as detailed research is unavailable. Professional judgment as applied in this NE Study area meant: (1) persons involved in making the judgment had scientific and / or engineering credentials and academic and or professional experience necessary to support a claim of “expert”; (2) persons involved in making the judgment had through knowledge of the relevant literature essential for interpretation of facts; and (3) concurrence existed among more than one expert to provide scientifically-valid and defendable conclusions.

The experts who contributed to the NE sub-region study Area vulnerability analysis included:

Dr. Kurt Philipp, Ph.D., Marine Sciences (Avatar Environmental). Credentials include being a Professional Wetland Scientist and former Professional Certification Board President. He has over 30 years of experience conducting wetlands investigations, particularly in wetlands restoration and creation, as well as delineation, mapping and the impact of hazardous waste. Dr. Philipp conducted his doctoral graduate research in salt and water relations of tidal marsh plants at the University of Delaware and conducted research in tidal marshes throughout the estuary. He has also provided historical and ecological characterizations in Estuarine Profiles - Delaware National Estuarine Research Reserve, Comprehensive Conservation and Management Plan for Delaware’s Tidal Wetlands, The ecology of freshwater tidal wetlands, History of Delaware and New Jersey salt marsh restoration sites, *Phragmites australis* expansion in Delaware Bay salt marshes, and presentations at conferences such as the Society of Wetland Scientists.

Siva Sangameswaran, Ph.D., P.E., C.F.M. (Dewberry). A Senior Water Resources Engineer, Dr. Sangameswaran has extensive knowledge and experience solving complex engineering problems and environmental issues using context sensitive modeling and sustainable, natural systems based approaches. His expertise includes 1-D and 2-D hydrodynamic modeling; hydraulic and hydrologic modeling; coastal engineering and wave modeling; and sediment transport modeling in riverine and coastal systems. He has experience with stream restoration; drainage design for flood protection; green infrastructure design; and TMDL development.

Kaveh Zomorodi, Ph.D., P.E., C.F.M. (Dewberry). A Senior Hydrologist and Water Resources Engineer, Dr. Zomorodi has over 27 years of work experience in academic and consulting engineering work dealing with surface water hydrology and hydraulics, groundwater, water resources planning and management and hazard mitigation. Dr. Zomorodi has published over 45 technical papers in various journals and conference proceedings and numerous R&D and project reports. Consulting and research work experience includes hydrological studies and modeling; floodplain modeling; benefit-cost analysis of hazard mitigation; modeling the impact of climate change on design peak discharges and coastal design flood elevations; highway hydraulic modeling and bridge scour analysis; management and operation of water resources networks; groundwater modeling and management; and artificial groundwater recharge.

Harry Stone, Ph.D. (ecology), M.S. (plant physiology), M.B.A. (Battelle). Dr. Stone is a Senior Research Scientist. He is a Certified Senior Ecologist (Ecological Society of America) with more than 25 years of project management experience. Recent work includes leading a team of experts in the evaluation of models applicable to prediction of algal blooms in Lake Erie on an EPA project and modeling the likelihood of observing pollution intolerant fish communities in the Ohio Interior Low Plateau Ecoregion. Recently for the US Army Corps of Engineers, he provided technical leadership for the evaluation of climate change impacts on ecosystem services in the Ohio River Basin and corresponding adaptation strategies.

Chuck Dobroski, M.S., Marine Biology (Avatar Environmental). He is a co-founder and Principal of Avatar Environmental, and provides the technical direction and oversight of ecological programs as well as ecological and human health risk assessments for Avatar. He has over 35 years of providing ecological services in marine and estuarine environments for the government and private sector. Activities have included the technical development, management and performance of a diverse array of coastal and estuarine projects throughout the United States as well as overseas. Mr. Dobroski provides consulting support for biological monitoring of marine/estuarine fisheries; marine construction and dredging impacts; ocean outfalls; salt marsh, beach and dune restoration; submerged aquatic vegetation evaluations; intertidal and benthic ecology; blue water biology; and tropical/subtropical ecology. Water/sediment quality and hydrographic investigations in marine and estuarine habitats have included evaluation of thermal plumes using standard techniques as well as remote sensing, tracer studies for ocean outfalls; nutrient chemistry and evaluation, chemical contaminant characterization; and dissolved oxygen reduction in poorly circulating marinas and embayments.

John Licsko, M.Sc., Water Resource Engineering (Dewberry). During his 20-year career, John Licsko has been a technical and management lead for the application and review of hydrologic & hydraulic procedures for floodplain, interior drainage, dam, transportation and stream restoration studies and designs, across the U.S., including New York, New Jersey, Virginia, and Maryland. Currently, he serves as a senior engineer and project manager with Dewberry's joint venture with URS Corporation for the Production and Technical Services contract with FEMA, which includes development of floodplain studies in FEMA Regions II, III, and IV. His work has included the development and review of engineering models, such as HEC-HMS, HEC-RAS (Steady and Unsteady State), XP-SWMM (1D & 2D), EPA SWMM, and FLO-2D in support of flood insurance studies, appeals, and Letter of Map Change (LOMC) requests. Prior to 2009, John worked within Dewberry's Water Resources Department developing and managing water quality monitoring programs to meet National Pollutant Discharge Elimination System

(NPDES) requirements for local municipalities and agencies. John also completed hydrologic and hydraulic models for dam, transportation, and stream restoration projects, primarily in Virginia and Maryland.

Krista Rand, M.S. Civil Engineering, E.I.T., C.F.M. (Dewberry). Ms. Rand is projects of national significance related to water resources and climate change, especially riverine flooding and transportation systems. Certified Floodplain Manager (2012 – 2014). Expertise include hydrology and hydraulics, climate vulnerability assessments, natural hazard mitigation and climate change adaptation, transportation systems, and natural resources management and policy.

4.1 Assumptions and Guidelines

An analysis was performed to elucidate the likelihood of risk using a “future without action” or “business as usual” scenario for two time periods (the years 2050 and 2100). Planned actions were not considered in the risk analysis. Outcomes that were judged to be zero risk were, per EPA direction, categorized as low consequence and low probability. For certain impacts, although there was insufficient quantitative data in the literature, based on expert judgment a medium “M” rating, rather than a low “L” rating was assigned. Only coral reef impacts were not evaluated because there are no coral reefs in the sub-regions.

The criteria for selecting high, medium, and low risk values were vetted by the team of experts prior to beginning the analysis. Consensus was reached with the team of experts during a teleconference on September 10, 2015 establishing the following orders of magnitude rating guide for assigning risk.

The probability (likelihood) of occurrence was rated using the following guideline:

- If confidence level is “Very High (strong evidence and scientific consensus)” or “High” (moderate evidence from multiple sources, medium consensus) – probability (likelihood) of occurrence is rated “high”.
- If confidence level is “Medium” (suggestive evidence, limited consensus, competing schools of thought) – probability (likelihood) of occurrence is rated “medium”.
- If confidence level is “Low” (inconclusive, limited evidence, disagreement or lack of opinions among experts) – probability (likelihood) of occurrence is rated “low”.

The consequence of impact was rated using the following guideline for the ranking of pollution control and recreation and public water supplies.

- High if
  - Spatial extent is large and/or
  - More than roughly 1 million people impacted and/or
  - More than roughly $1 billion impact and/or
- Medium if
  - Spatial extent is place or region and/or
  - More than roughly 10,000 people impacted and/or
  - More than roughly $1 million impact and/or

- Low if
  - o Spatial extent is one or a few sites and/or
  - o Less than roughly 1,000 people impacted and/or
  - o Less than roughly $1 million impact.

During the study, it was found that the above quantitative criteria was not directly usable for numerous situations owing to lack of data. For multiple situations, data was not available / complete. To assign a scientifically-informed consequence for the above, engineering judgement was used to assign a rank higher than low, if appropriate, following discussions between the experts of related disciplines

For this assessment, ecological consequences were rated based the implied effect on the specific Clean Water Goals to be achieved and the severity of the effect:

Habitat

- Severity - loss of habitat, modification of habitat, or shifting of habitat,
- Sensitivity or ecological importance of habitat,
- Spatial Scale - regional/sub-regional versus local,
- Potential for recovery – permanent loss or temporary loss, restoration possible,
- others

Fish, Wildlife, and Plants

- Level of biological organization – Community, population, individual (threatened/endangered species)
- Spatial scale of effect regional versus sub-regional versus local
- Effect on survival, maintenance, reproductive capacity of species
- Effect on trophic structure
- Commercial fishery
- Others

All values should be considered approximate order of magnitude, not absolutes.

In some cases a state report suggests that a risk has a different likelihood or a different consequence than was assigned in the Northeast (NE) analysis. For such cases, the following rules were applied by the experts.

- The results of the NE analysis were given greater weight than state reports with respect to likelihood.
- The state reports were given greater weight with respect to consequence.
- If the NE analysis and a state analysis differed greatly in what they suggested about a risk, then the differences were reconciled in this report with an indication of how the differences were resolved. Reconciliation is understood to mean revising the C/P matrices based on specified weighting of sources of data and, when appropriate and known, providing an explanation for the observed differences between the overall NE analysis and a given sub-region.

A number of the sub-regional sources are limited in their discussion of consequences. The consequence values from the NE analysis were used when the sub-region sources did not discuss consequences for impacts.

The assumption of “as is” conditions meant that although an expert might be aware that cities, and counties are planning and constructing infrastructure with futuristic goals, the tangible benefits of proposed measures were not considered. Highlighting these risks in the absence of following through on plans will better inform stakeholders (planners and decision makers) of the potential risk (consequence in particular) in the absence of adoption of proposed measures.

4.2 Consequence/Probability (C/P) Matrix

The C/P matrix is a risk management tool for sorting risks based on their likelihoods and consequences of the occurrence of a specific impact. The approach used to develop the C/P matrices is found in EPA’s *Being Prepared for Climate Change Workbook* – Step 5 (EPA 2014).

After reviewing the specified sources of information, expert judgment was used to assign a likelihood rating and a consequence rating for each potential impact. The potential impact was added to the appropriate cell in the corresponding C/P matrix. Figure 1 provides an example of a C/P matrix with a single impact (“Jellyfish may be more common”) added to the matrix. In this example, a medium consequence and a low probability rating [for illustration only] assigns this impact to a “green” cell, i.e. a cell with a low risk. Any combinations of low and medium ratings for consequence and likelihood results in an overall low risk rating. Any combination of medium/medium or low/high ratings for consequence and likelihood results in a “yellow” or overall medium risk rating. Any combination of medium/high or high/high ratings for consequence and likelihood results in a “red” or overall high risk rating.

The experts applied their knowledge and judgment and the existing information specified in the Quality Assurance Project Plan (QAPP) to analyze all four risk identification checklists (pollution control; habitat; fish, wildlife, and plants; recreation and public water supplies) of the NCA. Each checklist contains two to three Clean Water Act goals that may be affected by seven listed climate change stressors. Overall each checklist contains approximately 30 items that were assessed with regard to consequence (severity of impact) and likelihood (probability of occurrence). High/medium/low consequence rating and high/medium/low probability rating was applied to each potential impact in the checklists. Spreadsheets developed by the expert team were used to capture the ratings, sources of information supporting the ratings, and to generate the C/P matrices. These are submitted separately to the EPA.

[EPA is developing an online tool that can be used in conjunction with *Being Prepared for Climate Change: A Workbook for Developing Risk-Based Adaptation Plans* to generate C/P matrices. The beta version of the tool was considered for use in this study. EPA provided training on the tool to the team of experts. However, because the tool was expected to be unavailable during critical times in the study, the beta version of the tool was not used. Battelle’s team developed a simplified tool directly to meet the needs of this project. This spreadsheet tool enabled the assignment of individual and combined risk category ranking after the expert(s) assigns the literature and judgement based consequence and likelihood ranks. This tool helped expedite and standardize the analysis and ranking process. Experts of interrelated disciplines (for example pollution control, habitat, and wetlands) discussed and finalized rankings to ensure consistency in rankings due to a mutually impacting stressor.]

Probability (Likelihood) of Occurrence	**High**	Yellow (Medium Risk)	Red (High Risk)	Red (High Risk)
	Medium	Green (Low Risk)	Yellow (Medium Risk)	Red (High Risk)
	Low	Green (Low Risk)	*Jellyfish may be more common* Green (Low Risk)	Yellow (Medium Risk)
		Low	**Medium**	**High**
		Consequence of Impact		

Figure 1. Consequence/probability matrix with illustrative example.

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5.13 Buzzards Bay Pollution Control

The risks to EPA goals associated with pollution control in the Buzzards Bay sub-region by 2050 are shown in the matrix in Figure 26. The potential inadequacy of flood control facilities, potential for treatment plants to go offline, and eutrophication appear to be the highest risks by 2050 to EPA goals associated with pollution control. These are consistent with risks in the overall NE Study Area. There is less risk than in the NE Study Area associated with, for example, sewer pipes inflows and infiltration, contaminated sites flooding, and thermal discharge limit concerns.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High	1. Warmer Winters - Longer growing season can lead to more lawn maintenance with fertilizers and pesticides	1. Increasing Storminess - Flood control facilities (e.g., detention basins, manure management) may be inadequate 2. Warmer Water - Water may hold less dissolved oxygen 3. Warmer Water - Greater algae growth may occur 4. Warmer Winters - Loss of melting winter snows may reduce spring or summer flow volume and raise pollutant concentration in receiving waters	
Medium	1. Ocean Acidification - Decomposing organic matter releases carbon dioxide, which may exacerbate the ocean acidification problem in coastal waters 2. Warmer Summers - Wildfires may lead to soil erosion 3. Warmer Water - Temperature criteria for discharges may be exceeded (thermal pollution)	1. Increasing Drought - Critical-low-flow criteria for discharging may not be met 2. Increasing Drought - Pollutant concentrations may increase if sources stay the same and flow diminishes 3. Increasing Drought - Pollution sources may build up on land, followed by high-intensity flushes 4. Increasing Storminess - Combined sewer overflows may increase 5. Increasing Storminess - Streams may see greater erosion and scour 6. Increasing Storminess - Urban areas may be subject to more floods 7. Increasing Storminess - High rainfall may cause septic systems to fail 8. Sea Level Rise - Treatment plants may not be able to discharge via gravity at higher water levels 9. Sea Level Rise - Treatment infrastructure may be susceptible to flooding 10. Sea Level Rise - Sewage may mix with seawater in combined sewer systems 11. Sea Level Rise - Contaminated sites may flood or have shoreline erosion 12. Sea Level Rise - Sewer pipes may have more inflow (floods) or infiltration (higher water table) 13. Sea Level Rise - Tidal flooding may extend to new areas, leading to additional sources of pollution 14. Warmer Water - Warmer temperatures may increase toxicity of pollutants 15. Warmer Water - Higher solubility may lead to higher concentrations of pollutants 16. Warmer Water - Higher surface temperatures may lead to stratification 17. Warmer Water - Parasites, bacteria may have greater survival or transmission	1. Increasing Storminess - Treatment plants may go offline during intense floods
Low			

Figure 26. Buzzards Bay 2050 Pollution Control Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

The risks to EPA goals associated with pollution control in the Buzzards Bay sub-region by 2100 are shown in the matrix in Figure 27. The high risks for pollution control identified in 2050 are expected to continue to be the high risks in 2100. Additional high risk impacts are expected in 2100 including flooding of urban areas and infrastructure; increased pollution concentrations; sewage entering seawater; and impacts on discharge. These are consistent with NE Study Area risks identified for 2100.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High		1. Increasing Drought - Critical-low-flow criteria for discharging may not be met 2. Sea Level Rise - Treatment plants may not be able to discharge via gravity at higher water levels 3. Sea Level Rise - Treatment infrastructure may be susceptible to flooding 4. Sea Level Rise - Sewage may mix with seawater in combined sewer systems 5. Sea Level Rise - Sewer pipes may have more inflow (floods) or infiltration (higher water table) 6. Sea Level Rise - Tidal flooding may extend to new areas, leading to additional sources of pollution 7. Warmer Water - Water may hold less dissolved oxygen 8. Warmer Winters - Loss of melting winter snows may reduce spring or summer flow volume and raise pollutant concentration in receiving waters 9. Warmer Winters - Longer growing season can lead to more lawn maintenance with fertilizers and pesticides	1. Increasing Storminess - Flood control facilities (e.g., detention basins, manure management) may be inadequate 2. Warmer Water - Greater algae growth may occur
Medium	1. Ocean Acidification - Decomposing organic matter releases carbon dioxide, which may exacerbate the ocean acidification problem in coastal waters 2. Warmer Summers - Wildfires may lead to soil erosion	1. Increasing Drought - Pollutant concentrations may increase if sources stay the same and flow diminishes 2. Increasing Drought - Pollution sources may build up on land, followed by high-intensity flushes 3. Increasing Storminess - Streams may see greater erosion and scour 4. Increasing Storminess - High rainfall may cause septic systems to fail 5. Sea Level Rise - Contaminated sites may flood or have shoreline erosion 6. Warmer Water - Temperature criteria for discharges may be exceeded (thermal pollution) 7. Warmer Water - Warmer temperatures may increase toxicity of pollutants 8. Warmer Water - Higher solubility may lead to higher concentrations of pollutants 9. Warmer Water - Higher surface temperatures may lead to stratification 10. Warmer Water - Parasites, bacteria may have greater survival or transmission	1. Increasing Storminess - Combined sewer overflows may increase 2. Increasing Storminess - Treatment plants may go offline during intense floods 3. Increasing Storminess - Urban areas may be subject to more floods
Low			

Figure 27. Buzzards Bay 2100 Pollution Control Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

5.14 Buzzards Bay Habitat

The risks to EPA goals associated with habitat in the Buzzards Bay sub-region by 2050 are shown in the matrix in Figure 28. High risks of habitat damage or loss are associated with several stressors: sea level rise; increasing storms; increasing drought; and warmer water. These are consistent with high risks in the overall NE Study Area. No high risk concerns associated with ocean acidification or warmer summers or winters were identified for 2050. This is also consistent with the overall NE Study Area.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High		1. Increasing Drought - Base flow in streams may decrease 2. Increasing Drought - Groundwater tables may drop 3. Increasing Drought - Stream water may become warmer 4. Increasing Storminess - Stronger storms may cause more intense flooding and runoff 5. Increasing Storminess - The number of storms reaching an intensity that causes problems may increase	1. Increasing Storminess - Coastal overwash or island breaching may occur 2. Sea Level Rise - Ability of tidal marsh elevation to match rate of Sea Level Rise 3. Sea Level Rise - Ability of tidal marsh to migrate landward 4. Sea Level Rise - Higher salinity may kill targeted species 5. Sea Level Rise - Shoreline erosion may lead to loss of beaches, wetlands and salt marshes 6. Warmer Water - Warmer water may promote invasive species or disease
Medium	1. Increasing Storminess - Increased intensity of precipitation may yield less infiltration 2. Warmer Summers - Greater electricity demand may affect operation decisions at hydropower dams 3. Warmer Summers - Switching between surface and groundwater sources for public water supplies may affect the integrity of water bodies 4. Warmer Winters - Marshes and beaches may erode from loss of protecting ice 5. Warmer Winters - Less snow, more rain may change the runoff/infiltration balance; base flow in streams may change 6. Warmer Winters - Rivers may no longer freeze; a spring thaw would be obsolete	1. Increasing Storminess - Turbidity of surface waters may increase 2. Warmer Summers - Higher temperatures may lead to greater evaporation and lower groundwater tables 3. Warmer Water - Desired fish may no longer be present 4. Warmer Water - Warmer water may lead to greater likelihood of stratification	1. Increasing Storminess - Stream erosion may lead to high turbidity and greater sedimentation 2. Sea Level Rise - Bulkheads, sea walls and revetments may become more widespread 3. Sea Level Rise - Saline water may move farther upstream and freshwater habitat may become brackish 4. Sea Level Rise - Salinization of non-tidal freshwater coastal marshes 5. Sea Level Rise - Tidal influence may move farther upstream
Low	1. Increasing Drought - Increased human use of groundwater during drought may reduce stream baseflow 2. Increasing Drought - New water supply reservoirs may affect the integrity of freshwater streams 3. Warmer Winters - A spring runoff pulse may disappear along with the snow	1. Increasing Storminess - Lower pH for NPS pollution may affect target species 2. Ocean Acidification - Fish may be adversely affected during development stages 3. Ocean Acidification - Long term shellfish sustainability may be an open question 4. Sea Level Rise - Light may not penetrate through deeper water	

Figure 28. Buzzards Bay 2050 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

The risks to EPA goals associated with habitat in the Buzzards Bay sub-region by 2100 are shown in the matrix in Figure 29. The high risk concerns are consistent with those in the overall NE Study Area.

Likelihood of Occurrence	Low	Medium	High
High		1. Increasing Drought - Base flow in streams may decrease 2. Increasing Drought - Stream water may become warmer 3. Increasing Storminess - The number of storms reaching an intensity that causes problems may increase 4. Increasing Storminess - Turbidity of surface waters may increase 5. Warmer Summers - Higher temperatures may lead to greater evaporation and lower groundwater tables 6. Warmer Summers - Switching between surface and groundwater sources for public water supplies may affect the integrity of water bodies 7. Warmer Winters - Less snow, more rain may change the runoff/infiltration balance; base flow in streams may change	1. Increasing Drought - Groundwater tables may drop 2. Increasing Storminess - Coastal overwash or island breaching may occur 3. Increasing Storminess - Stronger storms may cause more intense flooding and runoff 4. Increasing Storminess - Stream erosion may lead to high turbidity and greater sedimentation 5. Sea Level Rise - Ability of tidal marsh elevation to match rate of Sea Level Rise 6. Sea Level Rise - Ability of tidal marsh to migrate landward 7. Sea Level Rise - Bulkheads, sea walls and revetments may become more widespread 8. Sea Level Rise - Higher salinity may kill targeted species 9. Sea Level Rise - Saline water may move farther upstream and freshwater habitat may become brackish 10. Sea Level Rise - Salinization of non-tidal freshwater coastal marshes 11. Sea Level Rise - Shoreline erosion may lead to loss of beaches, wetlands and salt marshes 12. Sea Level Rise - Tidal influence may move farther upstream 13. Warmer Water - Warmer water may promote invasive species or disease
Medium	1. Increasing Storminess - Increased intensity of precipitation may yield less infiltration 2. Warmer Summers - Greater electricity demand may affect operation decisions at hydropower dams 3. Warmer Winters - A spring runoff pulse may disappear along with the snow 4. Warmer Winters - Marshes and beaches may erode from loss of protecting ice 5. Warmer Winters - Rivers may no longer freeze; a spring thaw would be obsolete	1. Increasing Drought - Increased human use of groundwater during drought may reduce stream baseflow 2. Increasing Drought - New water supply reservoirs may affect the integrity of freshwater streams 3. Increasing Storminess - Lower pH for NPS pollution may affect target species 4. Ocean Acidification - Long term shellfish sustainability may be an open question 5. Ocean Acidification - Fish may be adversely affected during development stages 6. Warmer Water - Desired fish may no longer be present 7. Warmer Water - Warmer water may lead to greater likelihood of stratification	
Low		1. Sea Level Rise - Light may not penetrate through deeper water	
	Consequence of Impact		

Figure 29. Buzzards Bay 2100 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

5.15 Buzzards Bay Fish, Wildlife and Plants

The risks to EPA goals associated with fish, wildlife and plants in the Buzzards Bay sub-region by 2050 are shown in the matrix in Figure 30. These results are also similar to those observed for the overall NE Study Area in 2050. Most stressors, except ocean acidification, are expected to create some high risk impacts by 2050.

Likelihood of Occurrence	Low	Medium	High
High		1. Increasing Storminess - Greater soil erosion may increase sediment deposition in estuaries, with consequences for benthic species 2. Warmer Summers - Species may need to consume more water as temperature rises 3. Warmer Summers - Species that won't tolerate Warmer Summers may die/migrate; biota at the southern limit of their range may disappear from ecosystems 4. Warmer Water - Heat may stress immobile biota 5. Warmer Water - Some fish reproduction may require cold temperatures; other reproductive cycles are tied to water temperature	1. Increasing Drought - Changing freshwater inputs may affect salinity distribution in estuaries (especially of interest with regard to shellfish habitat) 2. Sea Level Rise - Ability of tidal marsh elevation to match rate of Sea Level Rise 3 .Sea Level Rise - Ability of tidal marsh to migrate landward 4. Sea Level Rise - Greater coastal wetland losses may occur 5. Warmer Water - Dissolved oxygen capacity of water may drop 6. Warmer Water - Habitat may become unsuitably warm, for a species or its food 7. Warmer Water - Newly invasive species may appear 8. Warmer Water - Parasites and diseases are enhanced by warmer water 9. Warmer Winters - Invasive species may move into places that used to be too cold 10. Warmer Winters - Pests may survive winters that used to kill them
Medium		1. Increasing Drought - Species may not tolerate a new drought regime 2. Sea Level Rise - Light may not penetrate through the full depth of deeper water 3. Warmer Summers - Essential food sources may die off or disappear, affecting the food web 4. Warmer Winters - Food supplies and bird migrations may be mistimed 5. Warmer Winters - Some plants may need a "setting" cold temperature 6. Warmer Winters - Species that once migrated through may stop and stay 7. Warmer Winters - Species that used to migrate away may stay all winter	1. Increasing Storminess - Greater soil erosion may increase turbidity and decrease water clarity 2. Increasing Drought - Native habitat may be affected if freshwater flow in streams is diminished or eliminated 3. Sea Level Rise - Salinization of non-tidal freshwater coastal marshes 4. Sea Level Rise - Sea level may push saltier water farther upstream (especially of interest with regard to shellfish habitat)
Low	1. Warmer Summers - Species may be weakened by heat and become out-competed 2. Ocean Acidification - Corrosive waters may impact shellfish development 3. Ocean Acidification - Fish may be adversely affected during development stages by changes to water chemistry 4. Ocean Acidification - Shellfish predators may not survive the disappearance of shellfish	1. Warmer Winters - A longer growing season may lead to an extra reproductive cycle 2. Ocean Acidification - The effect of Ocean Acidification on calcifying plankton may lead to cascading effects in the food chain	
	Consequence of Impact		

Figure 30. Buzzards Bay 2050 Fish, Wildlife, and Plant Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

The risks to EPA goals associated with fish, wildlife and plants in the Buzzards Bay sub-region by 2100 are shown in the matrix in Figure 31. The high risk concerns by 2100 are similar to those in the NE Study Area by 2100.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High		1. Increasing Drought - Species may not tolerate a new drought regime 2. Increasing Storminess - Greater soil erosion may increase sediment deposition in estuaries, with consequences for benthic species 3. Warmer Water - Heat may stress immobile biota 4. Warmer Summers - Essential food sources may die off or disappear, affecting the food web 5. Warmer Summers - Species may need to consume more water as temperature rises 6. Warmer Summers - Species that won't tolerate Warmer Summers may die/migrate; biota at the southern limit of their range may disappear from ecosystems 7. Warmer Water - Some fish reproduction may require cold temperatures; other reproductive cycles are tied to water temperature 8. Warmer Winters - Food supplies and bird migrations may be mistimed 9. Warmer Winters - Some plants may need a "setting" cold temperature	1. Increasing Drought - Changing freshwater inputs may affect salinity distribution in estuaries (especially of interest with regard to shellfish habitat) 2. Increasing Storminess - Greater soil erosion may increase turbidity and decrease water clarity 3. Sea Level Rise - Ability of tidal marsh elevation to match rate of Sea Level Rise 4. Sea Level Rise - Ability of tidal marsh to migrate landward 5. Sea Level Rise - Greater coastal wetland losses may occur 6. Sea Level Rise - Salinization of non-tidal freshwater coastal marshes 7. Sea Level Rise - Sea level may push saltier water farther upstream (especially of interest with regard to shellfish habitat) 8. Warmer Water - Dissolved oxygen capacity of water may drop 9. Warmer Water - Habitat may become unsuitably warm, for a species or its food 10. Warmer Water - Newly invasive species may appear 11. Warmer Water - Parasites and diseases are enhanced by warmer water 12. Warmer Winters - Invasive species may move into places that used to be too cold 13. Warmer Winters - Pests may survive winters that used to kill them
Medium	1. Warmer Summers - Species may be weakened by heat and become out-competed	1. Ocean Acidification - Corrosive waters may impact shellfish development 2. Ocean Acidification - Fish may be adversely affected during development stages by changes to water chemistry 3. Ocean Acidification - Shellfish predators may not survive the disappearance of shellfish 4. Ocean Acidification - The effect of Ocean Acidification on calcifying plankton may lead to cascading effects in the food chain 5. Sea Level Rise - Light may not penetrate through the full depth of deeper water 6. Warmer Winters - A longer growing season may lead to an extra reproductive cycle 7. Warmer Winters - Species that once migrated through may stop and stay 8. Warmer Winters - Species that used to migrate away may stay all winter	1. Increasing Drought - Native habitat may be affected if freshwater flow in streams is diminished or eliminated
Low			

Figure 31. Buzzards Bay 2100 Fish, Wildlife, and Plant Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

5.16 Buzzards Bay Recreation and Public Water Supplies

The risks to EPA goals associated with recreation and public water supplies in the Buzzards Bay sub-region by 2050 are shown in the matrix in Figure 32. While no high risk impacts were identified for the overall NE Study Area in 2050, coastal erosion and inundation, groundwater and water supplies, and fishing are at high risk by 2050 in the Buzzards Bay sub-region.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High	1. Increasing Storminess - More frequent or more intense storms may decrease recreational opportunities 2. Increasing Storminess - Greater NPS pollution may impair recreation 3. Increasing Storminess - Water infrastructure may be vulnerable to flooding 4. Increasing Storminess - Flood waters may raise downstream turbidity and affect water quality 5. Sea Level Rise - Water infrastructure may be vulnerable to inundation or erosion 6. Sea Level Rise - Clearance under bridges may decrease 7. Sea Level Rise - Sea level may push salt fronts upstream past water diversion 8. Warmer Summers - More people using water for recreation may raise the potential for pathogen exposure 9. Warmer Summers - Warmer temperatures may drive greater water demand 10. Warmer Summers - Evaporation losses from reservoirs and groundwater may increase 11. Warmer Water - Harmful algal blooms may be more likely 12. Warmer Water - Jellyfish may be more common 13. Warmer Water - Invasive plants may clog creeks and waterways 14. Warmer Water - Changes in treatment processes may be required 15. Warmer Water - Increased growth of algae and microbes may affect drinking water quality 16. Warmer Winters - Cold places may see more freeze/thaw cycles that can affect infrastructure 17 Sea Level Rise - Beaches or public access sites may be lost to coastal erosion or inundation	1. Sea Level Rise - Saltwater intrusion into groundwater may be more likely 2. Warmer Water - Fishing seasons and fish may become misaligned 3. Warmer Water - Desired recreational fish may no longer be present 4. Warmer Winters - Summer water supplies that depend on winter snow pack may disappear	
Medium	1. Increasing Drought - Freshwater flows in streams may not support recreational uses 2. Increasing Drought - Increased estuary salinity may drive away targeted recreational fish 3. Increasing Drought - Lower freshwater flows may not keep saltwater downstream of intakes 4. Increasing Drought - Coastal aquifers may be salinized from insufficient freshwater input 5. Increasing Drought - Coastal aquifers may be salinized from higher demand on groundwater 6. Increasing Drought - Maintaining passing flows at diversions may be difficult 7. Ocean Acidification - Eco-tourism resource or attractions (e.g., birding, diving, fishing) may be degraded 8. Ocean Acidification - Recreational shellfish harvesting may be lost 9. Increasing Drought - Groundwater tables may drop		
Low			

Figure 32. Buzzards Bay 2050 Recreation and Water Supply Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

The risks to EPA goals associated with recreation and public water supplies in the Buzzards Bay sub-region by 2100 are shown in the matrix in Figure 33. By 2100 a number of high risk impacts are expected. Most high risk impacts are consistent with those expected by 2100 in the overall NE Study Area. Groundwater tables are of greater concern than in the overall NE Study Area, whereas undesirable biota, loss of shellfish harvesting, and eco-tourism, and NPS pollution are only medium level concerns for Buzzards Bay, but high risk for the overall region.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High	1. Increasing Storminess - More frequent or more intense storms may decrease recreational opportunities 2. Increasing Storminess - Greater NPS pollution may impair recreation 3. Increasing Storminess - Flood waters may raise downstream turbidity and affect water quality 4. Ocean Acidification - Eco-tourism resource or attractions (e.g., birding, diving, fishing) may be degraded 5. Ocean Acidification - Recreational shellfish harvesting may be lost 6. Sea Level Rise - Clearance under bridges may decrease 7. Sea Level Rise - Sea level may push salt fronts upstream past water diversion 8. Warmer Summers - More people using water for recreation may raise the potential for pathogen exposure 9. Warmer Summers - Warmer temperatures may drive greater water demand 10. Warmer Summers - Evaporation losses from reservoirs and groundwater may increase 11. Warmer Water - Harmful algal blooms may be more likely 12. Warmer Water - Jellyfish may be more common 13. Warmer Water - Invasive plants may clog creeks and waterways 14. Warmer Water - Changes in treatment processes may be required 15. Warmer Water - Increased growth of algae and microbes may affect drinking water quality 16. Warmer Winters - Cold places may see more freeze/thaw cycles that can affect infrastructure	1. Increasing Storminess - Water infrastructure may be vulnerable to flooding 2. Sea Level Rise - Water infrastructure may be vulnerable to inundation or erosion 3. Sea Level Rise - Beaches or public access sites may be lost to coastal erosion or inundation	1. Sea Level Rise - Saltwater intrusion into groundwater may be more likely 2. Warmer Water - Fishing seasons and fish may become misaligned 3. Warmer Water - Desired recreational fish may no longer be present 4. Warmer Winters - Summer water supplies that depend on winter snow pack may disappear
Medium	1. Increasing Drought - Increased estuary salinity may drive away targeted recreational fish 2. Increasing Drought - Lower freshwater flows may not keep saltwater downstream of intakes 3. Increasing Drought - Maintaining passing flows at diversions may be difficult	1. Increasing Drought - Freshwater flows in streams may not support recreational uses 2. Increasing Drought - Coastal aquifers may be salinized from insufficient freshwater input 3. Increasing Drought - Coastal aquifers may be salinized from higher demand on groundwater	1. Increasing Drought - Groundwater tables may drop
Low			

Figure 33. Buzzards Bay 2100 Recreation and Water Supply Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

6 Conclusions and Comments

This scoping study provides climate change vulnerability assessments for six sub-regions, including estuaries and coastal watersheds:

1. Southern Maine concentrating on the Casco Bay Area
2. New Hampshire
3. Massachusetts Bay and environs
4. Buzzards Bay
5. Rhode Island
6. Long Island Sound (Connecticut and New York)

C/P matrices for four EPA goal areas (pollution control; habitat; fish, wildlife, and plants; recreation and public water supplies) for 2050 and 2100 indicate that risks to EPA Clean Water Act goals associated with climate change exist in the near term for most EPA goals and become substantially greater for all EPA goals by 2100.

The high risk climate change impacts for the sub-region were generally consistent with the results of the climate change vulnerability assessment for the overall NE Study Area from Long Island, NY to southern Maine.

Because these results represent expert judgment of a very limited number of individuals, the results should be considered preliminary, communicated and used with appropriate disclaimers, and due caution. Owing to the nature of data available and reviewed, high levels of uncertainty exist in the complexities of climate change applied to any potential impact, particularly ecological impacts. Quantitative data on the extent to which predicted climate change stressors will result in specific levels of impact by 2050 and 2100. The uncertainties were prevalent and enhanced the uncertainty in rank assignment based on spatial extents of the risk item.

The estimation of risk produced in this scoping study can be can be improved by ensuring that the breadth of understanding is available. No small group of experts will possess that breadth of knowledge. A full vetting of the scoping study vulnerability assessment results with a broad range of experts is strongly recommended.

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5 Results

The following sections provide the C/P matrices that were generated as described above.

5.1 Ocean Beach and Dune Ecosystem

The risks to EPA goals associated with the ocean beach and dune ecosystem NE Study Area by 2050 are shown in the matrix in Figure 2. The potential increase in storminess and sea level rise appear to pose the greatest risk to this habitat type by 2050 through an increase in erosion, over washing and inundation. There is less apparent risk associated with an increase in drought conditions and warmer seasons.

Likelihood of Occurrence		Low	Medium	High
	High		1. Increasing Storminess - Intense storms and associated storm surge will increase the likelihood of new temporary or permanent inlet development. 2. Increasing Storminess - Storm surge and the resulting beach and dune erosion will result in lowering of beach elevation. 3. Sea Level Rise - Beaches and dunes that currently lie adjacent to developed land will not be able to migrate landward resulting in loss of beach and dune habitat. 4. Sea Level Rise - Beaches and barrier islands may be degraded or lost by increased flooding frequency associated with sea level rise.	1. Increasing Storminess - An increase in intense coastal storms (i.e., nor'easters and hurricanes) may result in significant beach erosion and the reduction, or loss of coastal dunes with associated habitat loss for plants and wildlife. 2. Increasing Storminess - High winds and associated storm surge may result in the breaching or over wash of barrier islands. 3. Sea Level Rise - Barrier beaches will be more susceptible to erosion and overwash, and in some cases, breaching and inlet formation.
	Medium		1. Increasing Storminess - Intense storms may result in significant damage or loss of coastal/maritime forest community of the barrier islands. 2. Warmer Summers - Dune or beach species that cannot tolerate warmer summers may die or migrate. Biota at the southern limit of their range may disappear from beach/dune ecosystem. 3. Warmer Summers - Warmer summers may result in the promotion of invasive species and disease.	1. Increasing Storminess - Erosion of beaches and dunes will leave back-bay wetland habitat vulnerable to inundation from winter storms and high tides.
	Low	1. Warmer Winters - Marshes and beaches may erode from loss of protecting ice.	1. Increasing Drought - Increased drought may result in the potential degradation or loss of habitat to plant and animal species including migratory birds. 2. Increasing Drought - Increased drought may result in the potential degradation or loss of dune vegetation as well as adverse impact to maritime forest community on barrier islands. 3. Warmer Summers - Essential food sources may die-off or disappear affecting beach and dune ecology. 4. Warmer Winters - Species that once migrated through may stop and stay through winter.	
		Low	**Medium**	**High**
			Consequence of Impact	

Figure 2. Ocean Beach and Dune Ecosystem 2050 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

The risks to EPA goals associated with the ocean beach and dune ecosystem NE Study Area by 2100 are shown in the matrix in Figure 3. The high risks identified for this habitat type by 2050 are expected to be present in 2100. There is also an expected shift of low moderate risks identified for 2050 to move into the higher risk categories for 2100.

Likelihood of Occurrence				
	High		1. Increasing Storminess - Intense storms and associated storm surge will increase the likelihood of new temporary or permanent inlet development.	1. Increasing Storminess - An increase in intense coastal storms (i.e., nor'easters and hurricanes) may result in significant beach erosion and the reduction, or loss of coastal dunes with associated habitat loss for plants and wildlife. 2. Increasing Storminess - Erosion of beaches and dunes will leave back-bay wetland habitat vulnerable to inundation from winter storms and high tides. 3. Increasing Storminess - High winds and associated storm surge may result in the breaching or over wash of barrier islands. 4. Increasing Storminess - Storm surge and the resulting beach and dune erosion will result in lowering of beach elevation. 5. Sea Level Rise - Barrier beaches will be more susceptible to erosion and overwash, and in some cases, breaching and inlet formation. 6. Sea Level Rise - Beaches and dunes that currently lie adjacent to developed land will not be able to migrate landward resulting in loss of beach and dune habitat. 7. Sea Level Rise - Beaches and barrier islands may be degraded or lost by increased flooding frequency associated with sea level rise.
	Medium		1. Increasing Storminess - Intense storms may result in significant damage or loss of coastal/maritime forest community of the barrier islands. 2. Warmer Summers - Dune or beach species that cannot tolerate warmer summers may die or migrate. Biota at the southern limit of their range may disappear from beach/dune ecosystem. 3. Warmer Summers - Essential food sources may die-off or disappear affecting beach and dune ecology. 4. Warmer Summers - Warmer summers may result in the promotion of invasive species and disease. 5. Warmer Winters - Species that once migrated through may stop and stay through winter.	
	Low	1. Warmer Winters - Marshes and beaches may erode from loss of protecting ice.	1. Increasing Drought - Increased drought may result in the potential degradation or loss of habitat to plant and animal species including migratory birds. 2. Increasing Drought - Increased drought may result in the potential degradation or loss of dune vegetation as well as adverse impact to maritime forest community on barrier islands	
		Low	Medium	High
		Consequence of Impact		

Figure 3. **Ocean Beach and Dune Ecosystem 2100 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.**

5.2 Coastal Wetlands

The risks to EPA goals associated with coastal wetland habitat in the NE Study Area by 2050 are shown in the matrix in Figure 4. Habitat damage or loss caused by increasing storminess, sea level rise and warmer water are the high risk concerns by 2050.

Likelihood of Occurrence	High		1. Sea Level Rise - An increase in the rate of sea level rise will result in significant loss of coastal salt marsh habitat. 2. Increasing Storminess - Coastal overwash or barrier island breaching may result in a smothering of back-bay marshes by migrating beach sand and dunes. 3. Increasing Storminess - Increased frequency and intensity of coastal storms will impair coastal wetlands through wind, wave and surge effects. 4. Increasing Storminess - Increased shoreline erosion may lead to loss of coastal wetlands and marshes. 5. Sea Level Rise - An increase in sea-level will lead to greater susceptibility to storm surge. Shoreline erosion is likely to lead to loss of wetlands and salt marshes. 6. Sea Level Rise - As sea level rises, salinity migration farther up the estuary and tidal tributaries is likely to result in an upstream migration of brackish and fresh water wetlands. 7. Sea Level Rise - As sea level rises, salt marshes will migrate inland. The ability to migrate will be affected in locations where man-made structures, e.g., bulkheads, interfere with migration. 8. Sea Level Rise - If the rate of sea level rise increases dramatically, salt marshes may not be able to match the change in vertical elevation and will be lost. 9. Sea Level Rise - In low energy shores with ample sediment supply, intertidal flats may become vegetated as low marsh encroaches seaward. This may increase low marsh at the expense of tidal flats. 10. Sea Level Rise - In some cases where tidal range increases with increased rates of sea-level rise, there may be an overall increase in the acreage of tidal flats. 11. Warmer Water - Warmer water is likely to Increase incidence of marine and estuarine disease. 12. Warmer Winters - Warmer winter temperatures may promote the northern migration of southern species. 13. Warmer Summers - Warmer summer are likely to promote the northern migration of southern invasive species. 14. Warmer Water - Depending on the temperature increase, warmer waters may alter species composition of the coastal wetlands due to exceedance of temperature tolerance. 15. Warmer Winters - Warmer winters may facilitate the survival of invasive species, epizootics, and disease.	1. Sea Level Rise - Bulkheads, sea walls and revetments are likely to become more widespread.

Likelihood of Occurrence		Low	Medium	High
	Medium	1. Warmer Summers - Warmer summers leading to increased temperatures are likely to lead to reduced high marsh moisture and increased salinity because of greater evapotranspiration. 2. Warmer Winters - The alteration in the amplitude and timing of the annual spring freshets may adversely impact freshwater and brackish water wetlands.	1. Warmer Summers - Wetland species that can't tolerate warmer summers may die/migrate; biota at the southern limit of their range may disappear from ecosystems.	
	Low	1. Ocean Acidification - Changes in surface water pH may affect the viability of certain marsh species. 2. Increased Drought - A decrease in precipitation events may adversely impact coastal wetlands by reducing the supply of sediment necessary to sustain marsh elevation. 3. Increased Drought - A significant decrease in precipitation is likely to result in deceased marsh productivity. 4. Increased Drought - A decrease in precipitation may lead to the oxidation and formation of highly saline marsh soils. Hypersaline conditions on the high marsh will decreasing marsh production and habitat support. 5. Increasing Storminess - Increased nutrient loads from watershed runoff and flooding may increase the vulnerability of tidal marshes. 6. Warmer Waters - Warmer waters may alter the salinity distribution in marshes which may, in turn, alter the species composition due to exceedance of salinity tolerance. 7. Warmer Winters - Marshes and beaches may erode from loss of protecting ice.		
		Consequence of Impact		

Figure 4. Coastal Wetlands 2050 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

The risks to EPA goals associated with coastal wetland habitat in the NE Study Area by 2100 are shown in the matrix in Figure 5. Habitat damage or loss caused by sea level rise and warmer water continue to be the high risk concerns by 2100.

Likelihood of Occurrence	High		1. Sea Level Rise - -An increase in the rate of sea level rise will result in significant loss of coastal salt marsh habitat. 2. Increasing Storminess - Coastal overwash or barrier island breaching may result in a smothering of back-bay marshes by migrating beach sand and dunes. 3. Increasing Storminess - Increased frequency and intensity of coastal storms will impair coastal wetlands through wind, wave and surge effects. 4. Increasing Storminess - Increased shoreline erosion may lead to loss of coastal wetlands and marshes. 5. Sea Level Rise - An increase in sea-level will lead to greater susceptibility to storm surge. Shoreline erosion is likely to lead to loss of wetlands and salt marshes. 6. Sea Level Rise - As sea level rises, salinity migration farther up the estuary and tidal tributaries is likely to result in an upstream migration of brackish and fresh water wetlands. 7. Sea Level Rise - As sea level rises, salt marshes will migrate inland. The ability to migrate will be affected in locations where man-made structures, e.g., bulkheads, interfere with migration. 8. Sea Level Rise - If the rate of sea level rise increases dramatically, salt marshes may not be able to match the change in vertical elevation and will be lost. 9. Sea Level Rise - In low energy shores with ample sediment supply, intertidal flats may become vegetated as low marsh encroaches seaward. This may increase low marsh at the expense of tidal flats. 10. Sea Level Rise - In some cases where tidal range increases with increased rates of sea-level rise, there may be an overall increase in the acreage of tidal flats. 11. Warmer Water - Warmer water is likely to Increase incidence of marine and estuarine disease. 12. Warmer Winters - Warmer winter temperatures may promote the northern migration of southern species. 13. Warmer Summers - Warmer summer are likely to promote the northern migration of southern invasive species. 14. Warmer Summers - Wetland species that can't tolerate warmer summers may die/migrate; biota at the southern limit of their range may disappear from ecosystems. 15. Warmer Water - Depending on the temperature increase, warmer waters may alter species composition of the	1. Sea Level Rise - Bulkheads, sea walls and revetments are likely to become more widespread.

Likelihood of Occurrence		Low	Medium	High
			coastal wetlands due to exceedance of temperature tolerance. 16. Warmer Winters - Warmer winters may facilitate the survival of invasive species, epizootics, and disease.	
	Medium	1. Warmer Summers - Warmer summers leading to increased temperatures are likely to lead to reduced high marsh moisture and increased salinity because of greater evapotranspiration. 2. Warmer Winters - The alteration in the amplitude and timing of the annual spring freshets may adversely impact freshwater and brackish water wetlands.		
	Low	1. Ocean Acidification - Changes in surface water pH may affect the viability of certain marsh species. 2. Increased Drought - A decrease in precipitation events may adversely impact coastal wetlands by reducing the supply of sediment necessary to sustain marsh elevation. 3. Increased Drought - A significant decrease in precipitation is likely to result in deceased marsh productivity. 4. Increased Drought - A decrease in precipitation may lead to the oxidation and formation of highly saline marsh soils. Hypersaline conditions on the high marsh will decreasing marsh production and habitat support. 5. Increasing Storminess - Increased nutrient loads from watershed runoff and flooding may increase the vulnerability of tidal marshes. 6. Warmer Waters - Warmer waters may alter the salinity distribution in marshes which may, in turn, alter the species composition due to exceedance of salinity tolerance. 7. Warmer Winters - Marshes and beaches may erode from loss of protecting ice.		
		Low	**Medium**	**High**
		Consequence of Impact		

Figure 5. Coastal Wetlands 2100 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

5.3 Submerged Aquatic Vegetation

The risks to EPA goals associated with submerged aquatic vegetation (SAV) in the NE Study Area by 2050 are shown in the matrix in Figure 6. Habitat damage or loss caused by increasing storminess, sea level rise and warmer water are the high risk concerns by 2050.

Likelihood of Occurrence	High		1. Increasing Storminess -Greater soil erosion will increase turbidity and decrease water clarity. 2. Sea Level Rise - Additionally, hardened shoreline exacerbate the effects of sea level rise on seagrass beds by preventing landward migration and causing scour and decreased availability of suitable habitat. 3. Sea Level Rise - Increased overwash and breaching of barrier islands could negatively impact local SAV populations (e.g., eelgrass) by smothering. As sea level rises, however, the inundation of shorelines could create new SAV habitat. 4. Sea Level Rise - Shifts in salinity regime will affect the distribution of SAV. 5. Warmer Summers - Warmer summers may lead to latitudinal migration of SAV spp. 6. Warmer Winters - Warmer winters may lead to latitudinal expansion of invasive SAV spp.	1. Warmer Summers - Warmer summers may lead to warmer coastal water; possibly exceeding SAV temperature tolerance. 2. Warmer Summers - Warmer summers may result in the latitudinal expansion of invasive species and disease. 3. Warmer Water - Warmer water is likely to Increase incidence of marine and estuarine epizootics and disease (eelgrass wasting disease).
	Medium	1. Increasing Storminess - Stronger storms will cause more intense flooding and runoff potentially increasing nutrient loads (nitrogen, phosphorus) resulting in eutrophication.	1. Warmer Winters - Warmer winters may result in asynchrony of vegetative growth and bird migrations.	1. Increasing Storminess - Depending on depth of bed, increased wave action may severely damage SAV beds. 2. Warmer Water - Certain species of submerged aquatic vegetation are sensitive to large fluctuations in water temperature. Warmer water may exceed tolerance of some SAV species resulting in the loss of SAV habitat.
	Low	1. Ocean Acidification - Increased acidification may exceed the pH tolerance of some SAV species.	1. Increasing Drought - Potential decrease in freshwater runoff could result in salinity changes that could affect the propagation and growth of SAV. 2. Sea Level Rise - Sea level rise may pose significant threats to SAV habitat due to potential implications of increased water depth and reduction in light penetration.	
		Low	Medium	High
		Consequence of Impact		

Figure 6. Submerged Aquatic Vegetation 2050 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

The risks to EPA goals associated with submerged aquatic vegetation in the NE Study Area by 2100 are shown in the matrix in Figure 7. The high risk concerns by 2100 are similar to those in 2050 while risk concerns previously associated with the lower categories in the 2050 time frame have generally shifted to higher categories.

			1. Increasing Storminess - Greater soil erosion will increase turbidity and decrease water clarity. 2. Sea Level Rise - Additionally, hardened shoreline exacerbate the effects of sea level rise on seagrass beds by preventing landward migration and causing scour and decreased availability of suitable habitat. 3. Sea Level Rise - Increased overwash and breaching of barrier islands could negatively impact local SAV populations (e.g., eelgrass) by smothering. As sea level rises, however, the inundation of shorelines could create new SAV habitat. 4. Warmer Summers - Warmer summers may lead to latitudinal migration of SAV spp. 5. Warmer Winters - Warmer winters may lead to latitudinal expansion of invasive SAV spp. 6. Warmer Winters - Warmer winters may result in asynchrony of vegetative growth and bird migrations.	1. Increasing Storminess - Depending on depth of bed, increased wave action may severely damage SAV beds. 2. Sea Level Rise - Shifts in salinity regime will affect the distribution of SAV. 3. Warmer Summers - Warmer summers may result in the latitudinal expansion of invasive species and disease. 4. Warmer Summers - Warmer summers may lead to warmer coastal water; possibly exceeding SAV temperature tolerance. 5. Warmer Water - Warmer water is likely to Increase incidence of marine and estuarine epizootics and disease (eelgrass wasting disease).
	Medium		1. Increasing Drought - Potential decrease in freshwater runoff could result in salinity changes that could affect the propagation and growth of SAV. 2. Increasing Storminess - Stronger storms will cause more intense flooding and runoff potentially increasing nutrient loads (nitrogen, phosphorus) resulting in eutrophication. 3. Ocean Acidification - Increased acidification may exceed the pH tolerance of some SAV species.	1. Warmer Water - Certain species of SAV are sensitive to large fluctuations in water temperature. Warmer water may exceed tolerance of some SAV species resulting in the loss of SAV habitat.
	Low		1. Sea Level Rise - Sea Level Rise may pose significant threats to SAV habitat due to potential implications of increased water depth and reduction in light penetration.	
		Low	**Medium**	**High**
		Consequence of Impact		

Figure 7. Submerged Aquatic Vegetation 2100 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

5.4 Oyster Reefs

The risks to EPA goals associated with oyster reef habitat in the NE Study Area by 2050 are shown in the matrix in Figure 8. Two high risk impacts associated with increasing drought and warmer water were identified, while the majority of potential impacts to this habitat were identified as medium risks concerns.

Likelihood of Occurrence	High		1. Increasing Drought - Increase in water temperature and decrease flow during periods of drought may lead to harmful algal blooms some of which may be deleterious to oysters (e.g., cyanobacteria). 2. Warmer Water - Warmer water is likely to lead to an expansion of epizootics (MSX, Dermo) and invasive species.	
	Medium	1. Sea Level Rise - Changes in the salinity regime is; likely to change the distribution of shellfish habitat. 2. Warmer Water - Temperature changes could include changes in predator populations and natural food assemblages which could influence shellfish quality and survival.	1. Increasing Drought - Increase in water temperature leading to an increase in areas of hypoxia. 2. Increasing Storminess - Greater soil erosion may increase sediment deposition in estuaries, with potential for smothering nascent reefs or shell substrate required for setting. 3. Increasing Storminess - Habitat conditions for shellfish could be impacted by strong storms and increased frequency of rain events which can result in increased sedimentation. 4. Increasing Storminess - Increase freshwater events can lead to decreases in salinity which could affect the distribution of shellfish. 5. Ocean Acidification - Long Term shellfish sustainability may be an open question. 6. Ocean Acidification - Oysters and other mollusks may be adversely affected during development stages which construct calcareous shells through pH-sensitive calcification processes. 7. Sea Level Rise - An increase in salinity would promote the upstream migration of shellfish epizootics and disease. 8. Sea Level Rise - Sea level rise could reduce the availability of intertidal habitat thereby limiting the available habitat for some species such as oysters and blue mussels. 9. Sea Level Rise - An increase in salinity may affect the growth and propagation of oysters. 10. Warmer Summers - Warm summers will lead to warmer waters that may promote invasive species, epizootics (Dermo, MSX), or disease. 11. Warmer Water - Increased water temperature could affect reproduction and growth of oysters. 12. Warmer Water - increased water temperatures may affect the spawning of oysters which in turn may result in asynchrony between larval development and food supply. 13. Warmer Water - Warmer water is likely to Increase incidence of marine and estuarine disease.	

	Low	1. Increasing Storminess - Increased storminess may exacerbate exposure to pathogens from increased turbidity runoff and partially treated or untreated sewage overflows from storm events. 2. Warmer Water - Increased water temperature may result in dissolved oxygen levels sufficiently low to stress oysters. 3. Warmer Winters - Warmer winters may affect the reproduction and growth of oysters.	1. Increasing Drought - Increase in drought could reduce freshwater inflow and affect the salinity regime which may affect the distribution of the oyster reefs. 2. Warmer Summers - Warm summers will lead to warmer waters that may result in temperature stress to oysters. 3. Warmer Winters - Invasive species, epizootics, and disease previously killed due to cold water may survive.	
		Low	**Medium**	**High**
		Consequence of Impact		

Figure 8. Oyster Reef 2050 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

The risks to EPA goals associated with oyster reef habitat in the NE Study Area by 2100 are shown in the matrix in Figure 9. The risks identified for this habitat type by 2100 are similar to those previously identified for 2050.

Likelihood of Occurrence	High		1. Increasing Drought - Increase in water temperature and decrease flow during periods of drought may lead to harmful algal blooms some of which may be deleterious to oysters (e.g., cyanobacteria). 2. Warmer Water - Warmer water is likely to lead to an expansion of epizootics (MSX, Dermo) and invasive species.	
	Medium	1. Sea Level Rise - Changes in the salinity regime is; likely to change the distribution of shellfish habitat. 2. Warmer Water - Temperature changes could include changes in predator populations and natural food assemblages which could influence shellfish quality and survival.	1. Increasing Drought - Increase in water temperature leading to an increase in areas of hypoxia. 2 .Increasing Storminess - Greater soil erosion may increase sediment deposition in estuaries, with potential for smothering nascent reefs or shell substrate required for setting. 3. Increasing Storminess - Habitat conditions for shellfish could be impacted by strong storms and increased frequency of rain events which can result in increased sedimentation. 4. Increasing Storminess - Increase freshwater events can lead to decreases in salinity which could affect the distribution of shellfish. 5. Ocean Acidification - Long Term shellfish sustainability may be an open question. 6. Ocean Acidification - Oysters and other mollusks may be adversely affected during development stages which construct calcareous shells through pH-sensitive calcification processes. 7. Sea Level Rise - An increase in salinity would promote the upstream migration of shellfish epizootics and disease. 8. Sea Level Rise - Sea level rise could reduce the availability of intertidal habitat thereby limiting the available habitat for some species such as oysters and blue mussels. 9. Sea Level Rise - An increase in salinity may affect the growth and propagation of oysters. 10. Warmer Summers - Warm summers will lead to warmer waters that may promote invasive species, epizootics (Dermo, MSX), or disease. 11. Warmer Water - Increased water temperature could affect reproduction and growth of oysters. 12. Warmer Water - increased water temperatures may affect the spawning of oysters which in turn may result in asynchrony between larval development and food supply. 13. Warmer Water - Warmer water is likely to Increase incidence of marine and estuarine disease.	
		pathogens from increased turbidity runoff	and affect the salinity regime which	

		and partially treated or untreated sewage overflows from storm events. 2. Warmer Water - Increased water temperature may result in dissolved oxygen levels sufficiently low to stress oysters. 3. Warmer Winters - Warmer winters may affect the reproduction and growth of oysters.	may affect the distribution of the oyster reefs. 2. Warmer Summers - Warm summers will lead to warmer waters that may result in temperature stress to oysters. 3. Warmer Winters - Invasive species, epizootics, and disease previously killed due to cold water may survive.	
		Low	**Medium**	**High**
		Consequence of Impact		

Figure 9. Oyster Reef 2100 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

5.5 Rock Reefs and Shorelines

The risks to EPA goals associated with rock reef and shoreline habitat in the NE Study Area by 2050 are shown in the matrix in Figure 10. Habitat damage or loss caused by sea level rise and warmer water are the high risk concerns by 2050.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High		1. Sea Level Rise - Littoral zone biota are likely to respond to changing tide heights by shifting vertically where shoreline topography allows it. 2. Sea Level Rise - Loss or compression of intertidal habitat will alter the vertical zonation of the species which utilize this habitat. 3. Sea Level Rise - Rocky shorelines, especially intertidal and shallow water rocky habitat could become totally or partially inundated. Intertidal rock habitat may be lost or compressed and no longer available as intertidal habitat. 4. Warmer Water - Warmer coastal waters may result in a northward shift in rocky intertidal communities of plants and animals at their southern limit. 5. Warmer Water - Warmer waters may result in the colonization of rocky reefs and shorelines by southern species.	
Medium	1. Sea Level Rise - Shallow intertidal pools may become entirely submerged and intertidal habitat lost. 2. Warmer Winters - The ecological benefit of ice scour on rocky shorelines would be lost or reduced.	1. Increasing Storminess - An increase in strength and frequency of wave action may adversely affect associated invertebrates upon which multiple wildlife species forage. 2. Increasing Storminess - An increase in strength and frequency of wave action may adversely affect seaweed growing in rocky intertidal zones. 3. Increasing Storminess - In combination with Sea Level Rise, increased frequency and intensity of wave action, will result in erosion of sedimentary rock bluffs. 4. Ocean Acidification - Lowering of pH in adjacent coastal waters would affect the developmental calcification of shells by larval molluscs that might inhabit rocky shorelines i.e., barnacles, mussels, oysters.	
Low	1. Increasing Drought - Reduced precipitation and increased air temperature may result in stress to upper strata biota. 2. Sea Level Rise - Inundation periods of rock platforms may change altering habitat use. 3. Warmer Summers - Increased air temperatures may affect the survivability of some intertidal species.		

Figure 10. Rock Reefs and Shorelines 2050 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

The risks to EPA goals associated with rock reef and shoreline habitat in the NE Study Region by 2100 are shown in the matrix in Figure 11. The risks identified for this habitat type by 2100 are similar to those previously identified for 2050.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High		1. Sea Level Rise - Littoral zone biota are likely to respond to changing tide heights by shifting vertically where shoreline topography allows it. 2. Sea Level Rise - Loss or compression of intertidal habitat will alter the vertical zonation of the species which utilize this habitat. 3. Sea Level Rise - Rocky shorelines, especially intertidal and shallow water rocky habitat could become totally or partially inundated. Intertidal rock habitat may be lost or compressed and no longer available as intertidal habitat. 4. Warmer Water - Warmer coastal waters may result in a northward shift in rocky intertidal communities of plants and animals at their southern limit. 5. Warmer Water - Warmer waters may result in the colonization of rocky reefs and shorelines by southern species.	
Medium	1. Sea Level Rise - Shallow intertidal pools may become entirely submerged and intertidal habitat lost. 2. Warmer Winters - The ecological benefit of ice scour on rocky shorelines would be lost or reduced.	1. Increasing Storminess - An increase in strength and frequency of wave action may adversely affect associated invertebrates upon which multiple wildlife species forage. 2. Increasing Storminess - An increase in strength and frequency of wave action may adversely affect seaweed growing in rocky intertidal zones. 3. Increasing Storminess - In combination with Sea Level Rise, increased frequency and intensity of wave action, will result in erosion of sedimentary rock bluffs. 4. Ocean Acidification - Lowering of pH in adjacent coastal waters would affect the developmental calcification of shells by larval molluscs that might inhabit rocky shorelines i.e., barnacles, mussels, oysters.	
Low	1. Increasing Drought - Reduced precipitation and increased air temperature may result in stress to upper strata biota. 2. Sea Level Rise - Inundation periods of rock platforms may change altering habitat use. 3. Warmer Summers - Increased air temperatures may affect the survivability of some intertidal species.		

Figure 11. Rock Reefs and Shorelines 2100 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

5.6 Shallow Bay Habitat/Bay Islands

The risks to EPA goals associated with shallow bay and bay island habitat in the NE Study Area by 2050 are shown in the matrix in Figure 12. Habitat damage or loss caused by sea level rise and warmer water, and ocean acidification are the high risk concerns for this habitat type by 2050.

			1. Increasing Storminess - Increasing overwash and breaching of new inlets could potentially change the physical and environmental characteristics of the bays such as, flushing rates, salinity, light penetration and nutrient dynamics. 2. Increasing Storminess - Increased storminess will result in increased erosion of shallow bay shorelines. 3. Sea Level Rise - Some bay islands may become completely or almost completely submerged. 4. Sea Level Rise - Depth of waters in shallow bay habitat may be expected to increase as the sea rises potentially affecting coastal bay wetlands and shorelines. 5. Sea Level Rise - Hardening of shorelines with bulkheads, sea walls and revetments may become more widespread resulting in the loss of natural shoreline habitats and decreased water quality. 6. Sea Level Rise - Sea Level rise in conjunction with increased tidal amplitude will result in increased erosion of shallow bay shorelines. 7. Sea Level Rise - Sea level rise may change the salinity regime of the inland bays thereby affecting the distribution of salinity-sensitive flora and fauna. 8. Warmer Summers - Increased water temperature may increase areas of hypoxia in shallow embayments. 9. Warmer Summers -Finfish species at the southern end of their distribution may migrate northward. 10. Warmer Water - Desired fish may no longer be present. 11. Warmer Water - Warmer water is likely to lead to an expansion of invasive species, epizootics, and disease. 12. Warmer Water - Warmer water is likely to promote the migration of current fish species northward and immigration of fish from southern regions.	
	Medium	1. Warmer water will decrease oxygen solubility possibly resulting in a decrease in oxygen concentrations in bay waters.	1. Increasing Drought - An increase in long-term and seasonal short-term drought may decrease freshwater flow and affect the salinity distribution in the bays. 2. Increasing Drought - Increased drought may result in waters sufficiently warm to promote areas of hypoxia. 3. Increasing Drought - Increased drought may result in waters sufficiently warm to promote harmful algal blooms.	1. Ocean Acidification - The effect of embayment acidification on calcifying plankton may lead to cascading effects in the food chain. 2. Ocean Acidification - Fish and invertebrates may be adversely affected during developmental stages.

			4. Increasing Storminess - Increased runoff from the surrounding watershed may lead to increased loading of nitrogen and phosphorus to inland bays resulting in eutrophication. 5. Increasing Storminess - Increased storminess may result in increased turbidity and decrease water clarity. 6. Sea Level Rise - Sea level rise may result in drowning of bay wetlands. 7. Warmer Water - Warmer water may result in the loss of SAV habitat. 8. Warmer Winters - Invasive species, epizootics, and disease may survive winters that used to kill them. 9. Warmer Winters - Finfish species that used to migrate may stay all winter.	
	Low	1. Warmer Water - Warmer water is likely to lead to greater likelihood of stratification. 2. Warmer Winters - Increased foraging of plants and animals.		
		Low	**Medium**	**High**
		Consequence of Impact		

Figure 12. Shallow Bay Habitat/Bay Islands 2050 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

The risks to EPA goals associated with shallow bay and bay island habitat in the NE Study Area by 2100 are shown in the matrix in Figure 13. The high risks identified for this habitat type by 2050 are expected to be present in 2100.

	Low	Medium	High
		1. Sea Level Rise - Some bay islands may become completely or almost completely submerged. 2. Sea Level Rise - Depth of waters in shallow bay habitat may be expected to increase as the sea rises potentially affecting coastal bay wetlands and shorelines. 3. Sea Level Rise - Sea level rise may change the salinity regime of the inland bays thereby affecting the distribution of salinity-sensitive flora and fauna. 4. Warmer Summers -Finfish species at the southern end of their distribution may migrate northward. 5. Warmer Water - Desired fish may no longer be present. 6. Warmer Water - Warmer water is likely to lead to an expansion of invasive species, epizootics, and disease. 7. Warmer Winters - Finfish species that used to migrate may stay all winter.	1. Increasing Drought - Increased drought may result in waters sufficiently warm to promote areas of hypoxia. 2. Increasing Storminess - Increasing overwash and breaching of new inlets could potentially change the physical and environmental characteristics of the bays such as, flushing rates, salinity, light penetration and nutrient dynamics. 3. Increasing Storminess - Increased storminess will result in increased erosion of shallow bay shorelines. 4. Sea Level Rise - Hardening of shorelines with bulkheads, sea walls and revetments may become more widespread resulting in the loss of natural shoreline habitats and decreased water quality. 5. Sea Level Rise - Sea Level rise in conjunction with increased tidal amplitude will result in increased erosion of shallow bay shorelines. 6. Warmer Summers - Increased water temperature may increase areas of hypoxia in shallow embayments. 7. Warmer Water - Warmer water is likely to promote the migration of current fish species northward and immigration of fish from southern regions. 8. Warmer Winters - Invasive species, epizootics, and disease may survive winters that used to kill them.
Medium	1. Warmer Water - Warmer water is likely to lead to greater likelihood of stratification. 2. Warmer water will decrease oxygen solubility possibly resulting in a decrease in oxygen concentrations in bay waters.	1. Increasing Drought - An increase in long-term and seasonal short-term drought may decrease freshwater flow and affect the salinity distribution in the bays. 2. Increasing Drought - Increased drought may result in waters sufficiently warm to promote harmful algal blooms. 3. Increasing Storminess - Increased runoff from the surrounding watershed may lead to increased loading of nitrogen and phosphorus to inland bays resulting in eutrophication. 4. Increasing Storminess -Increased storminess may result in increased turbidity and decrease water clarity.	1. Ocean Acidification - The effect of embayment acidification on calcifying plankton may lead to cascading effects in the food chain. 2. Ocean Acidification - Fish and invertebrates may be adversely affected during developmental stages. 3. Sea Level Rise - Sea level rise may result in drowning of bay wetlands. 4. Warmer Water - Warmer water may result in the loss of SAV habitat.
Low	1. Warmer Winters - Increased foraging of plants and animals.		
	Low	**Medium**	**High**
	Consequence of Impact		

Figure 13. Shallow Bay Habitat/Bay Islands 2100 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

5.7 Terrestrial Upland

The risks to EPA goals associated with terrestrial upland habitat in the NE Study Area by 2050 are shown in the matrix in Figure 14. Three high risk impacts associated with increasing storminess, sea level rise, and warmer summers were identified, while the majority of potential impacts to this habitat were identified as medium risks concerns.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High		1. Increasing Storminess - Combined with sea level rise, increased flooding will impact adjacent upland habitat. 2. Sea Level Rise - As sea level rises, there will be an encroachment on and flooding of adjacent upland forests. 3. Warmer Summers - Species that won't tolerate warmer summers may migrate. Floral and faunal species at the southern limit of their range may disappear.	
Medium		1. Increasing Storminess - Severe storms may result in significant tree fall or damage. 2. Increasing Storminess - The number of storms reaching an intensity that causes problems may increase. 3. Warmer Summers - Essential food sources may disappear affecting the food web. 4. Warmer Summers - Some invasive species and disease are expected to expand into the Northeast forests. 5. Warmer Summers - Species may be weakened by heat and become out- competed. 6. Warmer Summers - Species may need to consume more water. 7. Warmer Winters - A longer growing season may lead to an extra reproductive cycle. 8. Warmer Winters - Food supplies and bird migrations may be mistimed. 9. Warmer Winters - Species that used to migrate away may stay all winter. 10. Warmer Winters - Invasive species may move into places that used to be too cold.	
Low	1. Increasing Drought - Stress from excess heat and decreased water may result in increased susceptibility to disease. 2. Increasing Drought - Stress from excess heat and decreased water may result in vegetative die-off.	1. Increasing Storminess - Increased storm damage will promote and exacerbate the effect of disease.	

Figure 14. Terrestrial Upland 2050 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

The risks to EPA goals associated with terrestrial upland habitat in the NE Study Area by 2100 are shown in the matrix in Figure 15. The risk concerns for this habitat type by 2100 are similar to those previously identified for the 2050 timeframe.

Likelihood of Occurrence		Low	Medium	High
	High		1. Increasing Storminess - Combined with sea level rise, increased flooding will impact adjacent upland habitat. 2. Sea Level Rise - As sea level rises, there will be an encroachment on and flooding of adjacent upland forests. 3. Warmer Summers - Species that won't tolerate warmer summers may migrate. Floral and faunal species at the southern limit of their range may disappear.	
	Medium		1. Increasing Storminess - Severe storms may result in significant tree fall or damage. 2. Increasing Storminess - The number of storms reaching an intensity that causes problems may increase. 3. Warmer Summers - Essential food sources may disappear affecting the food web. 4. Warmer Summers - Some invasive species and disease are expected to expand into the Northeast forests. 5. Warmer Summers - Species may be weakened by heat and become out- competed. 6. Warmer Summers - Species may need to consume more water. 7. Warmer Winters - A longer growing season may lead to an extra reproductive cycle. 8. Warmer Winters - Food supplies and bird migrations may be mistimed. 9. Warmer Winters - Species that used to migrate away may stay all winter. 10. Warmer Winters - Invasive species may move into places that used to be too cold.	
	Low	1. Increasing Drought - Stress from excess heat and decreased water may result in increased susceptibility to disease. 2. Increasing Drought - Stress from excess heat and decreased water may result in vegetative die-off.	1. Increasing Storminess - Increased storm damage will promote and exacerbate the effect of disease.	
		Low	**Medium**	**High**
			Consequence of Impact	

Figure 15. Terrestrial Upland 2100 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

5.8 Floodplains/Riparian

The risks to EPA goals associated with floodplain and riparian habitat in the NE Study Area by 2050 are shown in the matrix in Figure 16. Four high risk impacts associated with increasing drought, increasing storminess, sea level rise, and warmer winters were identified, while the majority of potential impacts to this habitat were identified as low and medium risks concerns.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High		1. Increasing Drought - An increase in long-term and seasonal short-term drought may decrease base flows in streams. 2. Increasing Storminess - Increased frequency and intensity of flooding events will result in erosion of floodplains and riparian habitat. 3. Sea Level Rise - Saline water may move farther upstream and the biological assemblages of floodplain and riparian habitat may change. 4. Warmer Winters - Less snow and more rain may change the runoff/infiltration balance; base flow in streams may change. 5. Sea Level Rise – Bulkheads, sea walls, and revetments may become more widespread along floodplains and riparian areas resulting in loss of habitat.	
Medium	1. Warmer Summers - As with terrestrial and aquatic habitats, warmer summers may result in a latitudinal shift in species.	1. Increasing Drought - Increased human use of groundwater during drought may reduce stream baseflow. 2. Sea Level Rise - May lead to an increase or decrease of floodplains or riparian habitat. 3. Warmer Winters - A spring runoff pulse may disappear along with the snow. 4. Warmer Winters - The absence of snowmelt may lead to a decrease of vernal pool habitat.	
Low	1. Increasing Storminess - Increased frequency and intensity of flooding events may result in the loss of existing floodplains and the formation of new floodplains. 2. Warmer Summers - Species may need to consume more water as temperature rises. 3. Warmer Winters - Rivers may no longer freeze; a spring thaw would be obsolete.		

Figure 16. Floodplain/Riparian 2050 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

The risks to EPA goals associated with floodplain and riparian habitat in the NE Study Area by 2100 are shown in the matrix in Figure 17. The risk concerns for this habitat type by 2100 are similar to those previously identified for the 2050 timeframe.

Likelihood of Occurrence	Low	Medium	High
High		1. Increasing Drought - An increase in long-term and seasonal short-term drought may decrease base flows in streams. 2. Increasing Storminess - Increased frequency and intensity of flooding events will result in erosion of floodplains and riparian habitat. 3. Sea Level Rise - Saline water may move farther upstream and the biological assemblages of floodplain and riparian habitat may change. 4. Warmer Winters - Less snow and more rain may change the runoff/infiltration balance; base flow in streams may change. 5. Sea Level Rise – Bulkheads, sea walls, and revetments may become more widespread along floodplains and riparian areas resulting in loss of habitat.	
Medium	1. Warmer Summers - As with terrestrial and aquatic habitats, warmer summers may result in a latitudinal shift in species.	1. Increasing Drought - Increased human use of groundwater during drought may reduce stream baseflow. 2. Sea Level Rise - May lead to an increase or decrease of floodplains or riparian habitat. 3. Warmer Winters - A spring runoff pulse may disappear along with the snow. 4. Warmer Winters - The absence of snowmelt may lead to a decrease of vernal pool habitat.	
Low	1. Increasing Storminess - Increased frequency and intensity of flooding events may result in the loss of existing floodplains and the formation of new floodplains. 2. Warmer Summers - Species may need to consume more water as temperature rises. 3. Warmer Winters - Rivers may no longer freeze; a spring thaw would be obsolete.		
	Consequence of Impact		

Figure 17. Floodplain/Riparian 2100 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

6 Conclusions and Comments

This scoping study provides climate change vulnerability assessments for eight habitat types in the NE Study Area:

1. Ocean Beach and Dune Ecosystem
2. Coastal Wetlands
3. Submerged Aquatic Vegetation
4. Oyster Reefs
5. Rock Reefs/Rocky Shorelines
6. Shallow Bay Habitat/Bay Islands
7. Terrestrial Upland
8. Floodplains/Riparian

C/P matrices for the eight habitat types for 2050 and 2100 indicate that risks to EPA Clean Water Act goals associated with climate change exist in the near term for most EPA goals and remain or generally increase for all EPA goals by 2100.

The high risk climate change impacts for the eight habitat types were generally consistent with the results of the climate change vulnerability assessment for the overall NE Study Area from Long Island, NY to southern Maine.

Because these results represent expert judgment of a very limited number of individuals, the results should be considered preliminary and communicated and used with appropriate disclaimers and due caution. Owing to the nature of data available and reviewed, high levels of uncertainty exist in the complexities of climate change applied to any potential impact, particularly ecological impacts. For example, there is certainty that increased carbon dioxide in the atmosphere will increase the pH of the oceans. The sources reviewed indicated that empirical data from aquaculture and from laboratory experiments show that pH changes negatively impact species of economic interest. What was less certain is the extent of acidification and the impacts over time. The uncertainties were prevalent and enhanced the uncertainty in rank assignment based on spatial extents of the risk item.

The estimation of risk produced in this scoping study can be can be improved by ensuring that the breadth of understanding is available. No small group of experts will possess that breadth of knowledge. A full vetting of the scoping study vulnerability assessment results with a broad range of experts is strongly recommended.

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5 Results

The following sections provide the C/P matrices that were generated as described above.

5.1 Pollution Control

The risks to EPA goals associated with pollution control in the NE Study Area by 2050 are shown in the matrix in Figure 2. The potential inadequacy of flood control facilities allowing flooding impacts appear to be the highest risk by 2050 to EPA goals associated with pollution control. There is also a high risk that water temperature may impact cooling water discharges that could impact energy production during peak demand periods (hot summers).

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High	1. Warmer Winters - Longer growing season can lead to more lawn maintenance with fertilizers and pesticides 2. Warmer Water - Greater algae growth may occur 3. Warmer Winters - Loss of melting winter snows may reduce spring or summer flow volume and raise pollutant concentration in receiving waters	1. Warmer Water - Water may hold less dissolved oxygen	1. Increasing Storminess - Flood control facilities (e.g., detention basins, manure management) may be inadequate
Medium	1. Increasing Storminess - High rainfall may cause septic systems to fail 2. Ocean Acidification - Decomposing organic matter releases carbon dioxide, which may exacerbate the ocean acidification problem in coastal waters 3. Warmer Summers - Wildfires may lead to soil erosion 4. Warmer Water - Higher surface temperatures may lead to stratification 5. Sea Level Rise - Sewage may mix with seawater in combined sewer systems	1. Increasing Drought - Pollution sources may build up on land, followed by high-intensity flushes 2. Increasing Storminess - Streams may see greater erosion and scour 3. Sea Level Rise - Tidal flooding may extend to new areas, leading to additional sources of pollution 4. Warmer Water - Higher solubility may lead to higher concentrations of pollutants 5. Warmer Water - Parasites, bacteria may have greater survival or transmission 6. Increasing Drought - Critical-low-flow criteria for discharging may not be met 7. Increasing Drought - Pollutant concentrations may increase if sources stay the same and flow diminishes 8. Increasing Storminess - Combined sewer overflows may increase 9. Warmer Water - Temperature criteria increase toxicity of pollutants	1. Increasing Storminess - Urban areas may be subject to more floods 2. Increasing Storminess - Treatment plants may go offline during intense floods 3. Sea Level Rise - Treatment plants may not be able to discharge via gravity at higher water levels 4. Sea Level Rise - Treatment infrastructure may be susceptible to flooding 5. Sea Level Rise - Contaminated sites may flood or have shoreline erosion 6. Sea Level Rise - Sewer pipes may have more inflow (floods) or infiltration (higher water table) 7. Warmer Water - Temperature criteria for discharges may be exceeded (thermal pollution)
Low			

Figure 2. Northeast Region 2050 Pollution Control Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

The risks to EPA goals associated with pollution control in the NE Study Area by 2100 are shown in the matrix in Figure 3. Problems associated with low flows and eutrophication join flooding as high risk challenges to EPA pollution control goals by 2100. Restrictions on discharges are also high risk that can impact operation of businesses and public services.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High	1. Warmer Winters - Longer growing season can lead to more lawn maintenance with fertilizers and pesticides	1. Increasing Drought - Critical-low-flow criteria for discharging may not be met 2. Sea Level Rise - Sewage may mix with seawater in combined sewer systems 3. Sea Level Rise - Tidal flooding may extend to new areas, leading to additional sources of pollution 4. Warmer Winters - Loss of melting winter snows may reduce spring or summer flow volume and raise pollutant concentration in receiving waters 5. Warmer Water - Water may hold less dissolved oxygen 6. Warmer Water - Greater algae growth may occur	1. Increasing Storminess - Flood control facilities (e.g., detention basins, manure management) may be inadequate 2. Sea Level Rise - Treatment plants may not be able to discharge via gravity at higher water levels 3. Sea Level Rise - Treatment infrastructure may be susceptible to flooding 4. Sea Level Rise - Sewer pipes may have more inflow (floods) or infiltration (higher water table)
Medium	1. Increasing Storminess - High rainfall may cause septic systems to fail 2. Ocean Acidification - Decomposing organic matter releases carbon dioxide, which may exacerbate the ocean acidification problem in coastal waters 3. Warmer Summers - Wildfires may lead to soil erosion 4. Warmer Water - Higher surface temperatures may lead to stratification	1. Increasing Drought - Pollutant concentrations may increase if sources stay the same and flow diminishes 2. Increasing Drought - Pollution sources may build up on land, followed by high-intensity, flushes 3. Increasing Storminess - Combined sewer overflows may increase 4. Increasing Storminess - Streams may see greater erosion and scour 5. Warmer Water - Temperature criteria increase toxicity of pollutants 6. Warmer Water - Higher solubility may lead to higher concentrations of pollutants 7. Warmer Water - Parasites, bacteria may have greater survival or transmission	1. Increasing Storminess - Treatment plants may go offline during intense floods 2. Increasing Storminess - Urban areas may be subject to more floods 3. Sea Level Rise - Contaminated sites may flood or have shoreline erosion 4. Warmer Water - Temperature criteria for discharges may be exceeded (thermal pollution)
Low			

Figure 3. Northeast Region 2100 Pollution Control Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

5.2 Habitat

The risks to EPA goals associated with habitat in the NE Study Area by 2050 are shown in the matrix in Figure 4. Habitat damage or loss caused by sea level rise and warmer water, supplemented by increasing turbidity and sedimentation from increased storms, are the high risk concerns by 2050.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High	1. Warmer Winters - Warmer winters may lead to less snow, more rain may change the runoff/infiltration balance; base flow in streams may change	1. Increasing Drought - An increase in long-term and seasonal short term drought may decrease base flows in streams 2. Increasing Drought -An increase in long-term and seasonal short term drought may cause groundwater tables to drop 3. Increasing Drought - Stream water may become warmer 4. Increasing Storminess - Stronger storms may cause more intense flooding and runoff 5. Increasing Storminess - The number of storms reaching an intensity that causes problems may increase 6. Increasing Storminess - Turbidity of surface waters may increase	1. Increasing Storminess - Coastal overwash or island breaching may occur 2. Sea Level Rise - Ability of tidal marsh elevation to match rate of sea level rise 3. Sea Level Rise - Ability of tidal marsh to migrate landward 4. Sea Level Rise - Higher salinity may kill targeted species 5. Sea Level Rise - Shoreline erosion may lead to loss of beaches, wetlands and salt marshes 6. Warmer Water - Warm water may promote invasive species or disease 7. Warmer Water - Warmer water is likely to increase incidence of marine and estuarine disease 8. Warmer Water - Warmer water is likely to lead to an expansion of invasive species
Medium	1. Increasing Storminess - Increased intensity of precipitation may yield less infiltration 2. Warmer Summers - Warmer summers may lead to greater electricity demand may affect operation decisions at hydropower dams 3. Warmer Summers - Warmer summers may result in the switching between surface and groundwater sources for public water supplies may affect the integrity of water bodies 4. Warmer Winters - Rivers may no longer freeze; a spring thaw would be obsolete 5. Warmer Winters - Marshes and beaches may erode from loss of protecting ice	1. Warmer Summers - Warmer summers are expected to result in higher temperatures which may lead to greater evaporation and lower groundwater tables 2. Warmer Water - Desired fish may no longer be present 3. Warmer Water - Warmer water is likely to lead to greater likelihood of stratification 4. Increasing Storminess - Turbidity of surface waters may increase	1. Increasing Storminess - Stream erosion may lead to high turbidity and greater sedimentation 2. Sea Level Rise - Bulkheads, sea walls and revetments may become more widespread 3. Sea Level Rise - Saline water may move farther upstream and freshwater habitat may become brackish 4. Sea Level Rise - Salinization of non-tidal freshwater coastal marshes 5. Sea Level Rise - Tidal influence may move farther upstream 6. Warmer Water - Warmer water may result in the loss of SAV habitat
Low	1. Increasing Drought - Increased human use of groundwater during drought may reduce stream baseflow 2. Increasing Drought - New water supply reservoirs may affect the integrity of freshwater streams 3. Increasing Storminess - Lower pH for NPS pollution may affect target species 4. Ocean Acidification - Long term shellfish sustainability may be an open question 5. Warmer Winters - A spring runoff pulse may disappear along with the snow	1. Sea Level Rise - Light may not penetrate through deeper water 2. Ocean Acidification - Fish may be adversely affected during development stages	

Figure 4. Northeast Region 2050 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

The risks to EPA goals associated with habitat in the NE Study Area by 2100 are shown in the matrix in Figure 5. Expanded habitat damage or loss caused by sea level rise and warmer water, supplemented by increasing turbidity and sedimentation from increased storms, are the high risk concerns by 2100.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High		1. Increasing Drought - An increase in long-term and seasonal short term drought may decrease base flows in streams 2. Increasing Drought - Stream water may become warmer 3. Increasing Storminess - The number of storms reaching an intensity that causes problems may increase 4. Increasing Storminess - Turbidity of surface waters may increase 5. Warmer Summers - Warmer summers are expected to result in higher temperatures which may lead to greater evaporation and lower groundwater tables 6. Warmer Summers - Warmer summers may lead to greater electricity demand may affect operation decisions at hydropower dams 7. Warmer Summers - Warmer summers may result in the switching between surface and groundwater sources for public water supplies may affect the integrity of water bodies 8. Warmer Winters - Warmer winters may lead to less snow, more rain may change the runoff/infiltration balance; base flow in streams may change	1. Increasing Drought - An increase in long-term and seasonal short term drought may cause groundwater tables to drop 2. Increasing Storminess - Coastal overwash or island breaching may occur 3. Increasing Storminess - Stream erosion may lead to high turbidity and greater sedimentation 4. Increasing Storminess - Stronger storms may cause more intense flooding and runoff 5. Sea Level Rise - Ability of tidal marsh elevation to match rate of sea level rise 6. Sea Level Rise - Ability of tidal marsh to migrate landward 7. Sea Level Rise - Bulkheads, sea walls and revetments may become more widespread 8. Sea Level Rise - Higher salinity may kill targeted species 9. Sea Level Rise - Saline water may move farther upstream and freshwater habitat may become brackish 10. Sea Level Rise - Salinization of non-tidal freshwater coastal marshes 11. Sea Level Rise - Shoreline erosion may lead to loss of beaches, wetlands and salt marshes 12. Sea Level Rise - Tidal influence may move farther upstream 13. Warmer Water - Warm water may promote invasive species or disease 14. Warmer Water - Warmer water is likely to Increase incidence of marine and estuarine disease 15. Warmer Water - Warmer water is likely to lead to an expansion of invasive species
Medium	1. Increasing Storminess - Increased intensity of precipitation may yield less infiltration 2. Increasing Storminess - Lower pH for NPS pollution may affect target species 3. Warmer Winters - A spring runoff pulse may disappear along with the snow 4. Warmer Winters - Marshes and beaches may erode from loss of protecting ice 5. Warmer Winters - Rivers may no longer freeze; a spring thaw would be obsolete	1. Increasing Drought - Increased human use of groundwater during drought may reduce stream baseflow 2. Increasing Drought - New water supply reservoirs may affect the integrity of freshwater streams 3. Ocean Acidification - Fish may be adversely affected during development stages 4. Ocean Acidification - Long term shellfish sustainability may be an open question 5. Warmer Water - Desired fish may no longer be present 6. Warmer Water - Warmer Water is likely to lead to greater likelihood of stratification	1. Warmer Water - Warmer water may result in the loss of SAV habitat
Low		1. Sea Level Rise - Light may not penetrate through deeper water	

Figure 5. Northeast Region 2100 Habitat Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

5.3 Fish, Wildlife and Plants

The risks to EPA goals associated with fish, wildlife and plants in the NE Study Area by 2050 are shown in the matrix in Figure 6. These results are similar to those observed for habitat loss with damage caused by sea level rise, warmer weather, and warmer water, supplemented by increasing turbidity and sedimentation from increased storms, as the high risk concerns by 2050.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High		1. Increasing Storminess - Greater soil erosion may increase sediment deposition in estuaries, with consequences for benthic species 2. Warmer Summers - Species may need to consume more water as temperature rises 3. Warmer Summers - Species that won't tolerate warmer summers may die/migrate; biota at the southern limit of their range may disappear from ecosystems 4. Warmer Water - Heat may stress immobile biota 5. Warmer Water - Some fish reproduction may require cold temperatures; other reproductive cycles are tied to water temperature	1. Increasing Drought - Changing freshwater inputs may affect salinity distribution in estuaries (especially of interest with regard to shellfish habitat 2. Warmer Water - Parasites and diseases are enhanced by warmer water 3. Sea Level Rise - Ability of tidal marsh elevation to match rate of sea level rise 4. Sea Level Rise - Ability of tidal marsh to migrate landward 5. Sea Level Rise - Greater coastal wetland losses may occur 6. Warmer Water - Dissolved oxygen capacity of water may drop 7. Warmer Water - Habitat may become unsuitably warm, for a species or its food 8. Warmer Water - Newly invasive species may appear 9. Warmer Winters - Invasive species may move into places that used to be too cold 10. Warmer Winters - Pests may survive winters that used to kill them
Medium		1. Increasing Drought - Species may not tolerate a new drought regime 2. Warmer Summers - Essential food sources may die off or disappear, affecting the food web 3. Warmer Winters - Food supplies and bird migrations may be mistimed 4. Warmer Winters - Some plants may need a "setting" cold temperature 5. Warmer Winters - Species that once migrated through may stop and stay 6. Warmer Winters - Species that used to migrate away may stay all winter	1. Increasing Drought - Native habitat may be affected if freshwater flow in streams is diminished or eliminated 2. Increasing Storminess - Greater soil erosion may increase turbidity and decrease water clarity 3. Sea Level Rise - Sea level may push saltier water farther upstream (especially of interest with regard to shellfish habitat) 4. Sea Level Rise - Salinization of non-tidal freshwater coastal marshes
Low	1. Warmer Summers - Species may be weakened by heat and become out- competed 2. Ocean Acidification - Corrosive waters may impact shellfish development 3. Ocean Acidification - Shellfish predators may not survive the disappearance of shellfish 4. Ocean Acidification - Fish may be adversely affected during development stages by changes to water chemistry 5. Ocean Acidification - The effect of ocean acidification on calcifying plankton may lead to cascading effects in the food chain	1. Sea Level Rise - Light may not penetrate through the full depth of deeper water 2. Warmer Winters - A longer growing season may lead to an extra reproductive cycle	

Figure 6. Northeast Region 2050 Fish, Wildlife, and Plant Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

The risks to EPA goals associated with fish, wildlife and plants in the NE Study Area by 2100 are shown in the matrix in Figure 7. Expanded impacts on fish, wildlife and plants caused by sea level rise, warmer weather, and warmer water, supplemented by increasing turbidity and sedimentation from increased storms, are the high risk concerns by 2100.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High		1. Increasing Drought - Species may not tolerate a new drought regime 2. Increasing Storminess - Greater soil erosion may increase sediment deposition in estuaries, with consequences for benthic species 3. Warmer Summers - Essential food sources may die off or disappear, affecting the food web 4. Warmer Summers - Species may need to consume more water as temperature rises 5. Warmer Summers - Species that won't tolerate warmer summers may die/migrate; biota at the southern limit of their range may disappear from ecosystems 6. Warmer Water - Heat may stress immobile biota 7. Warmer Water - Some fish reproduction may require cold temperatures; other reproductive cycles are tied to water temperature 8. Warmer Winters - Food supplies and bird migrations may be mistimed 9. Warmer Winters - Some plants may need a "setting" cold temperature	1. Increasing Drought - Changing freshwater inputs may affect salinity distribution in estuaries (especially of interest with regard to shellfish habitat 2. Increasing Storminess - Greater soil erosion may increase turbidity and decrease water clarity 3. Sea Level Rise - Ability of tidal marsh elevation to match rate of sea level rise 4. Sea Level Rise - Ability of tidal marsh to migrate landward 5. Sea Level Rise - Greater coastal wetland losses may occur 6. Sea Level Rise - Salinization of non-tidal freshwater coastal marshes 7. Sea Level Rise - Sea level may push saltier water farther upstream (especially of interest with regard to shellfish habitat) 8. Warmer Water - Dissolved oxygen capacity of water may drop 9. Warmer Water - Habitat may become unsuitably warm, for a species or its food 10. Warmer Water - Newly invasive species may appear 11. Warmer Water - Parasites and diseases are enhanced by warmer water 12. Warmer Winters - Invasive species may move into places that used to be too cold 13. Warmer Winters - Pests may survive winters that used to kill them
Medium	1. Warmer Summers - Species may be weakened by heat and become out- competed	1. Ocean Acidification - Corrosive waters may impact shellfish development 2. Ocean Acidification - Fish may be adversely affected during development stages by changes to water chemistry 3. Ocean Acidification - Shellfish predators may not survive the disappearance of shellfish 4. Ocean Acidification - The effect of ocean acidification on calcifying plankton may lead to cascading effects in the food chain 5. Warmer Winters - A longer growing season may lead to an extra reproductive cycle 6. Warmer Winters - Species that once migrated through may stop and stay 7. Warmer Winters - Species that used to migrate away may stay all winter	1. Increasing Drought - Native habitat may be affected if freshwater flow in streams is diminished or eliminated
Low		1. Sea Level Rise - Light may not penetrate through the full depth of deeper water	

Figure 7. Northeast Region 2100 Fish, Wildlife, and Plant Vulnerability Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

5.4 Recreation and Public Water Supplies

The risks to EPA goals associated recreation and public water supplies in the NE Study Area by 2050 are shown in the matrix in Figure 8. No high risk impacts to recreation and public water supplies were identified for 2050. However, medium risk concerns were identified associated with flooding, eutrophication, and impacts on fish and shellfish.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High	1. Sea Level Rise - Clearance under bridges may decrease 2. Warmer Water - Harmful algal blooms may be more likely		
Medium	1. Increasing Storminess - Greater NPS pollution may impair recreation 2. Ocean Acidification - Eco-tourism resource or attractions (e.g., birding, diving, fishing) may be degraded 3. Sea Level Rise - Saltwater intrusion into groundwater may be more likely 4. Warmer Summers - Warmer temperatures may drive greater water demand 5. Warmer Summers - Evaporation losses from reservoirs and groundwater may increase 6. Warmer Water - Jellyfish may be more common 7. Warmer Water - Increased growth of algae and microbes may affect drinking water quality	1. Increasing Storminess - Water infrastructure may be vulnerable to flooding 2. Sea Level Rise - Water infrastructure may be vulnerable to inundation or erosion 3. Sea Level Rise - Beaches or public access sites may be lost to coastal erosion or inundation 4. Warmer Water - Fishing seasons and fish may become misaligned 5. Warmer Water - Desired recreational fish may no longer be present 6. Warmer Winters - Summer water supplies that depend on winter snow pack may disappear 7. Warmer Water – Invasive plants may clog creeks and waterways 8. Ocean Acidification - Recreational shellfish harvesting may be lost	
Low	1. Increasing Drought - Freshwater flows in streams may not support recreational uses 2. Increasing Drought - Increased estuary salinity may drive away targeted recreational fish 3. Increasing Drought - Lower freshwater flows may not keep saltwater downstream of intakes 4. Increasing Drought - Groundwater tables may drop 5. Increasing Drought - Coastal aquifers may be salinized from insufficient freshwater input 6. Increasing Drought - Coastal aquifers may be salinized from higher demand on groundwater 7. Increasing Drought - Maintaining passing flows at diversions may be difficult 8. Increasing Storminess - More frequent or more intense storms may decrease recreational opportunities 9. Increasing Storminess - Flood waters may raise downstream turbidity and affect water quality 10. Warmer Summers - More people using water for recreation may raise the potential for pathogen exposure 11. Warmer Water - Changes in treatment processes may be required 12. Warmer Winters - Cold places may see more freeze/thaw cycles that can affect infrastructure	1. Sea Level Rise - Sea level may push salt fronts upstream past water diversion	

Figure 8. Northeast Region 2050 Recreation and Water Supply Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

The risks to EPA goals associated recreation and public water supplies in the NE Study Area by 2100 are shown in the matrix in Figure 9. High risk impacts to recreation and public water supplies were identified for 2100. These concerns are associated loss of recreational areas and infrastructure to flooding, erosion, and inundation; loss of species that support recreation; eutrophication; and the emergence of undesirable species.

Likelihood of Occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High		1. Increasing Storminess - Greater NPS pollution may impair recreation 2. Ocean Acidification - Eco-tourism resource or attractions (e.g., birding, diving, fishing) may be degraded 3. Ocean Acidification - Recreational shellfish harvesting may be lost 4. Sea Level Rise - Clearance under bridges may decrease 5. Sea Level Rise - Saltwater intrusion into groundwater may be more likely 6. Warmer Summers - Warmer temperatures may drive greater water demand 7. Warmer Summers - Evaporation losses from reservoirs and groundwater may increase 8. Warmer Water - Harmful algal blooms may be more likely 9. Warmer Water - Jellyfish may be more common 10. Warmer Water - Desired recreational fish may no longer be present 11. Warmer Water - Invasive plants may clog creeks and waterways 12. Warmer Water - Increased growth of algae and microbes may affect drinking water quality 13. Warmer Winters - Summer water supplies that depend on winter snow pack may disappear	1. Increasing Storminess - Water infrastructure may be vulnerable to flooding 2. Sea Level Rise - Water infrastructure may be vulnerable to inundation or erosion 3. Sea Level Rise - Beaches or public access sites may be lost to coastal erosion or inundation 4. Warmer Water - Fishing seasons and fish may become misaligned
Medium	1. Increasing Drought - Increased estuary salinity may drive away targeted recreational fish 2. Warmer Water - Changes in treatment processes may be required	1. Increasing Drought - Freshwater flows in streams may not support recreational uses 2. Increasing Drought - Lower freshwater flows may not keep saltwater downstream of intakes 3. Increasing Drought - Groundwater tables may drop 4. Increasing Drought - Coastal aquifers may be salinized from insufficient freshwater input 5. Increasing Drought - Coastal aquifers may be salinized from higher demand on groundwater 6. Increasing Drought - Maintaining passing flows at diversions may be difficult 7. Increasing Storminess - More frequent or more intense storms may decrease recreational opportunities 8. Increasing Storminess - Flood waters may raise downstream turbidity and affect water quality 9. Sea Level Rise - Sea level may push salt fronts upstream past water diversion 10. Warmer Summers - More people using water for recreation may raise the potential for pathogen exposure 11. Warmer Winters - Cold places may see more freeze/thaw cycles that can affect infrastructure	
Low			

Figure 9. Northeast Region 2100 Recreation and Water Supply Assessment where impacts in green cells have low risk, yellow cells have medium risk, and red cells have high risk.

6 Conclusions and Comments

This scoping study provides a climate change vulnerability assessment for the NE Study Area from Long Island, NY to southern Maine. C/P matrices for four EPA goal areas (pollution control; habitat; fish, wildlife, and plants; recreation and public water supplies) for 2050 and 2100 indicate that risks to EPA Clean Water Act goals associated with climate change exist in the near term for most EPA goals and become substantially greater for all EPA goals by 2100.

Because these results represent expert judgment of a very limited number of individuals, the results should be considered preliminary and communicated and used with appropriate disclaimers and due caution. Owing to the nature of data available and reviewed, high levels of uncertainty exist in the complexities of climate change applied to any potential impact, particularly ecological impacts. For example, there is certainty that increased carbon dioxide in the atmosphere will increase the pH of the oceans. The sources reviewed indicated that empirical data from aquaculture and from laboratory experiments show that pH changes negatively impact species of economic interest. What was less certain is the extent of acidification and the impacts over time. The uncertainties were prevalent and enhanced the uncertainty in rank assignment based on spatial extents of the risk item.

The estimation of risk produced in this scoping study can be can be improved by ensuring that the breadth of understanding is available. No small group of experts will possess that breadth of knowledge. A full vetting of the scoping study vulnerability assessment results with a broad range of experts is strongly recommended.

7 References

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Appendix D: Battelle Scoping Report: Buzzards Bay Municipal Recommendations

Summary Recommendations for the Town of Acushnet

The following is a summary of recommendations that describe potential climate adaptation actions for the Town of Acushnet in order to better address vulnerabilities to wastewater treatment plant, and pump station infrastructures. The assessed vulnerabilities and recommendations are based on the results of the Climate Change Vulnerability Assessment and Adaptation Planning Study for Water Quality Infrastructure in New Bedford, Fairhaven, and Acushnet, which evaluated the potential for damage and loss of function from modeled inundation scenarios using a combination of hurricane parameters and sea level rise (SLR) projections.

Typical wastewater design recommendations are to protect wastewater infrastructure against the 500-year flood. Furthermore, FEMA guidance provides an additional benchmark for quantifying risk to critical facilities, such as water quality infrastructure:

> *Under Executive Order 11988, Floodplain Management, Federal agencies funding and/or permitting critical facilities are required to avoid the 0.2% (500-year) floodplain or protect the facilities to the 0.2% chance flood level.*

Following the standard of protecting critical facilities against damages from a 500-year storm, we chose two modeled hurricane inundation scenarios based on the 2009 FEMA floodplain projections for a 500-year storm. The inundation scenario from the team's modeling approach that most closely resembled the FEMA 500-year storm floodplain was the Category 3 hurricane with baseline water levels (no SLR). We used this scenario, as well as the Category 3 hurricane with 4-foot SLR scenario to evaluate water quality infrastructure, and to make recommendations for individual water quality infrastructure features where possible.

After meeting with town officials and reviewing site-specific studies, we assessed the vulnerability of the water quality infrastructure based on information provided to the team. We also performed a visual evaluation of each pump station using Google Earth imagery to assess whether there were structural features or characteristics that put them at higher or lower risk of damage from inundation. This provided only a cursory engineering review that does not replace a more detailed site specific inspection and evaluation that will be required to be conducted in a future phase of this project. The following paragraphs summarize findings and general recommendations for pump stations. The summary table ranks individual pump station vulnerability and provides preliminary, site-specific recommendations.

Pump station recommendations

The Town of Acushnet has 3 pump stations, 1 of which is in the floodplain of the Category 3 scenario with no SLR. This is given a risk ranking of 3 (high) in the table below. An additional pump station is in the floodplain when 4-foot SLR is added to the Category 3 scenario. This is given a risk ranking of 2 (medium) in the table. The infrastructure housed at pump stations, including motors, electrical service and electronic controls, generators, buried compressors and fuel tanks, and manholes can all influence a pump station's ability to operate during flooding events. In addition, access to many structures will not be possible except by boat during the inundation scenarios evaluated. Generally the pump stations are above ground on level ground near the shoreline and are very exposed. A few are below ground.

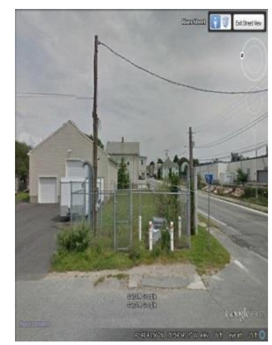
Adaptation actions should prioritize structures that fall within the Category 3 floodplain at current water levels, and focus secondarily on those which are at risk during Category 3 storms with 4-foot SLR. In the table below, we rank priority sites and provide specific recommendations based on information provided by the Town of Acushnet; however, this does not replace the need for site-specific evaluations. In general, site-specific evaluations should be performed to make a detailed assessment of potential risks to a facility. Individual assessments of each structure should be performed to determine the following:

- Whether the structure has already been floodproofed
- To confirm elevations of possible points of entry for water (e.g. vents, door sills, windows)
- The vulnerability of critical infrastructure within each pump station
- What would be required to flood-proof
- Whether the facility is currently able to operate during flood conditions (e.g. equipped with generator, ability to remote operate)

Once potential risks to a facility are understood, potential mitigation measures should be identified and more accurate opinions of costs can be developed to retrofit existing facilities.

Summary Table of Vulnerability and Recommendations

We have assessed risk based on the point location of each pump station and the water levels at that point for the two inundation scenarios described above and categorized these risks in the table below. Facilities that are not in the floodplain in either scenario are colored in green (low risk) and given a vulnerability ranking of 1. Facilities that are in the floodplain in the Category 3, 4-foot SLR scenario only are colored in orange (medium risk) and given a vulnerability ranking of 2, and facilities that are in the floodplain both scenarios are colored in red (high risk), and given a vulnerability ranking of 3. This table contains recommendations based on available information; however, we recommend that site-specific evaluations be performed for each feature to further evaluate vulnerability and refine adaptation measures.

Structure Location	Inundation depth (NAVD88 ft) for Category 3 Hurricane with no SLR	Inundation depth (NAVD88 ft) for Category 3 Hurricane with 4-ft SLR	Vulnerability Rank	Preliminary Recommendations	Comments
Blueberry Drive	0	0	1	None	
Allen Street	0	4.72	2	Consider berm with weir boards for access. Need for generator is unknown. Cost is $25,000 to $50,000	 Above ground structure type unknown, likely pre-manufactured housing for pump station. If so, likely cannot be floodproofed and earthen berm will be required.
Slocum Street	.85	23.61	3	Add flood proof door and extend vents. Cost is $10,000 to $25,000.On-site generator will be expensive and not included in these costs.	 Below ground structure. Vents likely could be flooded with SLR scenario.

Summary Recommendations for the Town of Fairhaven

The following is a summary of recommendations that describe potential climate adaptation actions for the Town of Fairhaven in order to better address vulnerabilities to wastewater treatment plant, and pump station infrastructures. The assessed vulnerabilities and recommendations are based on the results of the Climate Change Vulnerability Assessment and Adaptation Planning Study for Water Quality Infrastructure in New Bedford, Fairhaven, and Acushnet, which evaluated the potential for damage and loss of function from modeled inundation scenarios using a combination of hurricane parameters and sea level rise (SLR) projections.

Typical wastewater design recommendations are to protect wastewater infrastructure against the 500-year flood. Furthermore, FEMA guidance provides an additional benchmark for quantifying risk to critical facilities, such as water quality infrastructure:

> *Under Executive Order 11988, Floodplain Management, Federal agencies funding and/or permitting critical facilities are required to avoid the 0.2% (500-year) floodplain or protect the facilities to the 0.2% chance flood level.*

Following the standard of protecting critical facilities against damages from a 500-year storm, we chose two modeled hurricane inundation scenarios based on the 2009 FEMA floodplain projections for a 500-year storm. The inundation scenario from the team's modeling approach that most closely resembled the FEMA 500-year storm floodplain was the Category 3 hurricane with baseline (no SLR) water level scenario. We used this scenario, as well as the Category 3 hurricane with 4-foot SLR scenario to evaluate water quality infrastructure, and to make recommendations for individual water quality infrastructure features where possible.

After meeting with town officials and reviewing site-specific studies, we assessed the vulnerability of the water quality infrastructure based on information provided to the team. We also performed a visual evaluation of each pump station using Google Earth imagery to assess whether there were structural features or characteristics that put them at higher or lower risk of damage from inundation. This provided only a cursory engineering review that does not replace a more detailed site-specific inspection and evaluation that will be required to be conducted in a future phase of this project. The following paragraphs summarize findings and general recommendations for pump stations and wastewater treatment facilities. The summary table ranks individual water quality infrastructure feature vulnerability and provides preliminary, site-specific recommendations.

Pump stations

The Town of Fairhaven has 19 pump stations, 10 of which are in the floodplain during the Category 3 scenario with no SLR. These are given a risk ranking of 3 (high) in the table below. 5 additional pump stations are in the floodplain when 4-foot SLR is added to the Category 3 scenario. These are given a risk ranking of 2 (medium) in the table below. The pump stations at Causeway Rd., Bernese St., and South St. pump water from downstream pump stations. These require additional consideration as they would render the other pump stations useless if they were to malfunction. The infrastructure housed at pump stations, including motors, electrical service and electronic controls, generators, buried compressors and fuel tanks, and manholes can all influence a pump station's ability to operate during flooding events. In addition, access to many structures will not be possible except by boat during the inundation scenarios evaluated. Generally the pump stations are above ground on level ground near the shoreline and are very exposed. A few are below ground.

Adaptation actions should prioritize structures that fall within the Category 3 floodplain at current water levels, and focus secondarily on those which are at risk during Category 3 storms with 4-foot SLR. In the table below, we rank priority sites and provide specific recommendations based on information provided by the Town of Fairhaven; however, this does not replace the need for site-specific evaluations. In general, site-specific evaluations should be performed to make a detailed assessment of potential risks to a facility. Individual assessments of each structure should be performed to determine the following:

- Whether the structure has already been floodproofed
- To confirm elevations of possible points of entry for water (e.g. vents, door sills, windows)
- The vulnerability of critical infrastructure within each pump station
- What would be required to flood-proof
- Whether the facility is currently able to operate during flood conditions (e.g. equipped with generator, ability to remote operate)

Once potential risks to a facility are understood, potential mitigation measures should be identified and more accurate opinions of costs can be developed to retrofit existing facilities.

Wastewater treatment plants

The Town of Fairhaven has two wastewater treatment facilities. The Category 3 storms at both baseline water levels and 4-foot SLR levels show over ground flooding at the Arsene Street facility. This facility has a generator in an above ground brick structure, which should provide sufficient protection during these scenarios. The West Island facility is not at risk for flooding in either of these scenarios. Future studies should assess the storm scenarios that the treatment facility should be protected from and focus on thorough evaluations of the flood control system and critical infrastructure for those scenarios to ensure they are protected during these flood events. Ideally, flood controls should keep the entire site dry for the specified inundation scenario but some limited flooding could be acceptable if the site can be kept operational throughout these events.

The team recommends a detailed, site-specific assessment of each facility's vulnerability to flooding. This would include a site visit to determine point of entry and where flood waters could damage equipment/structures and a survey to identify actual elevations of critical points to compare with target flood elevations. Once potential risks to a facility are understood, potential mitigation measures should be identified and more accurate opinions of costs can be developed to retrofit existing facilities.

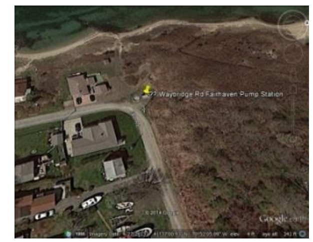
Summary Table of Vulnerability and Recommendations

We have assessed risk based on the point location of each pump station and treatment plants, and the water levels at that point for the two inundation scenarios described above and categorized these risks in the table below. Facilities that are not in the floodplain in either scenario are colored in green (low risk) and given a vulnerability ranking of 1. Facilities that are in the floodplain in the Category 3, 4-foot SLR scenario only are colored in orange (medium risk) and given a vulnerability ranking of 2, and facilities that are in the floodplain for both Category 3 scenarios are colored in red (high risk), and given a vulnerability ranking of 3. This table contains recommendations based on available information; however, we recommend that site-specific evaluations be performed for each feature to further evaluate vulnerability and refine adaptation measures.

Structure Location	Inundation depth (NAVD88 ft) for Category 3 Hurricane with no SLR	Inundation depth (NAVD 88 ft) for Category 3 Hurricane with 4-ft SLR	Vulnerability Rank	Preliminary Recommendations	Comments
Taber Street	0	20.73	2	Potentially require flood proof door. Cost is $10,000 to $250,000.	 Above ground structure with brick construction. Door sill is close to ground.
Pilgrim Avenue	0	20.63	2	Potentially require flood proof door as well as generator and remote controls. Structure should be checked for buoyancy. Cost is $10,000 to $250,000.	 Above ground brick structure, first floor within 2-3 ft of ground.
Bridge Street	0	18.04	2	Potentially require flood proof door as well as generator and remote controls. Structure should be checked for buoyancy. Cost is $10,000 to $250,000.	 Above ground brick structure, first floor within 2-3 ft of ground.

Arsene Street	0	0	1		Unknown
South Street	0	11.74	2	Potentially require flood proof door as well as generator and remote controls. Structure should be checked for buoyancy. Cost is $10,000 to $250,000.	 Above ground structure with brick construction. Door sill is close to ground. Pumps water from downstream pump stations.
Rivard Street	0	0	1		
Marguerite Street	0	0	1		
Pine Grove Road	0	0	1		
Middle Street	0	18.82	2	This pump station reportedly only manages stormwater and therefore should be assessed to determine how essential it is to operate during coastal floods. Cost is $10,000 to $50,000.	 Above ground structure. Door sill is 1 to 2 feet above ground.
Causeway Road	3.93	7.67	3	Structure would require complete reconstruction and on-site generator. Cost is $200,000 to $500,000	 Above ground wood structure. Door sill is just above ground. No generator. Pumps water from downstream pump stations.
Rocky Point Road	7.44	11.25	3		No image available

Camel Street	8.03	11.67	3	Below ground pump station. Flood door for vault required and on site generator. Cost is \$50,000 - \$250,000	
Manhattan Avenue	8.75	12.49	3	Minimum likely requirement is flood-proofing doors. Cost is \$10,000 to \$250,000	 Above ground structure with pump station on-site.
Bernese Street	8.72	12.59	3	New structure that is flood resistant would be required. \$200,000 to \$500,000.	 Above ground wood structure with no generator. Pumps water from downstream pump stations.
Shore Drive	12.17	15.97	3	Floodproof access hatch and provide on-site generator. \$100,000 - \$250,000	 Below grade pump station with no generator

Abbey Street	12.49	16.76	3	On-site generator recommended. Cost is $100,000 to $250,000	
Waybridge Road	12.59	16.40	3	On-site generator recommended. Cost is $10,000 to $250,000	 Aboveground pump station with elevated first floor, reportedly 5’ above grade.
Seaview Avenue	12.82	16.59	3	Generator on site with above ground structure. Cost is $10,000 to $250,000	
Boulder Park	13.18	17.32	3		

Treatment Plants					
Arsene Street	6.46	10.36	3	Above ground brick structure with generator. Likely improvements include floodproofing doors. $10,000 to $250,000	Generator above ground brick, inside building
West Island	0	0	1		

Summary Recommendations for the City of New Bedford

The following is a summary of recommendations that describe potential climate adaptation actions for the City of New Bedford in order to better address vulnerabilities to combined sewer outfalls (CSOs), wastewater treatment plant, and pump station infrastructures The assessed vulnerabilities and recommendations are based on the results of the Climate Change Vulnerability Assessment and Adaptation Planning Study for Water Quality Infrastructure in New Bedford, Fairhaven, and Acushnet, which assessed the potential for damage and loss of function from modeled inundation scenarios using a combination of hurricane parameters and sea level rise projections.

The project team developed recommendations for CSOs, wastewater treatment facilities, and pump stations based on two inundation scenarios.

Typical wastewater design recommendations are to protect wastewater infrastructure against the 500-year flood. Furthermore, FEMA guidance provides an additional benchmark for quantifying risk to critical facilities, such as water quality infrastructure:

> *Under Executive Order 11988, Floodplain Management, Federal agencies funding and/or permitting critical facilities are required to avoid the 0.2% (500-year) floodplain or protect the facilities to the 0.2% chance flood level.*

Following the standard of protecting critical facilities against damages from a 500-year storm, we chose the two scenarios based on the 2009 FEMA floodplain projections for a 500-year storm. The inundation scenario from the team's modeling approach that most closely resembled the FEMA 500-year storm floodplain was the Category 3 hurricane with baseline (no SLR) water level scenario. We used this scenario, as well as the Category 3 hurricane with 4-foot (SLR) scenario to evaluate vulnerability for each CSO, wastewater treatment facility, and pump station, and to make recommendations based on each feature's vulnerability.

After meeting with town officials and reviewing site-specific studies, we assessed the vulnerability of the water quality infrastructure based on information provided to the team. We also performed a visual evaluation of each pump station using Google Earth imagery to assess whether there were structural features or characteristics that put them at higher or lower risk of damage from inundation. This provided only a cursory engineering review that does not replace a more detailed site specific inspection and evaluation that will be required to be conducted in a future phase of this project.

CSOs

The City of New Bedford has 23 CSOs. CSO discharges are controlled by regulators, many of which are already below MSL (mean sea level) and MHW (mean high water), which means that there are likely to be additional regulators, sets of controls, and/or storage which would prevent the system from flooding during normal operation. Additionally, many, if not all outfalls are likely have a tide gate that protects against back flow and thereby helps preserve system storage. The project team understands that several regulators currently flood with water from the river and/or bay during storms and other extreme tide events resulting in river/bay water draining to the treatment plant. This inflow into the system unnecessarily impacts the system hydraulic loads and likely negatively impacts the waste water treatment system performance. Sea level rise will only exacerbate these flooding issues. However, it is not currently possible to quantify the extent of these impacts beyond understanding that increased sea level rise will add backflow to the existing CSO outfalls and reduce their hydraulic performance.

More information is needed as to whether increased water levels at discharge locations would prevent regulators from functioning properly. As such, we suggest that assessing the impacts of SLR will require hydraulic modeling of the system, which answers questions about the storage capacity of the system and its ability to drain. In general, the hydraulic modeling would need to assess the ability of the system to temporarily store water during target design storms and then release that water as tides recede for sea level rise scenarios. In terms of priority study activities, we recommend that CSO hydraulics should be modeled for those CSOs where regulator weir elevations are below sea level rise e levations for specific sea level rise scenarios. These data were provided by CDM Smith and can be found in the project's technical report. This study modeled flooding from hurricane events, however, sea level rise is likely to have a greater impact on CSOs than an individual storm. CSOs are typically evaluated based on potential risk, and low probability coastal flood events are likely within their range of acceptable risk.

Pump stations

The City of New Bedford has 26 pump stations, 4 of which are in the flood plain in a Category 3 storm with no SLR. These are given a risk ranking of 3 (high) in the table below. 5 additional pump stations are located in the floodplain when 4-foot SLR is added to the Category 3 storm scenario. These are given a risk ranking of 2 (medium) in the table below. The pump stations at xxx pump water from downstream pump stations. These require additional consideration as they would render the other pump stations useless if they were to malfunction. The infrastructure housed at pump stations, including motors, electrical service and electronic controls, generators, buried compressors and fuel tanks, and manholes can all influence a pump station's ability to operate during flooding events. In addition, access to many structures will not be possible except by boat during the inundation scenarios evaluated. Generally the pump stations are above ground on level ground near the shoreline and are very exposed. A few a re below ground.

Adaptation actions should prioritize structures that fall within the Category 3 floodplain at current water levels, and focus secondarily on those which are at risk during Category 3 storms with 4-foot SLR. In the table below, we rank priority sites and provide specific recommendations based on information provided by the City of New Bedford; however, this does not replace the need for site -specific evaluations. In general, site-specific evaluations should be performed to make a detailed assessment of potential risks to a facility. Individual assessments of each structure should be performed to determine the following:

- Whether the structure has already been floodproofed
- To confirm elevations of possible points of entry for water (e.g. vents, door sills, windows)
- The vulnerability of critical infrastructure within each pump station
- What would be required to flood-proof

– Whether the facility is currently able to operate during flood conditions (e.g. equipped with generator, ability to remote operate)

Once potential risks to a facility are understood, potential mitigation measures should be identified and more accurate opinions of costs can be developed to retrofit existing facilities.

Wastewater treatment plants

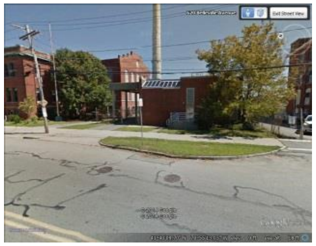
The City of New Bedford has one wastewater treatment facility. The Category 3 storms at both baseline water levels and 4-foot SLR levels show over ground flooding of the wastewater treatment plant location. Future studies should assess the storm scenarios that the treatment facility should be protected from and focus on thorough evaluations of the flood control system and critical infrastructure for those scenarios to ensure they are protected during these flood events. Ideally, flood controls should keep the entire site dry for the specified inundation scenario but some limited flooding could be acceptable if the site can be kept operational throughout these events.

The New Bedford facility is protected by an existing levee; however, there is the potential for inundation around this levee in the Category 3 storm scenarios. The ability to enhance the existing flood control system around these structures should be assessed as part of any consideration to providing further flood protection for this structure.

The team recommends a detailed, site-specific assessment of the facility's vulnerability to flooding. This would include a site visit to determine point of entry and where flood waters could damage equipment/structures and a survey to identify actual elevations of critical points to compare with target flood elevations. Once potential risks to a facility are understood, potential mitigation measures should be identified and more accurate opinions of costs can be developed to retrofit existing facilities.

Summary Table of Vulnerability and Recommendations

We have assessed risk based on the point location of each pump station and treatment plant, and the water levels at that point for the two inundation scenarios described above and categorized these risks in the table below. Facilities that are not in the floodplain in either scenario are colored in green (low risk) and given a vulnerability ranking of 1. Facilities that are in the floodplain in the Category 3, 4-foot SLR scenario only are colored in orange (medium risk) and given a vulnerability ranking of 2, and facilities that are in the floodplain for both Category 3 scenarios are colored in red (high risk), and given a vulnerability ranking of 3.This table contains recommendations based on available information; however, we recommend that site-specific evaluations be performed for each feature to further determine vulnerability and refine adaptation measures.

Structure Location	Inundation depth (NAVD88 ft) for Category 3 Hurricane with no SLR	Inundation depth (NAVD 88 ft) for Category 3 Hurricane with 4-ft SLR	Preliminary Recommendations	Comments
Belleville Avenue	0	17.71	Require flood proof doors for entries and loading dock as well as floodproofing electrical vault and air intakes. Also, incoming sewer manholes will need to have covers bolted and gasketed. $25,000 to $150,000.	 Above ground brick structure. Door and loading dock landing is about 3.3’ above ground. Air intake or exhaust is about 3’ above ground. Below grade electrical vault will be vulnerable to flooding. Equipped with SCADA and telemetry so can be remote operated. Generator is located on-site.
MacArthur Drive	0	13.25	Potentially require flood proof door, generator and floodproofing of vaults that could be points of entry. Potential buoyancy of building should also be assessed. $100,000 to $200,000	 Above ground brick structure.First floor is at about 3.1’ above ground at entry door landing. Several buried concrete vaults are adjacent or nearby the structure. Contents of those vaults are not known but likely points of entry into pump station. The vaults may be inlet works, wet wells or electrical vaults.Site is not equipped with a generator and pigtail connection is at door sill elevation. Some electrical service enters building from ground. Facility will be equipped with SCADA and telemetry to allow remote operation.

Wamsutta Street	0	23.52	Potentially require flood proof doors as well as floodproofing at-grade entryway and building penetrations. Generator will also need to be protected likely with wall system.Potential buoyancy of building should also be assessed$75,000 to $200,000.	 Above ground structure with brick construction. Door sill is close to ground. No generator, likely pigtail
Rowe Street	0	0		
Coggeshall Street	0	16.66	Floodproofing of doors, windows and vaults will be required. Existing vents will need to be raised. Electrical infrastructure such as services, generators and transformers will either need to be raised or protected with floodwall system with flashboards for access. Structure and vaults should be checked for buoancy.$150,000 to $350,000.	 Above ground brick structure with brick construction. Door sill is about 0.8' above ground. Window sills are about 4.7' above ground. Several concrete vaults with hatches or accessways exist below grade that likely provide pathway for flooding inside of building. A vent to one of the vaults also has a low point at about the same elevation of the window sills. Two other vents also exist at a lower elevation. Building electrical service is below inundation levels. A transformer adjacent to the site and generator is on right at grade.

Peckham Road	0	0		
Sassaquin Avenue	0	0		
Pequot Street	0	0		
Phillips Road	0	0		
Marlborough Street	0	0		
Forbes Street	0	0		
Hanover Street	0	0		
Welby Road	0	0		
Church Street	0	0		
Joyce Street	0	0		
Aviation Way	0	0		
Shawmut Avenue	0	0		
Howard Avenue	0.52	23.45	Require flood proof doors and windows including accessways to below grade vaults. Above ground tank will have to be anchored and vaults checked for buoyancy. Generator should be provided for site. $150,000 to $350,000.	 Above ground structure with brick construction. Two stainless steel doors have sills at grade. Window sills are as low as 2.7' above ground. Below grade vaults exist with hatches or grates providing access to the vaults. Above ground storage tank exists at grade. Generator transfer switch and connection are located about 3.2' above grade. A below grade electrical vault also exists on this site. bove ground structure with brick construction. Two stainless steel doors have sills at grade. Window sills are as low as 2.7' above ground. Below grade vaults exist with hatches or grates providing access to the vaults. Above ground storage tank exists at grade.

Valley View Drive	0	0		
Joy Street	0	0		
Hathaway Road	0	0		
Apple Tree Lane	0	0		
Merrimac Street	0	0		
Popes Island	0	16.69	Access hatch to pump station will need to be floodproofed. Electrical service and control panels will need to be raised and floodproofed. Ability to operate pump station remotely will need to be confirmed. Generator should also be provided that will need to be protected as well. \$100,000 to \$250,000.	 Below ground pump station. Electrical service and control panels are at about 2.8’ above grade. Vent is about 4.25’ above grade. No generator
South Water Street	6.82	15.12	Potentially require flood proof door and flood proof windows. Generator and electrical service will likely need to be raised or protected. Little information available for this site to identify other needs. \$100,000 to \$250,000.	 Above ground structure. Door sill is just above ground. Generator is reportedly located on site

East Rodney French Boulevard	11.38	15.74	Floodproof doors and windows. Vents will need to be protected with cutoff wall. Electrical service will need to be raised and gas service needs to be evaluated $25,000 to $150,000.	 One door sill and vent are located 3.6’ above grade. One door sill is 1.8’ above grade. Ground elevations vary at both doors. Electrical service meter box located 2.3’ above grade. Electrical junction boxes appear to be as low as 0.8’ above grade. Intake/exhaust vents for generator are about 1.8’ above grade. Gas service is at grade for backup generator.
Cove Road	11.87	15.12	Floodproof existing doors. Electrical service should be raised and floodproofed with transformer protected as well. Generator vent should be protected with cut off wall. Gas service needs to be assessed. $50,000 to$250,000.	 Protected by existing levee; The ability to enhance the existing flood control system around this structure should be assessed as part of any consideration to providing further flood protection for this structure. First floor 4’ above grade with two stainless steel doors providing access. Electrical box is located 3’ above grade. Transformer is located at grade. Gas service is also located at grade. Generator intake/exhaust vents is located 4.4’ above grade. Odor control system is located outdoors but is not critical to system operation and would not be required to be protected. Generator is on site in building.
Wastewater Treatment Plant				
South Rodney French Boulevard	1.37	5.41		Protected by existing levee; The ability to enhance the existing flood control system around these structure should be assessed as part of any consideration to providing further flood protection for this structure.

Appendix E: Buzzards Bay Coalition Facilitated Workshop Outcomes

Buzzards Bay CCMP Climate Vulnerability Assessment Support

This is the Final Report to the Buzzards Bay National Estuary Program and includes information on the status of the goals and objectives described in the original contract.

Project Motivation

In 2021, the Buzzards Bay NEP began a Climate Change Vulnerability Assessment to meet the needs of the program, and to help guide climate-related recommendations in the planned Buzzards Bay CCMP 2023 Update. The NEP's effort largely adopted the methodology and approach defined in EPA's Climate Ready Estuaries program's Being Prepared for Climate Change: A Workbook for Developing Risk-Based Adaptation Plans (U.S. EPA, 2014). However, rather than assessing species and habitat impacts due to predicted climate stressors, the Buzzards Bay NEP's assessment sought to characterize how climate change may impact the Buzzards Bay NEP's ability to meet management goals outlined in the 2013 CCMP and planned 2023 Update. Specifically, through forums and meetings hosted by the Buzzards Bay Coalition, the NEP aimed to identify climate related management goals and priorities that should be included in the 2023 CCMP update.

Project Activities

The Coalition hosted meetings and workshops with key stakeholders in Buzzards Bay to gather feedback on the draft Climate Change Vulnerability Assessment (CCVA). The BBC hosted four workshops geared at different audiences. The key stakeholder groups that were engaged were:

1) The scientific community as represented by the Buzzards Bay Coalition Science Advisory Committee (In-person workshop held October 21, 2021)

2) State and Federal Officials/Scientists (Virtual workshop held February 17, 2022)

3) Regional and Municipal Officials (Virtual workshop held March 3, 2022)

4) General Public and Non-Profit Staff (Virtual workshop held April 19, 2022)

Email invitations were sent to over 250 people. The list of registrations and attendees is below as Appendix 1.

The format for all the workshops was similar. Background information to set the context of the Climate Change Vulnerability Assessment was provided and specific feedback on some Action Plans was sought. In the first workshop, all Action Plans were considered but this proved to be too much to tackle in a single workshop. At the subsequent workshops, a few Action Plans were selected and general feedback was also requested. For the virtual workshops, the polling functionality was used to get quantitative feedback on specific questions. The polling results are included as Appendix 2.

The first workshop, held with scientists from the Buzzards Bay Coalition's Science Advisory Committee resulted in a number of potential additions to climate risks to consider. Those were:

Action Plan	Climate risk (stressor and outcome)	Adaptation Strategy(ies) or Comments
1 Managing Nitrogen Sensitive Embayments	Warmer water creates additional stress to eelgrass survival on top of eutrophication.	Eelgrass recovery is habitat goal for many Buzzards Bay TMDLs. Eelgrass in lower nutrient environments is more resilient, so lower nitrogen targets are needed to achieve habitat goal in face of rising water temperatures and occurrence of ocean heat waves.
	Warmer water will lead to more algal growth and blooms, decreasing water clarity and limiting light availability for eelgrass.	Eelgrass recovery is habitat goal for many Buzzards Bay TMDLs. Eelgrass in lower nutrient environments is more resilient, so lower nitrogen targets are needed to achieve habitat goal.
	Warmer temperatures will extend growing season and lead to additional crop planting and additional fertilizer and pesticide inputs.	Some farmers in region already planting additional crop because of extended warm season. Need to account for additional fertilizer in TMDL budgets where agriculture is a significant proportion of nutrient load. Also addressed in Action Plan 16.
	Increased precipitation amount and intensity may change nutrient inputs from rivers (amount, forms of nitrogen, rate of delivery, etc).	Net impact of this is unknown. Will big storms flush watershed moving N quickly out to sea?
	Increases in freshwater to sewer networks will reduce wastewater treatment capacity and nitrogen removal efficiency due to increased inflow and infiltration from sea level rise raising groundwater near the coast and due to increased intensity of precipitation leading to higher flows from sump pumps illegally connected to sewer network.	
	Certain climate drivers like increasing rates of sea level rise and increased storm intensity will increase the rate of salt marsh loss in Buzzards Bay	Nutrient TMDLs that modelled salt marshes as net sinks for nitrogen will need to be revised to account for the loss of that sink over time.
10 Managing Water Withdrawals to Protect Wetlands, Habitat, and Water Supplies	Sea level rise will result in salt water intrusion of some drinking water supplies and increase pressure on those not impacted by salt water intrusion.	As coastal properties with wells are forced to abandon private wells due to salt water intrusion, there will be pressure to increase connections to town water supplies, increasing demand.
	Increasing drought will reduce groundwater levels impacting drinking water supply availability.	
		Continued on next page…

Action Plan	Climate risk (stressor and outcome)	Adaptation Strategy(ies) or Comments
2 Protecting and Enhancing Shellfish Resources	Ocean acidification impairs shellfish development, survival, and growth resulting in population declines.	Eutrophication is the dominant cause of coastal ocean acidification, so reducing eutrophication in estuaries will limit impacts of ocean acidification.
	Increased storm intensity will threaten aquaculture hard infrastructure, which may limit benefits to wild populations and to water quality.	
	Increased storm intensity may threaten aquaculture and native shellfish stocks by bringing influxes of fresh, acidic water, and/or bacteria.	Impacts will be episodic and location dependent with aquaculture operations near the mouths of rivers more susceptible.
6 Managing Impacts from Boating, Marinas, and Moorings	Increased storm intensity/precipitation will result in increased inputs of bacteria from inundation animal farmlands of and marina storage tanks.	
	Increased storm intensity/precipitation will result in increased inputs of harmful chemicals when marinas and cranberry bogs are overtopped	
7 Protecting and Restoring Wetlands	Increased precipitation leading to freshwater runoff may limit potential for upslope salt marsh migration.	
	Increased precipitation and storm intensity may impact wetland restoration projects, particularly before new vegetation is established.	Small geographic impact.
8 Restoring Migratory Fish Passage and Populations	Increasing drought may lower water levels in streams and ponds making it difficult for anadromous fish to migrate up and down stream.	
12 Protecting Open Space	Need for coastal retreat of roads and other infrastructure will place development pressure on nearby undeveloped lands for the relocation of infrastructure.	
13 Protecting and Restoring Ponds and Streams	Increasing drought will reduce groundwater levels impacting pond and stream water level.	
		Continued on next page…

Action Plan	Climate risk (stressor and outcome)	Adaptation Strategy(ies) or Comments
9 Protecting Bio-Diversity and Rare and Endangered Species Habitat	Warmer water will lead to range shifts - with species that were previously abundant moving north and new species coming into Buzzards Bay	Buzzards Bay is the northern edge of range of many species, so may be large shifts; food web impacts could be large due to top down control by predators (e.g., lobsters, striped bass)
	Increased precipitation and storm intensity will impact habitat restoration projects by inundating more places, placing flooding and/or salt water stress on vegetation, particularly if it is not well-established.	Potential climate change impacts need to be accounted for when planning restoration projects.
	Sea level rise will result in loss of beach habitat for shorebirds such as piping plover, terns.	Colonies may need to be elevated to combat sea level rise.
	Warmer water in cold water streams will reduce habitat suitability for some species including sea run brook trout.	
	Ocean acidification may impact additional species besides shellfish. Low pH, particularly in combination with hypoxia can negatively impact sensitive larval stages of other species.	Impacts will be species specific. More research required to understand how important a threat this is.
	As climate drivers limit/shift high quality habitat, there will be an increased need for connecting habitat areas to allow species to adapt/migrate.	
14 Reducing Beach Debris, Marine Floatables, and Litter in Wetlands	Increased storm frequency and intensity will wash more litter into coastal waters and wetlands.	More frequent litter removal from beaches and streets would limit impact of increased flows.
15 Managing Coastal Watersheets, Tidelands, and the Waterfront	The myriad effects of climate change on ecosystem health and values will mean that assessments may become quickly out of date as a result of rapid changes.	Adaptive management and regular communication with researchers will be needed to manage this risk.
	Sea level rise will increase demand for clean material to maintain beaches and potential raise salt marshes.	Opportunities for the beneficial use of dredged sediments must continue to be maximized.
		Continued on next page…

Action Plan	Climate risk (stressor and outcome)	Adaptation Strategy(ies) or Comments
16 Reducing Toxic Pollution	Warmer temperatures will extend growing season and lead to additional crop planting and additional fertilizer and pesticide inputs.	Some farmers in region already planting additional crop because of extended warm season. Also addressed in Action Plan 1.
	Increased storm intensity could remobilize PCBs in/around New Bedford Harbor that are under sediment caps.	
18 Planning for a Shifting Shoreline and Coastal Storms	Sea level rise leads to desire for armoring roads, culverts, which may negatively impact coastal ecosystems by interupting the natural flow of water and sediment.	Projects must evaluate the impacts on wetlands and coastal areas and mitigate them.
20 Monitoring Management Action, Status, and Trends	Climate change impacts and stressors are not sufficiently captured in ongoing monitoring efforts that have focused on problem of eutrophication, so additional effort is needed to evaluate monitoring needs.	

The BBC Science Advisory Committee also offered suggestions about potential research/monitoring areas that could provide valuable information in the face of climate change. These included:

1. Central Buzzards Bay temperature data (BBC has one seasonal station, plus year-round logger at mouth of canal).
2. Groundwater flow models and nutrient measurements to be able to better characterize watershed loading and predict impacts of climate change stressors.
3. Will the mix of nitrogen sources change with climate change? Will there be more DON from increased precipitation/storm intensity?
4. Will climate-driven changes in ocean circulation impact Buzzards Bay circulation (it is influencing Gulf of Maine circulation now)? How will that impact flushing of estuaries, sediment transport, etc?
5. The slowing of the Gulf Stream is increasing SLR rates in Buzzards Bay. How will that impact salt marshes and other ecosystems and infrastructure?
6. Tracking of pH or carbonate system parameters in water.
7. Expanded measurements of biodiversity (currently BBC does marsh vegetation, counts river herring) to be able to characterize climate change impacts.
8. Gauge every stream for flow and temperature to be able to characterize climate change impacts.
9. Wind data - has there been a shift in dominant wind direction due to climate change? How will wind speeds change?

The second workshop, aimed towards State and Federal government employees, received the highest number of participants out of all three workshops. The state and federal workers who participated in the workshop were most concerned with damages and losses to the coastlines due to sea level rise. The Action Plans discussed with this group were 7. Protecting and Restoring Wetlands and 1. Managing Nitrogen Sensitive Embayments. A participant questioned how climate change might impact nitrogen pollution, as they were familiar with the issues on sewage and wastewater. Another participant, coming from an emergency management perspective, pointed out the significance of the impacts of sea level rise on groundwater levels, and how that is a rising concern amongst other emergency management agencies. This is a growing concern as rising sea levels will be impacting infrastructure and other assets of stakeholders. This point was agreed upon by other participants. It was also pointed out how increases in precipitation was not mentioned as a threat to the health of the Buzzards Bay, and may not necessarily fall under the "increased storminess" category. While an increase in storminess will lead to an increase in precipitation, there may also be a need to focus on amount of water over time vs. independent extreme weather events. A participant raised the point that the amount of salt marsh loss depends on the level and speed of sea level rise, but also whether there is space for marshes to migrate into areas that are currently upland. Sea level rise may also affect stormwater systems, so source reduction will be important as high upstream as possible to limit how much nitrogen-rich water flows into nitrogen sensitive embayments. Land acquisition of shoreline, low-lying land and buffers will help to provide habitat into the future and filter nutrient pollutants as water passes through the watershed. It was also pointed out that wetland restoration projects are challenging currently, even without the potential for increased drought due to climate change, so irrigation may be necessary for helping wetland plants to establish. One participant noted that range expansions of some species is already occurring and that lionfish have been found in Westport. A less cold winter and warmer winter temperatures allow some species to spread (green crabs, tunicates). Rapid assessment surveys were suggested as a strategy to understand the spread of invasive species which could inform management actions. Phragmites is very prevalent around Buzzards Bay and is a species that may be influenced by changes in the water table as a result of climate change, but there are other factors (e.g., culverts) that will influence the water table and Phragmites survival that are not related to climate change. The health of eelgrass was also discussed as a major concern, as eelgrass coverage is declining significantly and rapidly.

The discussion in the third workshop, with participants from regional organizations and municipalities focused primarily on Action Plans 2. Protecting and Enhancing Shellfish Resources and 7. Protecting and Restoring Wetlands. Again a participant noted the difficulty in wetland restoration projects, even without any consideration of climate change. An important adaptation strategy would be for the design of wetland restoration projects to incorporate resiliency. It was noted that increased precipitation can have a variety of impacts. Increased delivery of traditional nutrient pollutants through stormwater is often noted, but as the potential for wildfires increases, there is also the possibility of remnants from wildfires washing into estuaries. With respect to protecting and enhancing shellfish resources, it was noted that nitrogen reduction and better stormwater controls will be important adaptation strategies for limiting the number of stressors on shellfish and thereby enhancing their resiliency to climate change. Boat traffic in some areas was also noted as a potential additional stressor that could be managed. Participants also noted that they would have liked to comment on all action plans in regards to the question "Which action plans do you believe will be impacted the most from climate change". Zoom poll questions limit multiple choice responses to 10, thus limiting the amount of action plans listed as answers to the question. The top ten action plans from the online surveys were used as the responses for the zoom poll. Additionally, a participant noted a lack of conversation regarding plastic and litter throughout Buzzards Bay. A participant noted that management plans need to acknowledge that things are changing rapidly and should build in adaptability and flexibility to address that. A participant also asked about how we were engaging with indigenous groups or environmental justice populations.

Lastly, the fourth workshop was aimed towards the general public and non-profit organizations. This group of participants discussed how the loss and degradation of habitat, nitrogen pollution, and sea level rise are the top three main issues facing water quality in the Buzzards Bay. When asked about issues that were not used in the polling questions, one participant brought up the increasing amount of hardened shorelines, and noted that coastal armoring is an issue regarding erosion. Furthermore, regulations and policies regarding hardened shorelines differ between towns and municipalities. The Action Plans discussed were 3. Managing Stormwater Runoff and Promoting Low Impact Design and 18. Planning for a Shifting Shoreline and Coastal Storms. When discussing Action Plan 3, one participant wondered what plans there would be to educate the public about stormwater runoff, and things citizens can do to help mitigate the impacts. While the CCMP is a governmental document and not designed for public outreach due to its technical nature, there are aspects to the CCMP regarding education and outreach. Additionally, towns and municipalities are charged with stormwater management for their own town. A participant noted that stormwater issues are very location dependent. The intense rainfall in a short period of time can overwhelm current design – storms that had been considered a 25 year storm are happening now every 5 years. One participant felt better accountability for stormwater was needed, that the Bay should have rights. For Planning for a Shifting Shoreline and Coastal Storms there was discussion about communities' willingness to allow for migration and shoreline retreat. Even where there is space for migration, the rate of sea level rise is fast enough that it may be necessary to facilitate migration in order for it to keep pace with sea level rise.

The consensus from all the workshops was that climate change will impact our collective ability to meet the goals in the Buzzards Bay CCMP and it is important to plan for ways to adapt in order to increase our chance of success in meeting the goals.

Appendix 1. Workshop Registrants and Attendees

Workshop 1. Buzzards Bay Coalition Science Advisory Committee

Name	Affiliation	Registered	Attended
Chris Neill	Woodwell Climate Research Center	Y	Y
Mike Huguenin	Industrial Economics, retired	Y	Y
John Farrington	Woods Hole Oceanographic Institution, retired	Y	Y
John Waterbury	Woods Hole Oceanographic Institution, retired	Y	Y
Anne Giblin	Marine Biological Laboratory	Y	Y
Mark Rasmussen	Buzzards Bay Coalition	Y	Y
Alice Besterman	Buzzards Bay Coalition/ Woodwell Climate Research Center	Y	Y
Tony Williams	Buzzards Bay Coalition	Y	Y
Rachel Jakuba	Buzzards Bay Coalition	Y	Y

Workshop 2. State and Federal Officials/Scientists

Name	Affiliation	Registered	Attended
Bailey Stokes	USDA Farm Service Agency	Y	Y
Regina Lyons	US EPA Region 1	Y	Y
Marybeth Groff	MA Emergency Management Agency (MEMA)	Y	Y
Adrienne Pappal	Massachusetts Office of Coastal Zone Management	Y	Y
Samuel Haines	Massachusetts Office of Coastal Zone Management	Y	Y
Sarah Williams	Buzzards Bay National Estuary Program	Y	Y
Ian M. Jarvis	Massachusetts Department of Environmental Protection	Y	Y
Cindy Corsair	U.S. Fish and Wildlife Service - Southern New England Coastal Program	Y	Y
Elizabeth McCann	MassDEP Water Management Program	Y	N
Yashika Dewani	Department of Public Health	Y	Y
Irena Draksic	Massachusetts Dept. of Public Health/Environmental Toxicology Program	Y	Y
Alicia Grimaldi	US EPA Region 1	Y	Y
Kevin Bartsch	Buzzards Bay National Estuary Program	Y	Y
Joe Costa	Buzzards Bay National Estuary Program	Y	Y
Rachel Jakuba	Buzzards Bay Coalition	Y	Y
Virginia Parker	Buzzards Bay Coalition	Y	Y

Workshop 3. Regional and Municipal Officials

Name	Affiliation	Registered	Attended
Alan Slavin	Town of Wareham Selectman	Y	Y
Chancery Perks	City of New Bedford - Conservation	Y	N
Jim Munise	Town of Wareham Selectman	Y	N
Doug Brown	Falmouth Select Board	Y	N
Paul Foley	Town of Fairhaven	Y	N
Elizabeth McCann	MassDEP Water Management Program	Y	N
Kathy Fox Alfano	Bourne Wastewater Advisory Committee	Y	Y
Kathleen Mason	Cape Cod Commission	Y	Y
Sam Patterson	Falmouth Select Board	Y	Y
Christopher Michaud	Town of Dartmouth	Y	N
Norman Hills	BBAC, Select Board	Y	Y
Alicia Grimaldi	US EPA Region 1	Y	Y
Michael Lorenco	Town of Mattapoisett	Y	Y
Marc A Bellanger	Marion Conservation Commission	Y	Y
Whitney McClees	Town of Fairhaven	Y	N
Betty Ludtke		Y	Y
Amy Messier	Town of Westport	Y	Y
Merilee Kelly	Rochester Conservation	Y	Y
Joe Costa	Buzzards Bay National Estuary Program	Y	Y
Rachel Jakuba	Buzzards Bay Coalition	Y	Y
Virginia Parker	Buzzards Bay Coalition	Y	Y

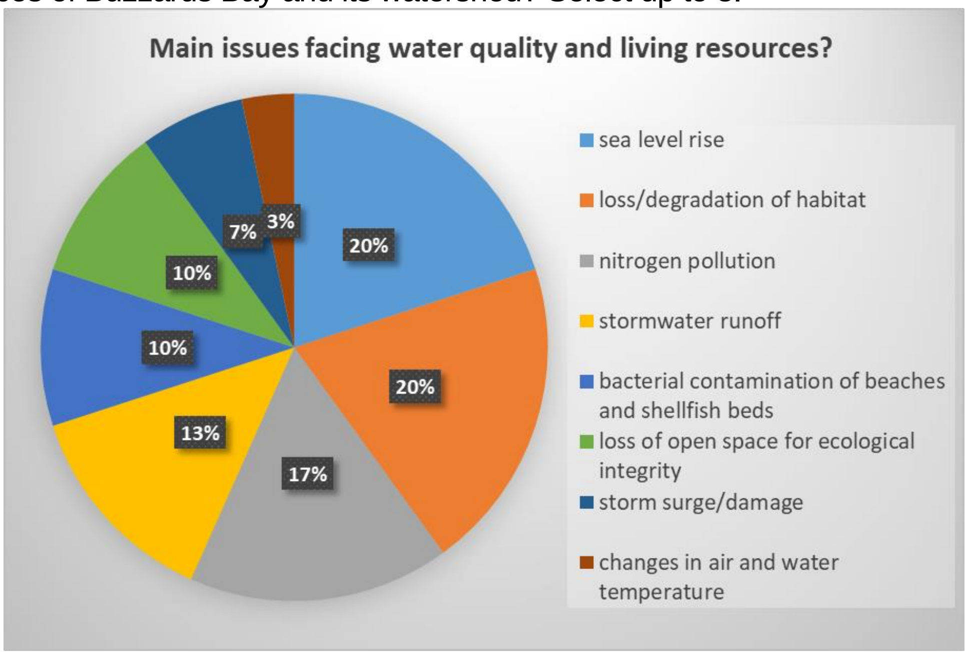
Workshop 4. General Public and Non-Profit Staff

Name	Affiliation	Registered	Attended
Cynthia Dittbrenner	The Trustees of Reservations	Y	N
James Frank Michielli	Trinity College	Y	N
Jim Munise	Town of Wareham Selectman	Y	N
Elise Leduc-Fleming	Wareham Land Trust	Y	Y
Stephen Uzzo	Woods Hole Institute	Y	Y
Catherine B. Cramer	Woods Hole Institute	Y	Y
Kathy Fox Alfano	Bourne Wastewater Advisory Committee	Y	N
Susan Quirk	Bourne Conservation Trust	Y	N
Cynthia Callow	Marion Zoning Board of Appeals	Y	N
Jim Bride	Sippican Lands Trust	Y	Y
Naomi S. Boak	Buzzards Bay Coalition	Y	Y
Alicia Grimaldi	US EPA Region 1	Y	Y
Chris Neill	Woodwell Climate Research Center	Y	N
Eileen Gunn	Falmouth resident	Y	N
David Dow	retired marine scientist/grassroots environmental activist	Y	N
Laura Hadley		Y	Y
Gary Magoon		Y	Y
Jennie Johnston		Y	N
Danielle Perry	Mass Audubon	Y	Y
Katerina McWilliam		Y	N
Linda Vanderveer	Dartmouth Natural Resources Trust	Y	Y
Joe Costa	Buzzards Bay National Estuary Program	Y	Y
Rachel Jakuba	Buzzards Bay Coalition	Y	Y
Virginia Parker	Buzzards Bay Coalition	Y	Y

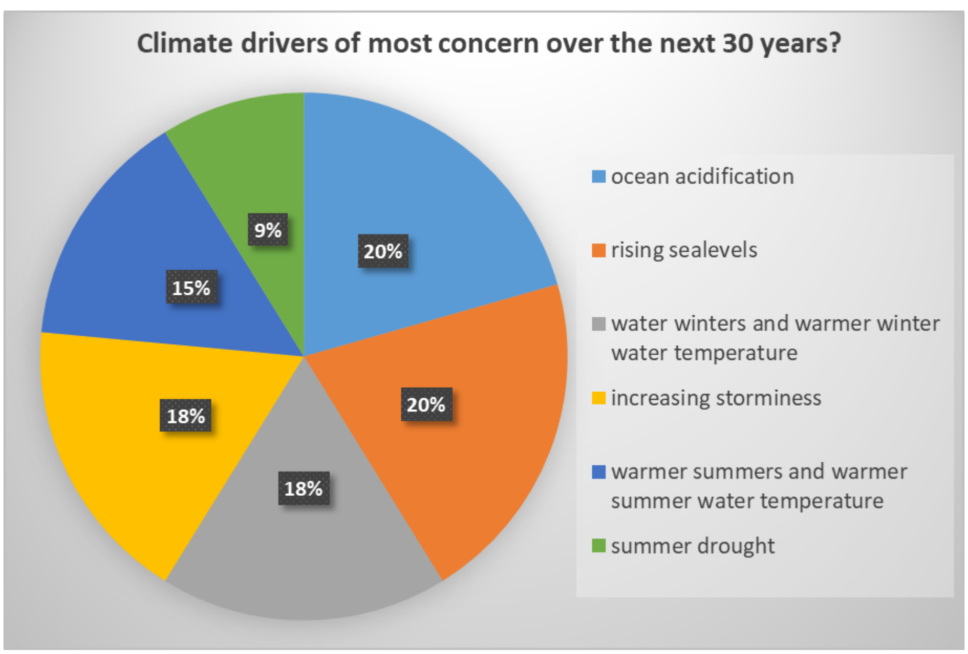
Appendix 2. Virtual Workshop Polling Results

Workshop 2. State and Federal Officials/Scientists

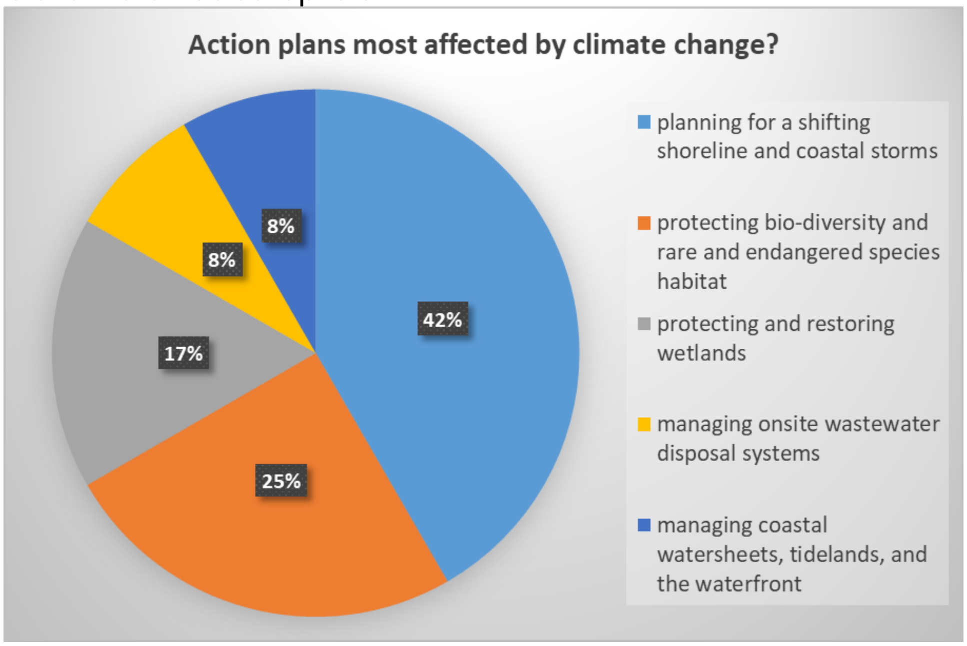
Poll Question 1: What do you see as the main issues facing the water quality and living resources of Buzzards Bay and its watershed? Select up to 3.



Poll Question 2: Of the following climate drivers, which are you most concerned about for their potential impact on water quality and natural resources over the next 30 years? Select up to 3.

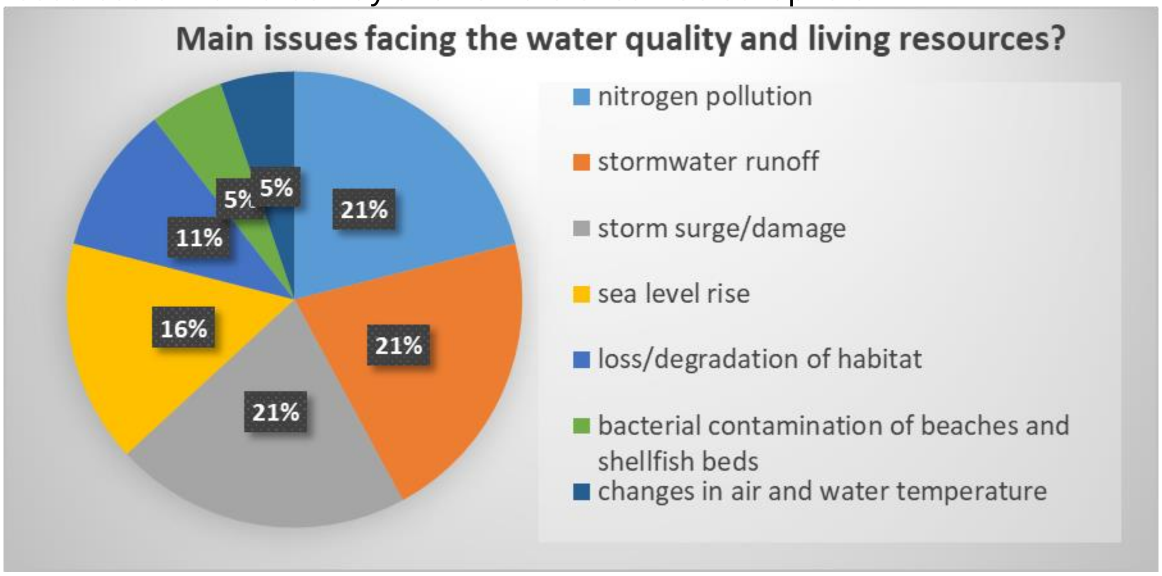


Poll Question 3: Which Action Plan do you think will be most affected or difficult to achieve because of climate? Select up to 3.

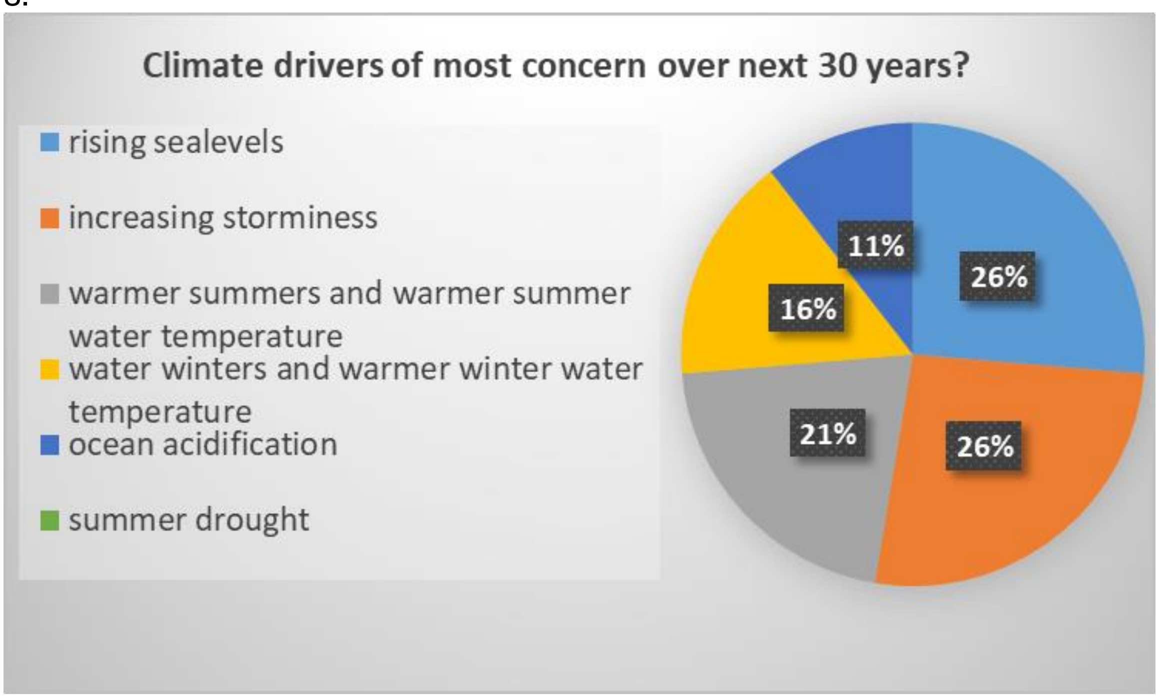


Workshop 3. Regional and Municipal Officials

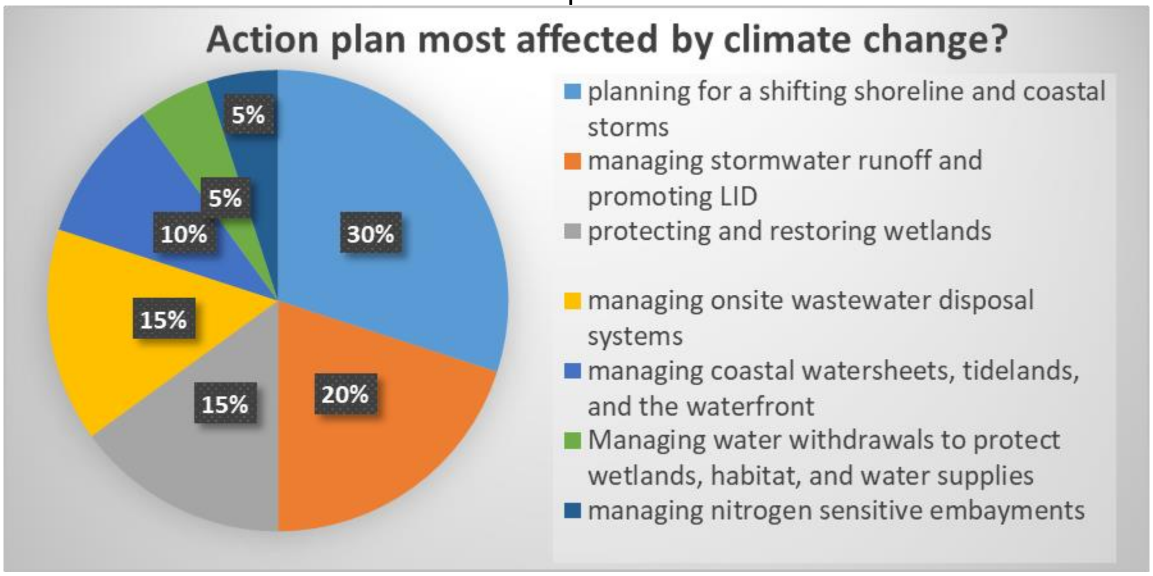
Poll Question 1: What do you see as the main issues facing the water quality and living resources of Buzzards Bay and its watershed? Select up to 3.



Poll Question 2: Of the following climate drivers, which are you most concerned about for their potential impact on water quality and natural resources over the next 30 years? Select up to 3.

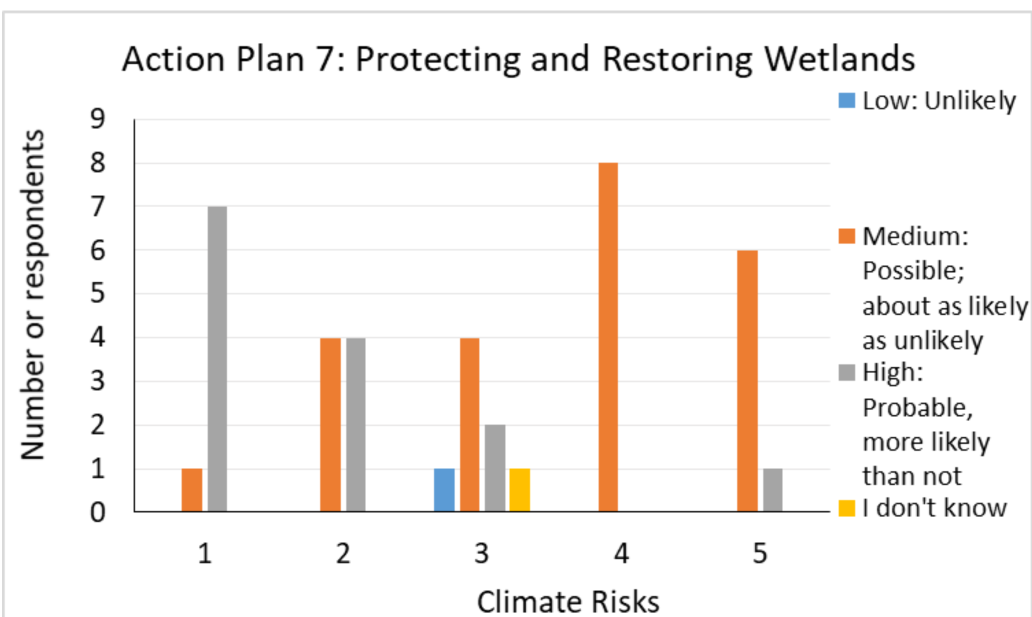


Poll Question 3: Which Action Plan do you think will be most affected or difficult to achieve because of climate? Select up to 3.



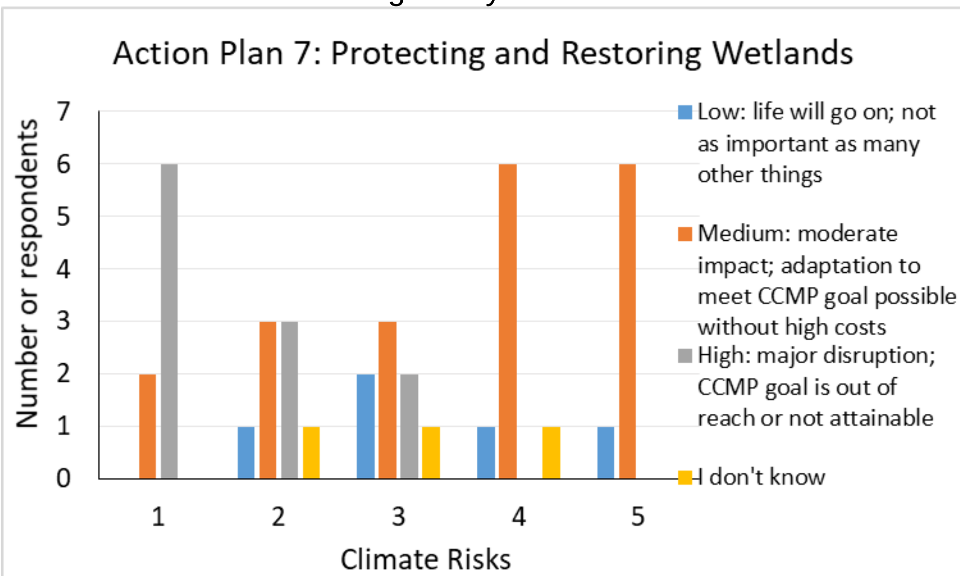
Poll Questions 4 - 8: Action Plan 7: Protecting and Restoring Wetlands. What is the likelihood that the following climate stressors and responses will happen by 2050?

1. Certain climate stressors like increasing rates of sea level rise and increased storm intensity may increase the rate of salt marsh loss in Buzzards Bay.
2. Warmer water may enhance survival of certain invasive species that may degrade both freshwater and salt-water wetlands.
3. Increased precipitation leading to freshwater runoff may limit potential for upslope salt marsh migration.
4. Increased precipitation and storm intensity may impact wetland restoration projects, particularly before new vegetation is established.
5. Increased summer drought may lead to less successful wetland restoration projects.



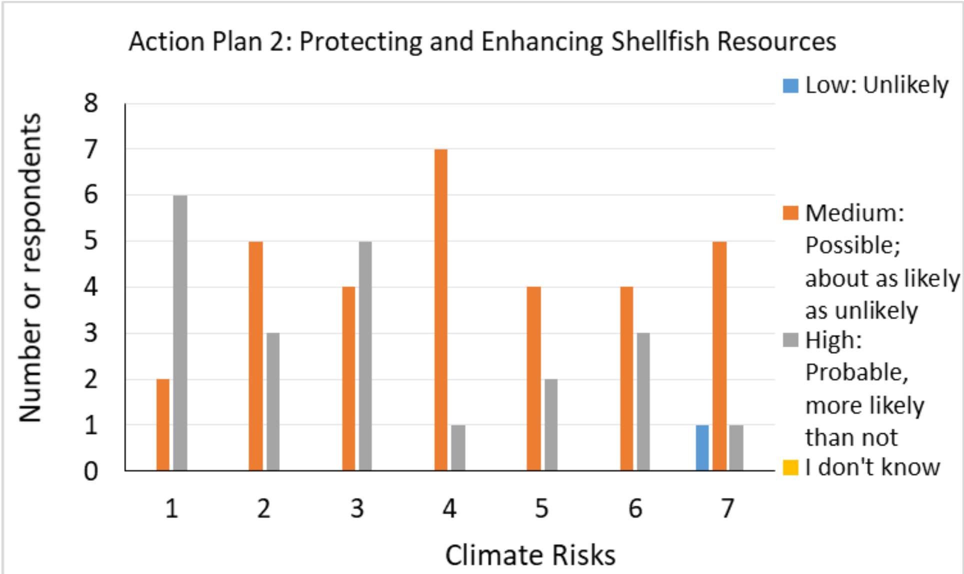
Poll Questions 9 - 13: Action Plan 7: Protecting and Restoring Wetlands. Rank the likely severity by 2050 of the following stressors?

1. Certain climate stressors like increasing rates of sea level rise and increased storm intensity may increase the rate of salt marsh loss in Buzzards Bay.
2. Warmer water may enhance survival of certain invasive species that may degrade both freshwater and salt-water wetlands.
3. Increased precipitation leading to freshwater runoff may limit potential for upslope salt marsh migration.
4. Increased precipitation and storm intensity may impact wetland restoration projects, particularly before new vegetation is established.
5. Increased summer drought may lead to less successful wetland restoration projects.



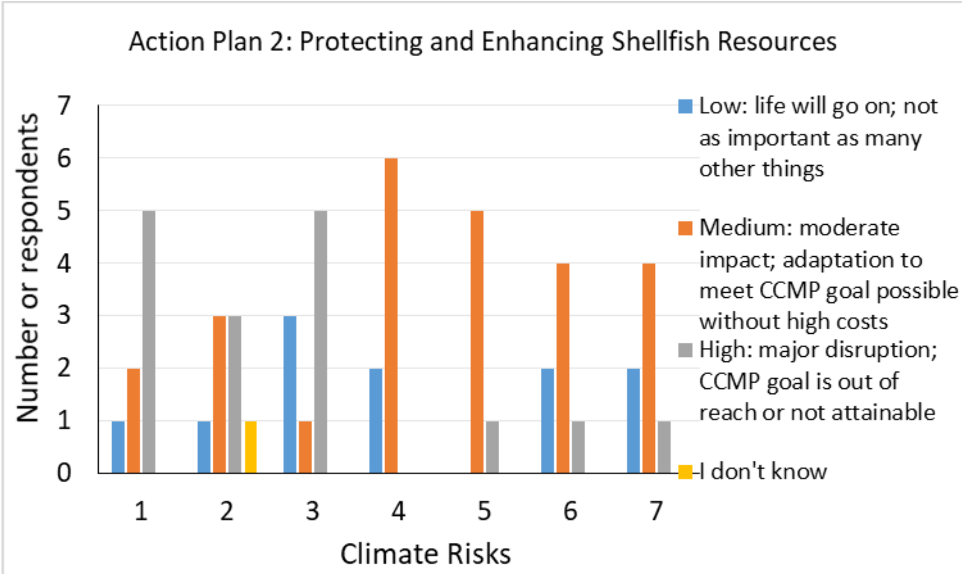
Poll Questions 14 - 20: Action Plan 2: Protecting and Enhancing Shellfish Resources. What is the likelihood that the following climate stressors and responses will happen by 2050?

1. Runoff from more frequent and intense precipitation events may contribute to expansion in the geographic extent and duration of shellfish bed closures.
2. Warmer water may enhance survival of indicator bacteria leading to expansion in the geographic extent and duration of shellfish bed closures.
3. Increased water temperatures may alter seasonal growth and extent of harmful algae blooms increasing the frequency or extent of shellfish bed closures.
4. Increasing summertime drought may cause changing freshwater inputs, which may affect salinity distribution in estuaries (important for some species like oysters).
5. Ocean acidification may impair shellfish development, survival, and growth resulting in population declines.
6. Increased storm intensity may threaten aquaculture hard infrastructure, which may limit benefits to wild populations and to water quality.
7. Increased storm intensity may threaten aquaculture and native shellfish stocks by bringing influxes of fresh, acidic water, and/or bacteria.



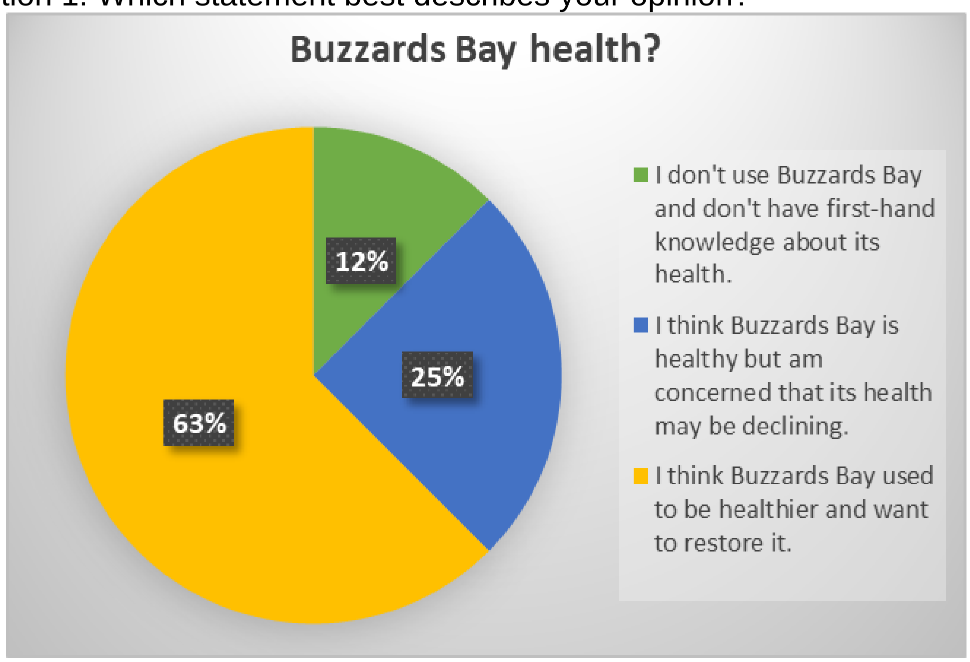
Poll Questions 21 - 27: Action Plan 2: Protecting and Enhancing Shellfish Resources. Rank the likely severity by 2050 of the following stressors?

1. Runoff from more frequent and intense precipitation events may contribute to expansion in the geographic extent and duration of shellfish bed closures.
2. Warmer water may enhance survival of indicator bacteria leading to expansion in the geographic extent and duration of shellfish bed closures.
3. Increased water temperatures may alter seasonal growth and extent of harmful algae blooms increasing the frequency or extent of shellfish bed closures.
4. Increasing summertime drought may cause changing freshwater inputs, which may affect salinity distribution in estuaries (important for some species like oysters).
5. Ocean acidification may impair shellfish development, survival, and growth resulting in population declines.
6. Increased storm intensity may threaten aquaculture hard infrastructure, which may limit benefits to wild populations and to water quality.
7. Increased storm intensity may threaten aquaculture and native shellfish stocks by bringing influxes of fresh, acidic water, and/or bacteria.

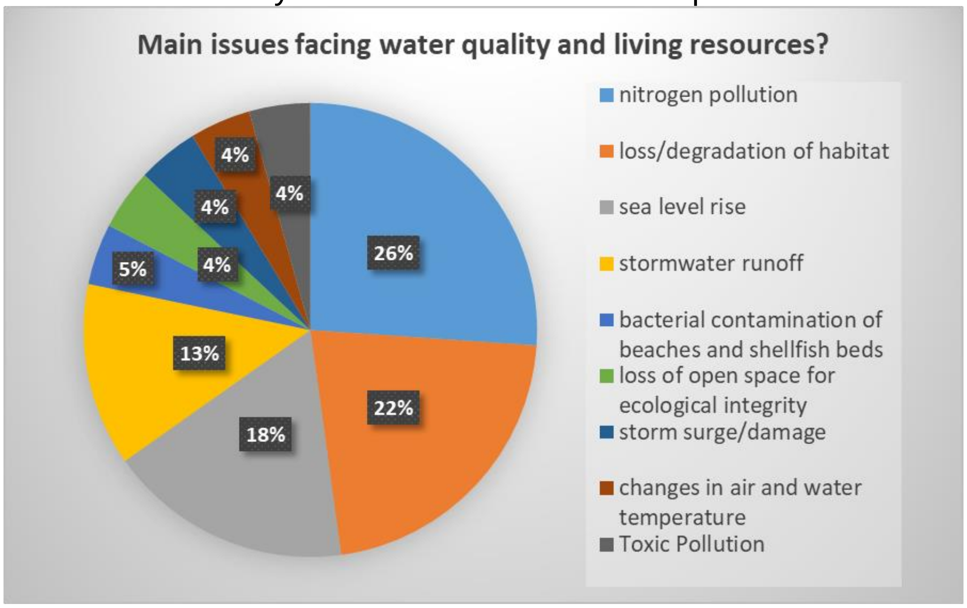


Workshop 4. General Public and Non-Profit Staff

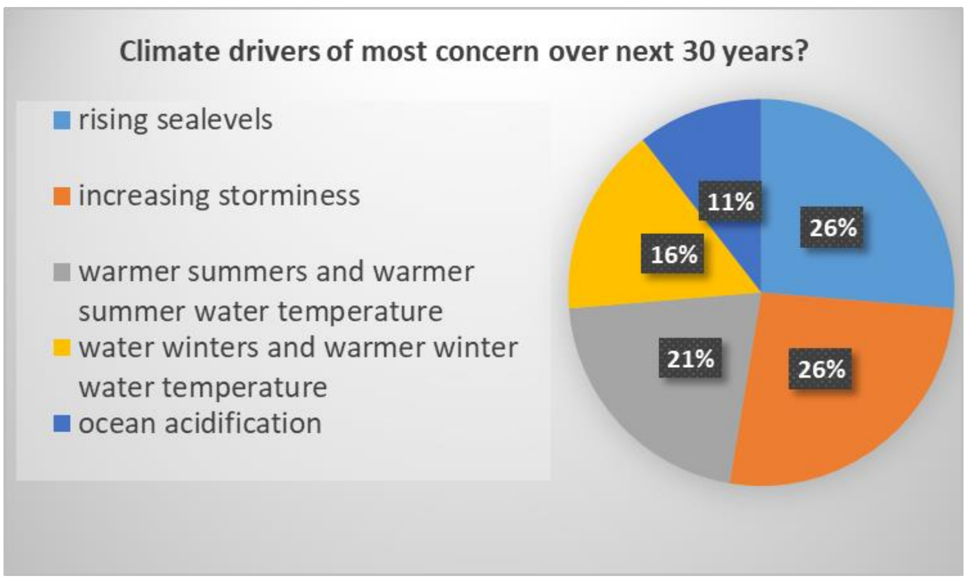
Poll Question 1: Which statement best describes your opinion?



Poll Question 2: What do you see as the main issues facing the water quality and living resources of Buzzards Bay and its watershed? Select up to 3.



Poll Question 3: Of the following climate stressors, which are you most concerned about for their potential impact on water quality and natural resources over the next 30 years? Select up to 3.



Appendix F: Climate Vulnerability Assessment Online Questionnaire

The Buzzards Bay Comprehensive Conservation and Management Plan (CCMP) identifies goals, objectives, actions, and approaches for government and the public to protect and restore water quality and living resources in Buzzards Bay and its surrounding watershed, (including freshwater systems). These strategies are contained in 21 Action Plans. The Buzzards Bay CCMP focuses on locally actionable actions, not global or national actions or policies.

The Buzzards Bay CCMP will be updated in 2023. As part of the CCMP update, the Buzzards Bay NEP must undertake a climate vulnerability assessment to determine how climate stressors might affect our collective ability to protect and restore water quality and natural resources in Buzzards Bay and its surrounding watershed. This vulnerability assessment will principally focus on the effects of climate stressors over the next thirty years. This preliminary questionnaire is meant to gauge the level of concern about which climate stressors are of the greatest concern to area residents, government managers, and non-profit partners. However, it is also important that we also receive input on the individual action plans.

When you are done with this questionnaire, please return to the Climate Vulnerability Assessment Overview page and select one of the Action Plans that either interest you, or represent an area of expertise, and rank specific vulnerabilities, or identify vulnerabilities we overlooked.

https://buzzardsbay.org/management-solutions/2022-climate-vulnerability-assessment/

* Required

About You

Do you reside in the Buzzards Bay watershed? *

Which best describes you in your responses to this questionnaire? *

- concerned person or resident business owner
- farmer or grower
- non-profit or land steward scientist
- local government
- regional or county government state government
- federal government

Age (optional): Less than 30 years old 30, or older

Overall threats to Buzzards Bay in Next 30 years (climate and non-climate issues)

In your opinion, what do you see as the three most important issues facing the * water quality and living resources of Buzzards Bay and its watershed over the next 30 years? Check all that apply.

- Nitrogen pollution Stormwater runoff Toxic pollution
- Bacterial contamination of beaches and shellfish beds Sea level rise
- Storm surge/damage Oil spills
- Low water levels for rivers, ponds, lakes, wetlands Loss/degradation of habitat
- Loss of open space for ecological integrity, especially for rare/endangered species Invasive and nuisance species
- Marine debris
- Changing water and air temperatures
- Other

Effects of climate on Buzzards Bay water quality and natural resources (bay and watershed) over the next 30 Years

How concerned are you are about warmer summers and warmer summer water temperature affecting water quality and natural resources?(Not concerned Highly Concerned, 1-5)

How concerned are you are about warmer winters and warmer winter water temperature affecting water quality and natural resources?(Not concerned Highly Concerned, 1-5)

How concerned are you are about summer drought affecting water quality and natural resources?(Not concerned Highly Concerned, 1-5)

How concerned are you about increasing storminess and increased precipitation affecting water quality and natural resources?(Not concerned Highly Concerned, 1-5)

How concerned are you about rising sea levels affecting water quality and natural resources?(Not concerned Highly Concerned, 1-5)

How concerned are you about ocean acidification affecting water quality and natural resources?(Not concerned Highly Concerned, 1-5)

What other climate stressors are you concerned about not included above?

How will climate related changes (sea level, temperature, precipitation, etc.) affect our ability to achieve the goals of Buzzards Bay Action Plans over the Next 30 Years?

Our ability to achieve the goals of each of the 21 Buzzards Bay CCMP Action Plans may or may not be affected by climate stressors over the next 30 years. Estimate those impacts below. (Don't Know, Hardly Affected, Moderately Affected, Greatly Affected)

1. Managing Nitrogen Sensitive Embayments (Goals: Prevent estuary degradation from excessive nitrogen inputs and Restore estuaries already degraded).

2. Protecting and Enhancing Shellfish Resources (Goals: Increase shellfish availability for recreational and commercial use, improve habitat to increase shellfish abundance, reduce the area of shellfish beds closed to pollution, and reopen closed areas).

3. Managing Stormwater Runoff and Promoting Low Impact Development (Goals: Prevent new or increased untreated stormwater flows to Buzzards Bay that would adversely affect shellfishing areas, swimming beaches, water quality, and wetlands. Treat stormwater discharges contributing to degradation. Encourage low impact development techniques to minimize impacts from stormwater).

4. Improving Land Use Management and Promoting Smart Growth (Goals: Improve land use management using smart growth strategies to maintain and improve the natural resources and ecology of Buzzards Bay.)

5. Managing Onsite Wastewater Disposal Systems (Goals: Prevent public health threats and environmental degradation from on-site wastewater disposal systems).

6. Managing Impacts from Boating, Marinas, and Moorings (Goals: Eliminate the discharge of wastewater from all boats in Buzzards Bay, minimize environmental impacts from marinas and mooring fields.)

7. Protecting and Restoring Wetlands (Goals: Protect existing wetlands and achieve a net long-term increase of high-quality wetlands.)

8. Restoring Migratory Fish Passage and Populations (Goals: Ensure that the migration of fish species between salt and fresh water is unimpeded. Restore degraded stream habitat, better manage fishing pressures on anadromous fish populations).

9. Protecting Bio-Diversity and Rare and Endangered Species Habitat (Goals: Conserve and protect vital fish and wildlife habitats of Buzzards Bay and in its surrounding watershed.)

10. Managing Water Withdrawals to Protect Wetlands, Habitat, and Water Supplies (Goals: Protect and preserve groundwater and surface water supplies in order to ensure a sustainable supply of high-quality drinking water. Protect and restore the natural flows of rivers and the natural waters of ponds, lakes, and wetlands and the habitat that depend on them. Maintain natural hydrology. Protect and preserve estuarine and brackish surface water habitats in river mixing zones.)

11. Managing Invasive and Nuisance Species (Goals: Minimize the potential introduction of new invasive and nuisance species. Reduce the extent and limit the spread of existing invasive and nuisance species that are degrading habitats of Buzzards Bay and its surrounding watershed.)

12. Protecting Open Space (Goal: Preserve the ecological integrity of Buzzards Bay and its watershed by increasing the amount of permanently protected open space.)

13. Protecting and Restoring Ponds and Streams (Goals: Prevent ecosystem degradation and loss of beneficial uses caused by pollution discharges, nuisance species, or alterations of flow to fresh surface waters in the Buzzards Bay watershed. Restore degraded ponds and streams.)

14. Reducing Beach Debris, Marine Floatables, and Litter in Wetlands (Goals: To ensure that

Buzzards Bay beaches, coastal waters, and inland wetlands habitat are clear of harmful and degrading levels of litter and debris.)

15. Managing Coastal Watersheets, Tidelands, and the Waterfront (Goals: Manage the uses and activities in the waters and on the tidelands of Buzzards Bay in an integrated manner using sound assessments of natural resources, habitat, and water quality, to ensure sustainable recreational and commercial activities while protecting and improving ecosystem health and values. Ensure that the effects of dredging activities are minimized on water quality, physical processes, marine productivity, and public health, and that the beneficial use of dredged sediments is maximized.)

16. Reducing Toxic Pollution (Goals: Protect public health and the bay ecosystem from the effects of toxic contamination and toxic pollutant discharges.)

17. Preventing Oil Pollution (Goals: Reduce the amount of petroleum hydrocarbons released to Buzzards Bay. Prevent oil spills in Buzzards Bay, both large and small.)

18. Planning for a Shifting Shoreline and Coastal Storms (Goals: Protect public health and safety associated with coastal hazards including rising sea level, shifting shorelines, and damage from storms and storm surge. Reduce the public financial burden caused by the destruction of or damage to coastal property. Plan for shifting shorelines and the inland migration of buffering wetlands and shifting sand formations, and the species that utilize these habitats.)

19. Protecting Public Health at Swimming Beaches (Goal: Reduce or eliminate pollution sources contributing to beach closures.)

20. Monitoring Management Action, Status, and Trends (Goals: Document environmental trends of water quality and living resources in order to assess the effectiveness of management actions taken, or identify the need for new actions. Identify research and monitoring needs to understand more clearly the causes of impairments, reduce uncertainties about health risks, and better define conditions in Buzzards Bay.)

21. Enhancing Public Education and Participation (Goals: Expand the public's knowledge of the natural resources and water quality of Buzzards Bay and surrounding watershed and the threats they face. Increase public participation in actions that support the goals, objectives, and recommendations in the Buzzards Bay CCMP.)

Which Action Plan do you think will be most affected or difficult to achieve because of climate ?

- Managing Nitrogen Sensitive Embayments Protecting and Enhancing Shellfish Resources
- Managing Stormwater Runoff and Promoting Low Impact Development
- Improving Land Use Management and Promoting Smart Growth
- Managing Onsite Wastewater Disposal Systems
- Managing Impacts from Boating, Marinas, and Moorings
- Protecting and Restoring Wetlands

- Restoring Migratory Fish Passage and Populations
- Protecting Bio-Diversity and Rare and Endangered Species Habitat
- Managing Water Withdrawals to Protect Wetlands, Habitat, and Water Supplies
- Managing Invasive and Nuisance Species
- Protecting Open Space
- Protecting and Restoring Ponds and Streams
- Reducing Beach Debris, Marine Floatables, and Litter in Wetlands
- Managing Coastal Watersheets, Tidelands, and the Waterfront
- Reducing Toxic Pollution
- Preventing Oil Pollution
- Planning for a Shifting Shoreline and Coastal Storms
- Protecting Public Health at Swimming Beaches
- Monitoring Management Action, Status, and Trends
- Enhancing Public Education and Participation

Impediments to action

(Don't Know, Not or Hardly Important, Moderately Important, Greatly Important)

How important is the lack of local monitoring data an impediment to taking action?

How important is the lack of public understanding an impediment to taking action?

How important is elected official leadership an impediment to taking action?

How important are costs or adequate funding an impediment to taking action?

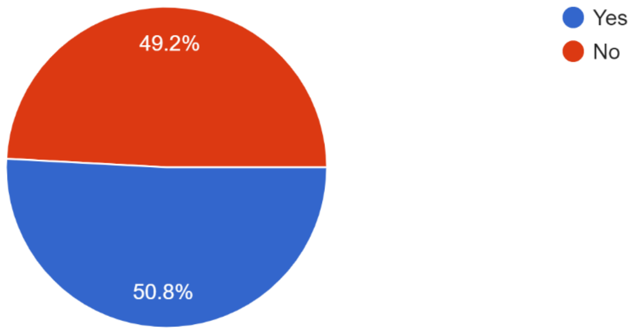
Are there other impediments we should consider?

Any other comments or suggestions about our climate vulnerability assessment?

Appendix G: Responses to the online questionnaire

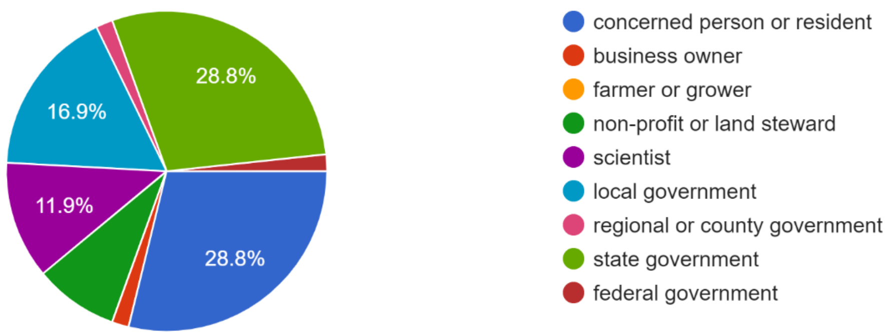
Do you reside in the Buzzards Bay watershed?

59 responses



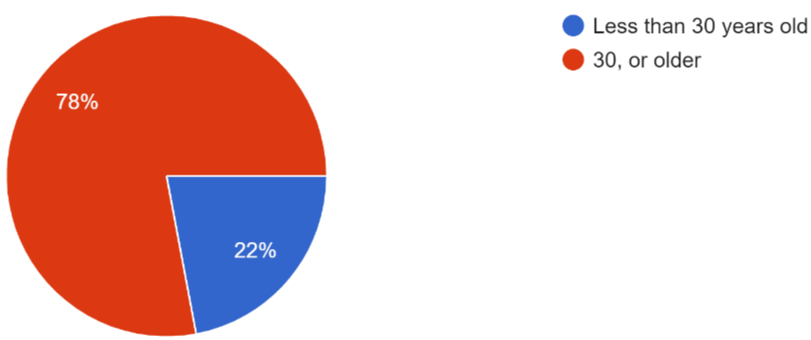
Which best describes you in your responses to this questionnaire?

59 responses



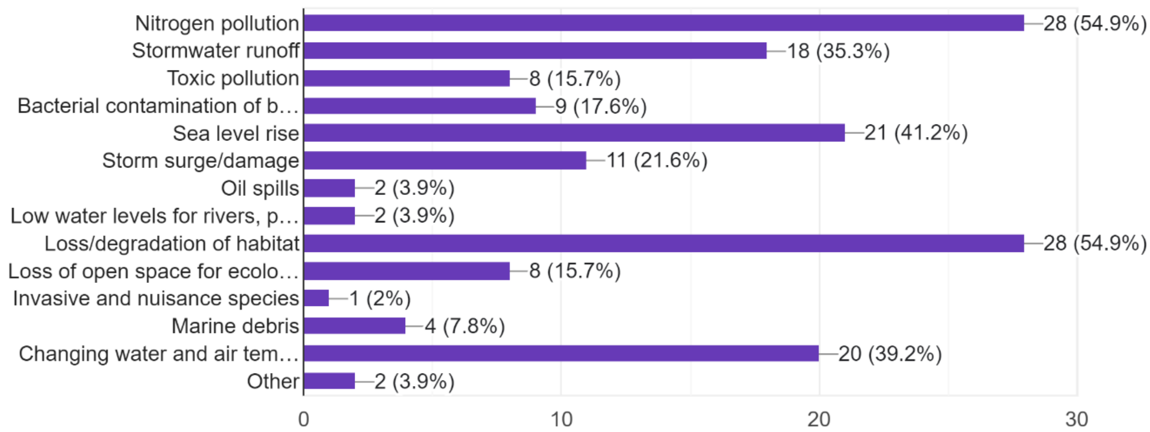
Age (optional)

59 responses



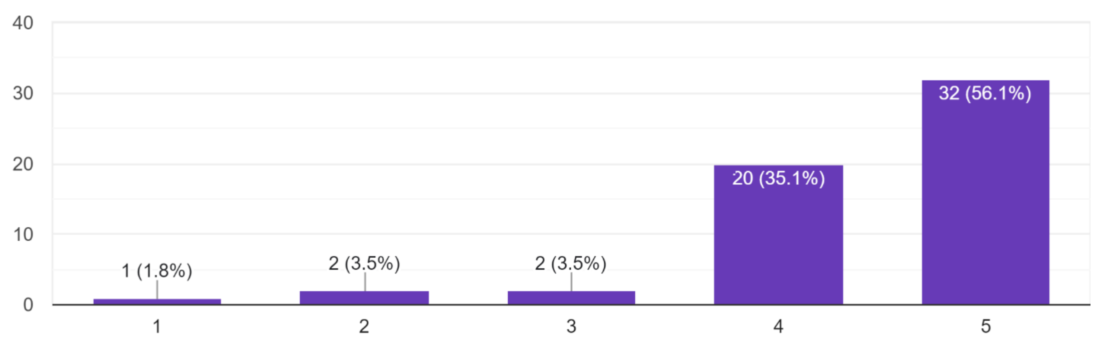
In your opinion, what do you see as the three most important issues facing the water quality and living resources of Buzzards Bay and its watershed over the next 30 years?

51 responses



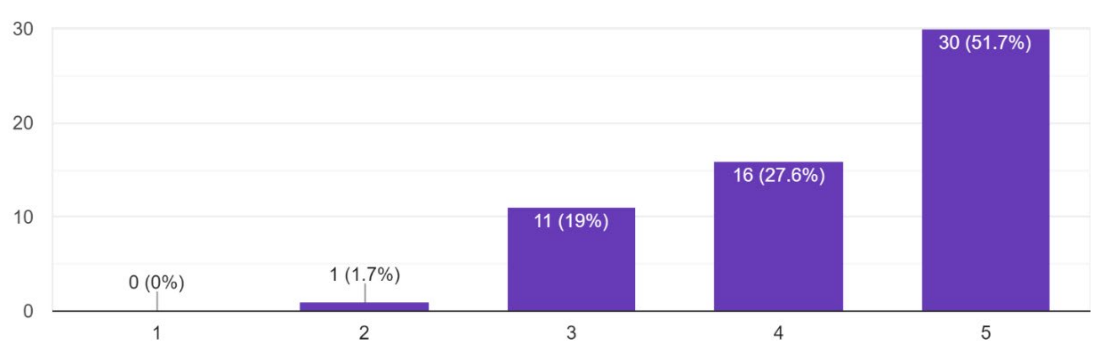
How concerned are you are about warmer summers and warmer summer water temperature affecting water quality and natural resources?

57 responses

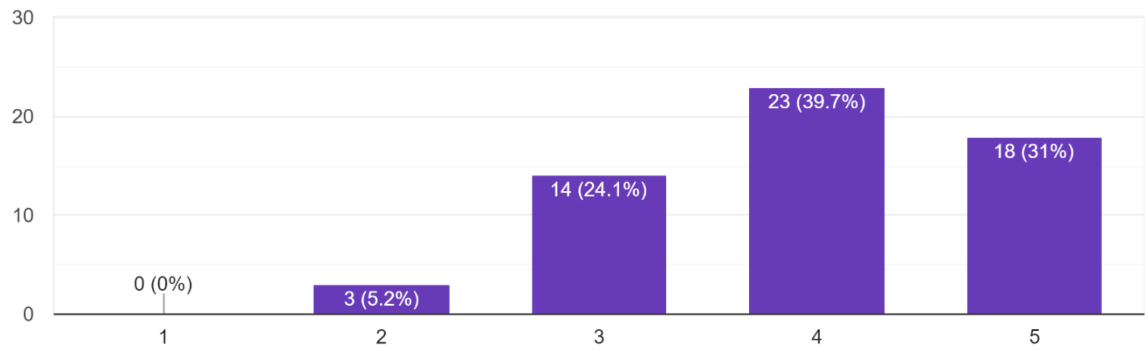


How concerned are you are about warmer winters and warmer winter water temperature affecting water quality and natural resources?

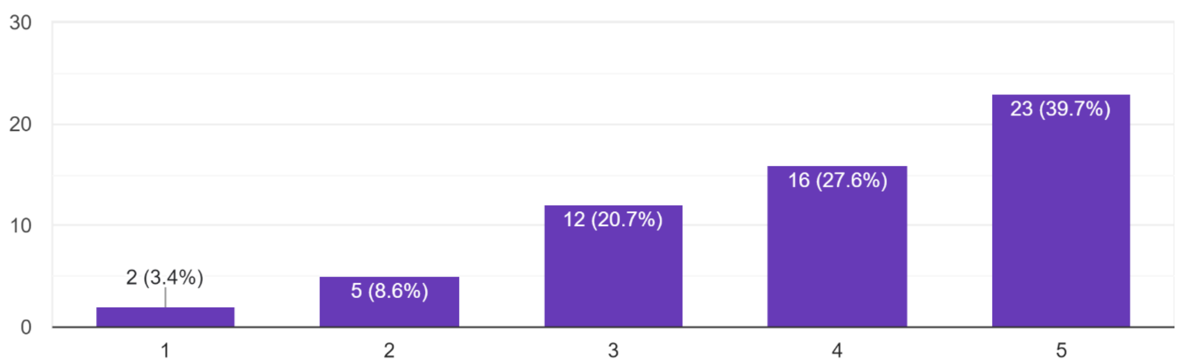
58 responses



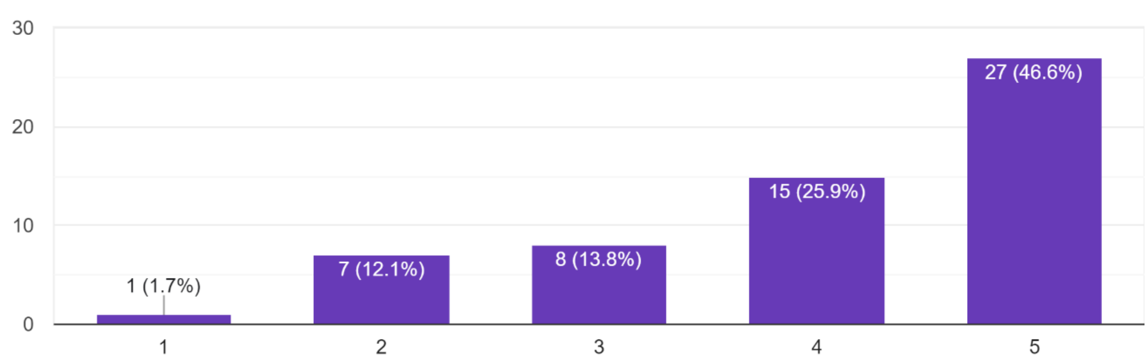
How concerned are you are about summer drought affecting water quality and natural resources?
58 responses



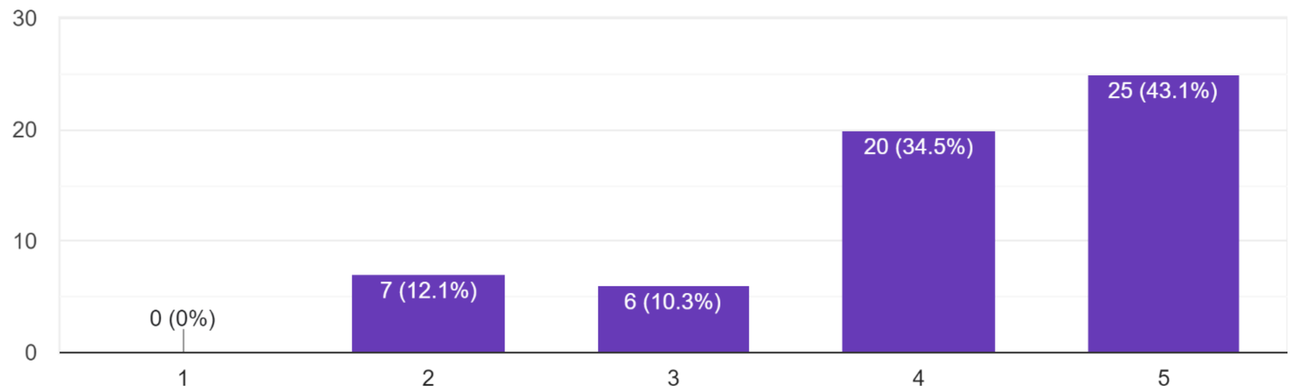
How concerned are you about increasing storminess and increased precipitation affecting water quality and natural resources?
58 responses



How concerned are you about rising sea levels affecting water quality and natural resources?
58 responses



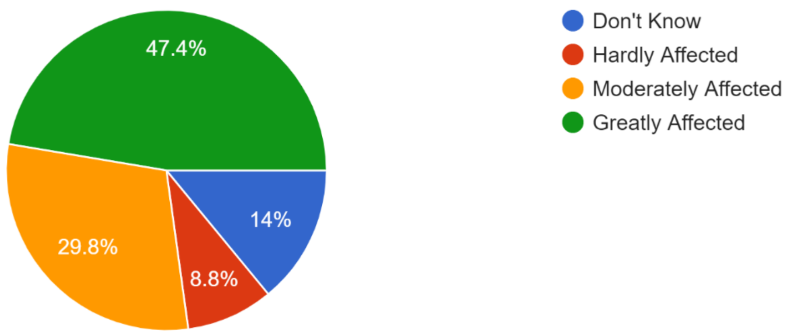
How concerned are you about ocean acidification affecting water quality and natural resources?
58 responses



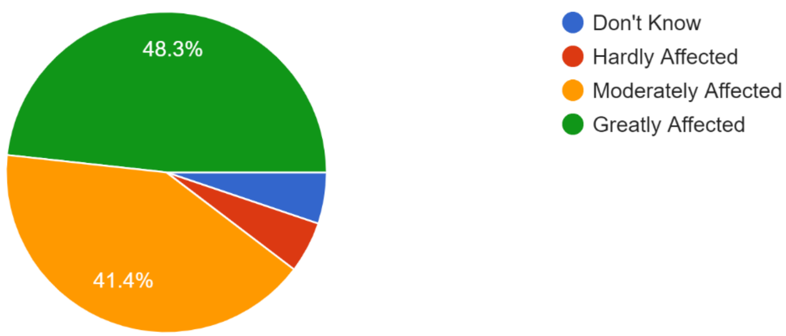
What other climate stressors are you concerned about not included above?
24 responses

- Increased precipitation
- Battle between nature & private landowners trying to protect homes having long term impacts on shoreline.
- Diseases and pathogens from warmer climate. -Health impacts on Children -wildfire
- All of them.
- 19,000,000 gallons per week of process water discharged to the Acushnet River by P.J. Keating
- Continuing coastal development
- Not just storminess, but big precip events causing flooding (inundating areas, various pollutants entering system)
- Invasive species
- Possible forest fires
- eutrophication
- Changes in the location and velocity of the Gulf Stream and Labrador Current and how they affect the availability of appropriate ocean conditions for marine life recruitment throughout the Northeast.
- Runoff from local marinas
- Length of seasons
- Virginian Zonal conditions extending north into the Boreal Zonation.
- Coastal Storm Damage and Habitat Loss due to Coastal Storm Damage
- Flooding, saltwater intrusion, storm surges from more extreme weather events and erosion from that.
- Storm water floods in Falmouth- civil life and commerce affected. Roads closed from flooding
- Effects of climate change on fisheries management & protection of North Atlantic right whales
- Inland flooding associated with increased precipitation and rising groundwater levels.
- wastewater damaging our environment
- Armored shoreline, beach erosion and depletion and lack of uniform policies about traditional indigenous access rights to shorelines, waterways, and other resources.
- Coastal development
- Socioeconomic consequences of climate emergency on coastal communities (i.e. Economic Multiplier Effect or shifts in ecosystem services/natural capital)
- The towns allowing construction abutting salt marshes.
- Loss of saltmarshes

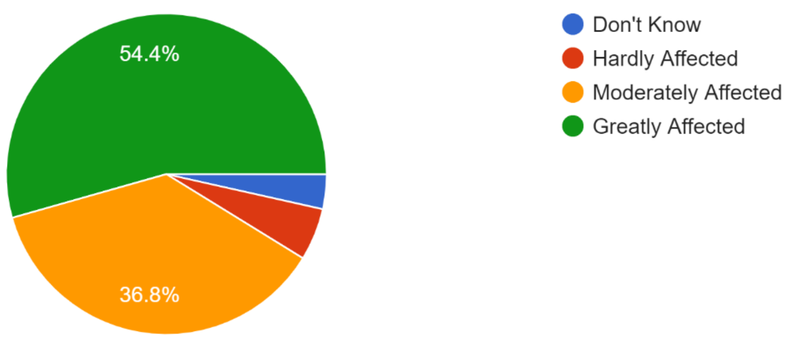
1. Managing Nitrogen Sensitive Embayments (Goals: Prevent estuary degradation from excessive nitrogen inputs and Restore estuaries already degraded).
57 responses



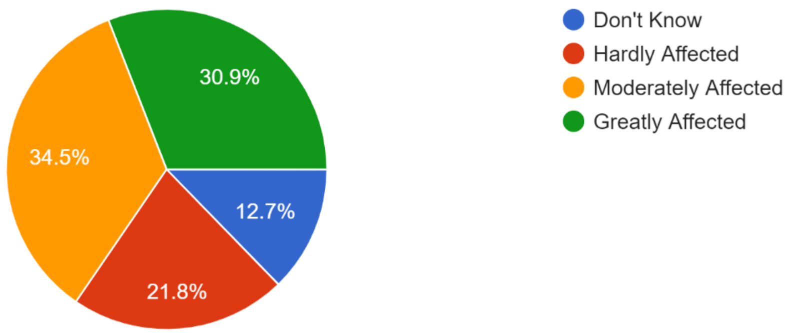
2. Protecting and Enhancing Shellfish Resources (Goals: Increase shellfish availability for recreational and commercial use, improve habitat t...eds closed to pollution, and reopen closed areas).
58 responses



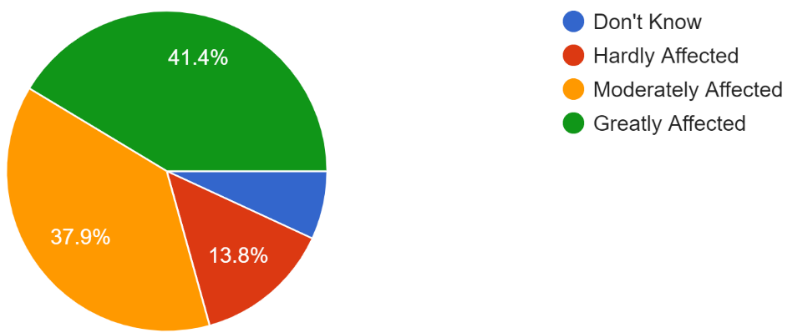
3. Managing Stormwater Runoff and Promoting Low Impact Development (Goals: Prevent new or increased untreated stormwater flows to Buzzards...echniques to minimize impacts from stormwater).
57 responses



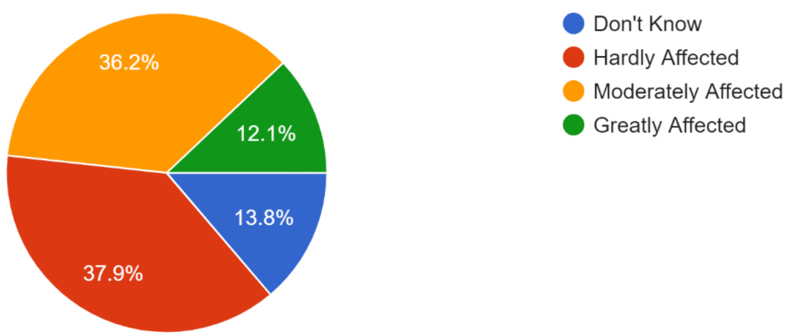
4. Improving Land Use Management and Promoting Smart Growth (Goals: Improve land use management using smart growth strategies to main...natural resources and ecology of Buzzards Bay.)
55 responses



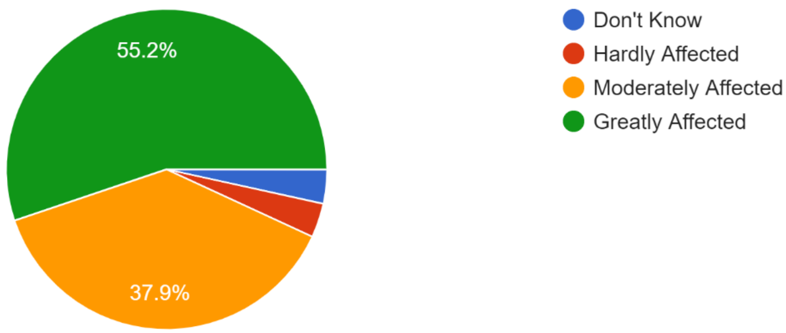
5. Managing Onsite Wastewater Disposal Systems (Goals: Prevent public health threats and environmental degradation from on-site wastewater disposal systems).
58 responses



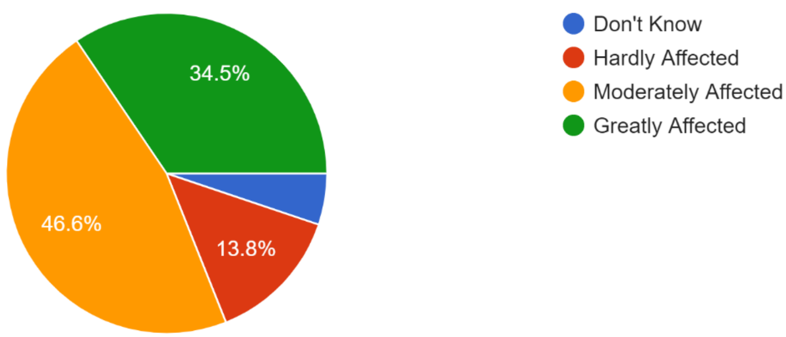
6. Managing Impacts from Boating, Marinas, and Moorings (Goals: Eliminate the discharge of wastewater from all boats in Buzzards Bay, minimi...mental impacts from marinas and mooring fields.)
58 responses



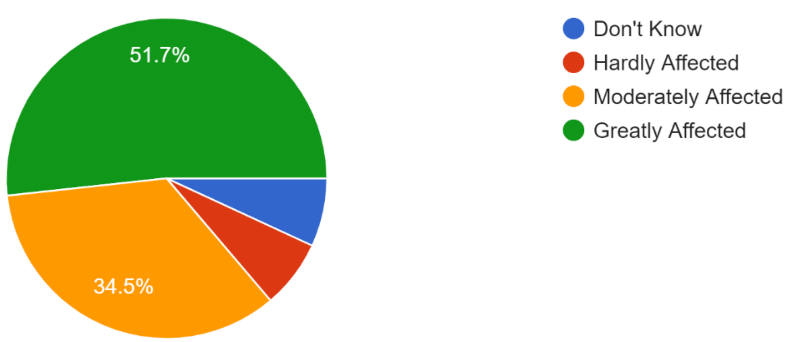
7. Protecting and Restoring Wetlands (Goals: Protect existing wetlands and achieve a net long-term increase of high-quality wetlands.)
58 responses



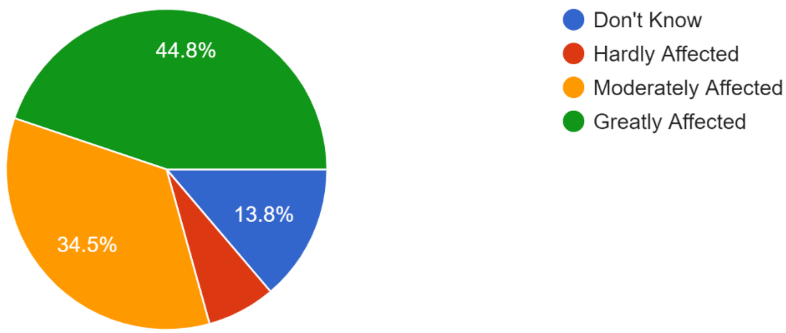
8. Restoring Migratory Fish Passage and Populations (Goals: Ensure that the migration of fish species between salt and fresh water is unimpede...shing pressures on anadromous fish populations).
58 responses



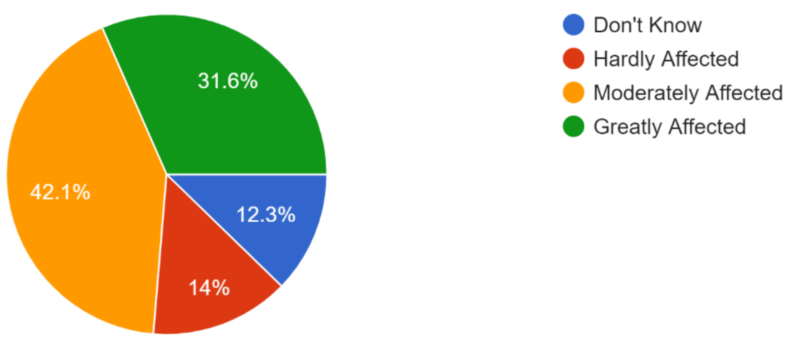
9. Protecting Bio-Diversity and Rare and Endangered Species Habitat (Goals: Conserve and protect vital fish and wildlife habitats of Buzzards Bay and in its surrounding watershed.)
58 responses



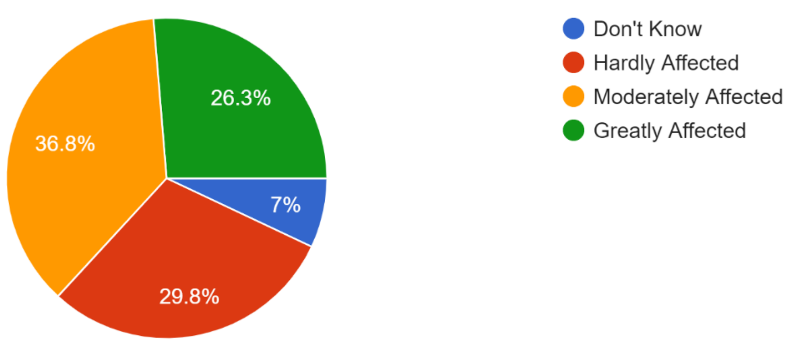
10. Managing Water Withdrawals to Protect Wetlands, Habitat, and Water Supplies (Goals: Protect and preserve groundwater and surface water suppli...sh surface water habitats in river mixing zones.)
58 responses



11. Managing Invasive and Nuisance Species (Goals: Minimize the potential introduction of new invasive and nuisance species. Reduce the extent ...s of Buzzards Bay and its surrounding watershed.)
57 responses



12. Protecting Open Space (Goal: Preserve the ecological integrity of Buzzards Bay and its watershed by increasing the amount of permanently protected open space.)
57 responses



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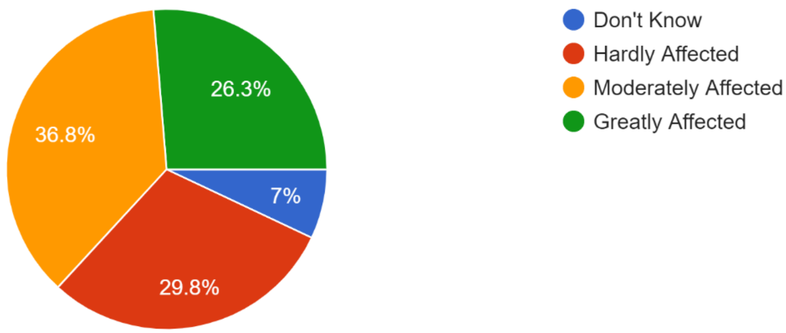
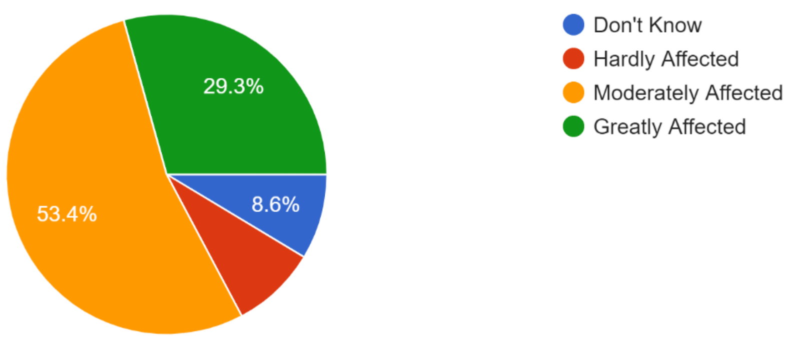
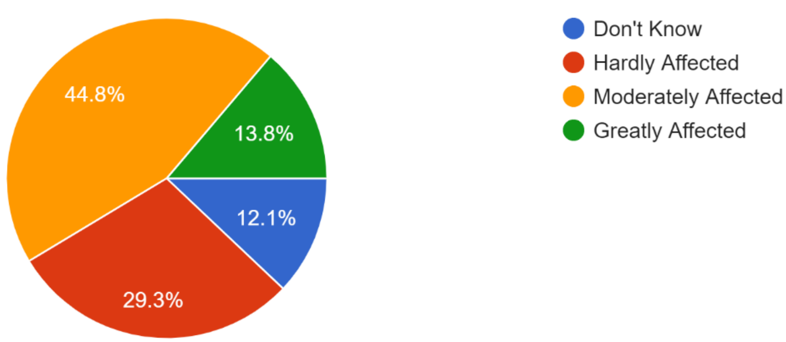


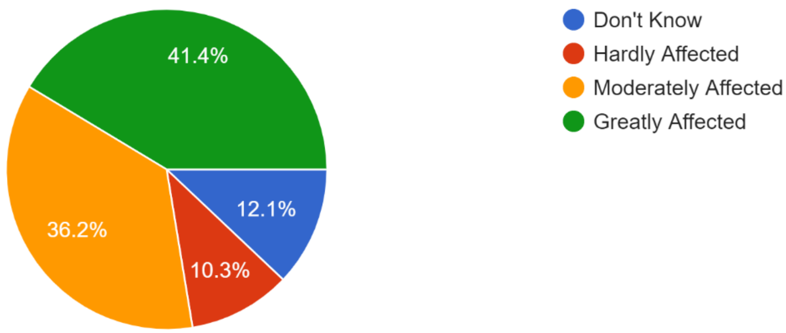
13. Protecting and Restoring Ponds and Streams (Goals: Prevent ecosystem degradation and loss of beneficial uses caused by pollution discharges... watershed. Restore degraded ponds and streams.)
58 responses



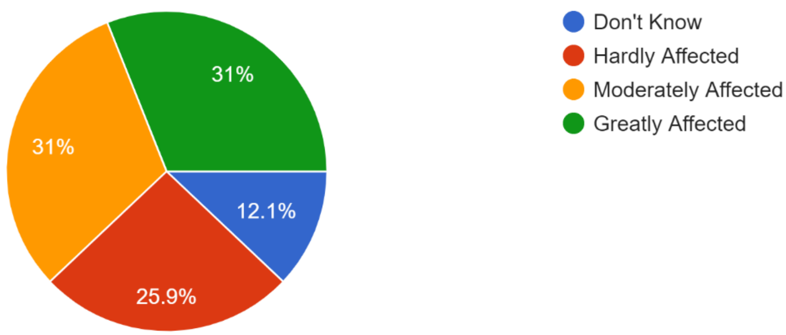
14. Reducing Beach Debris, Marine Floatables, and Litter in Wetlands (Goals: To ensure that Buzzards Bay beaches, coastal waters, and inland w...armful and degrading levels of litter and debris.)
58 responses



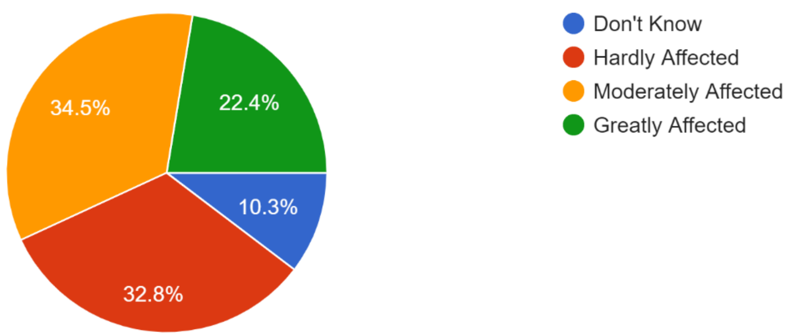
15. Managing Coastal Watersheets, Tidelands, and the Waterfront (Goals: Manage the uses and activities in the waters and on the tidelands of B...beneficial use of dredged sediments is maximized.)
58 responses



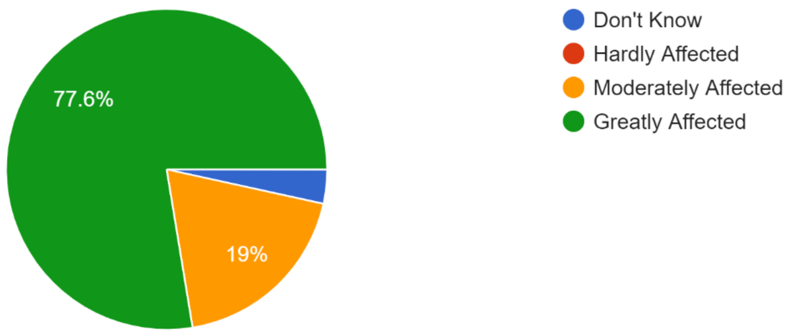
16. Reducing Toxic Pollution (Goals: Protect public health and the bay ecosystem from the effects of toxic contamination and toxic pollutant discharges.)
58 responses



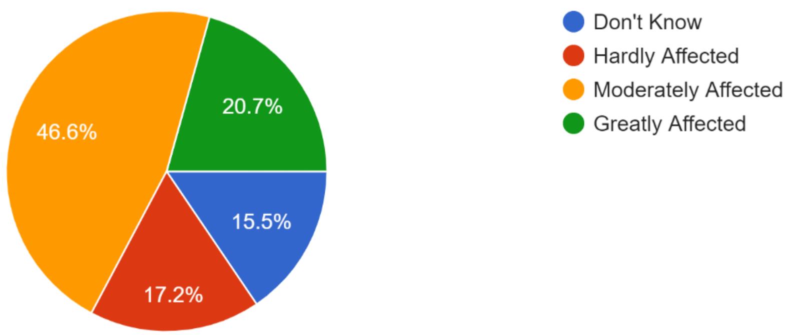
17. Preventing Oil Pollution (Goals: Reduce the amount of petroleum hydrocarbons released to Buzzards Bay. Prevent oil spills in Buzzards Bay, both large and small.)
58 responses



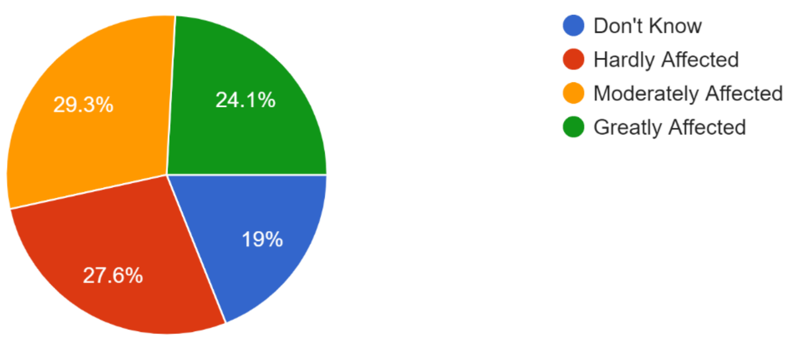
18. Planning for a Shifting Shoreline and Coastal Storms (Goals: Protect public health and safety associated with coastal hazards including rising sea...ions, and the species that utilize these habitats.)
58 responses



19. Protecting Public Health at Swimming Beaches (Goal: Reduce or eliminate pollution sources contributing to beach closures.)
58 responses

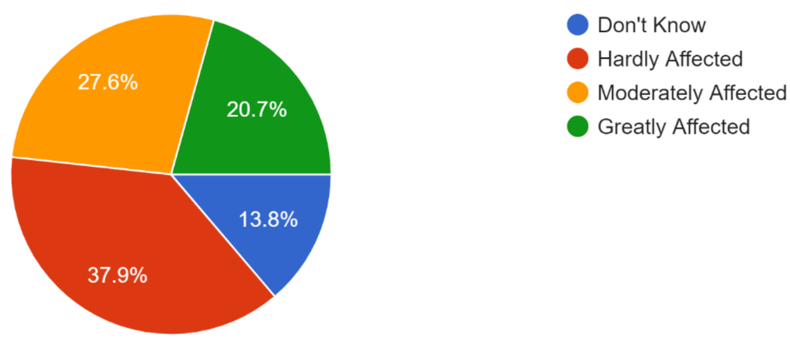


20. Monitoring Management Action, Status, and Trends (Goals: Document environmental trends of water quality and living resources in order to asse...sks, and better define conditions in Buzzards Bay.)
58 responses



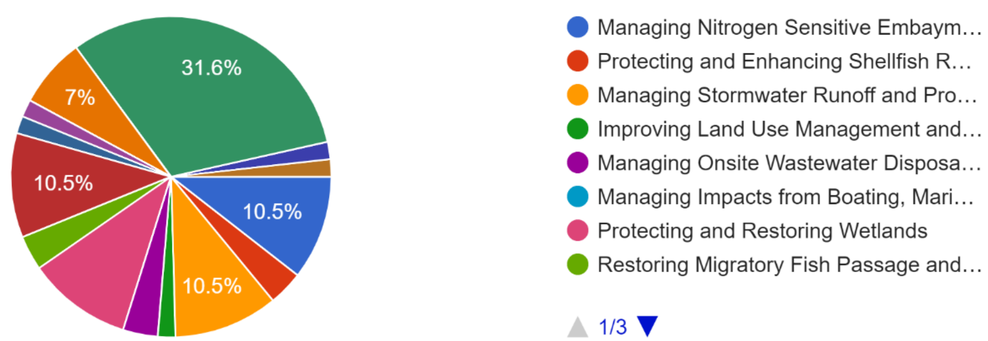
21. Enhancing Public Education and Participation (Goals: Expand the public's knowledge of the natural resources and water quality of Buzzards ..., and recommendations in the Buzzards Bay CCMP.)

58 responses



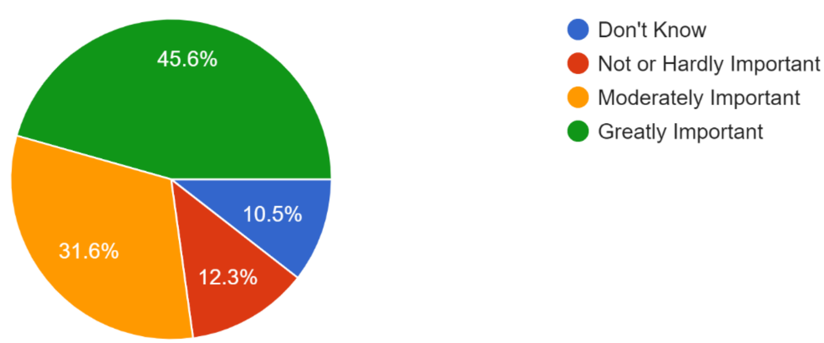
Which Action Plan do you think will be most affected or difficult to achieve because of climate ?

57 responses

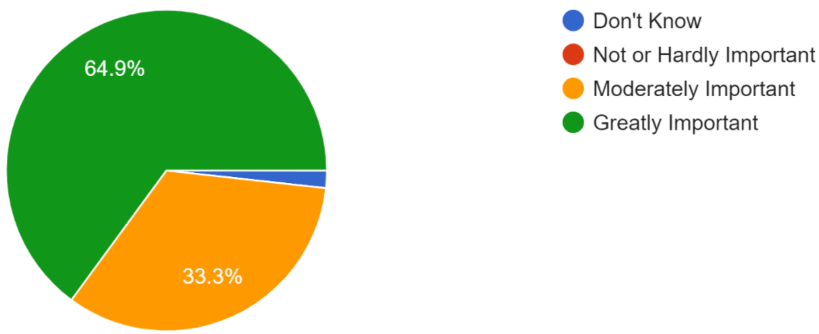


How important is the lack of local monitoring data an impediment to taking action?

57 responses



How important is the lack of public understanding an impediment to taking action?
57 responses



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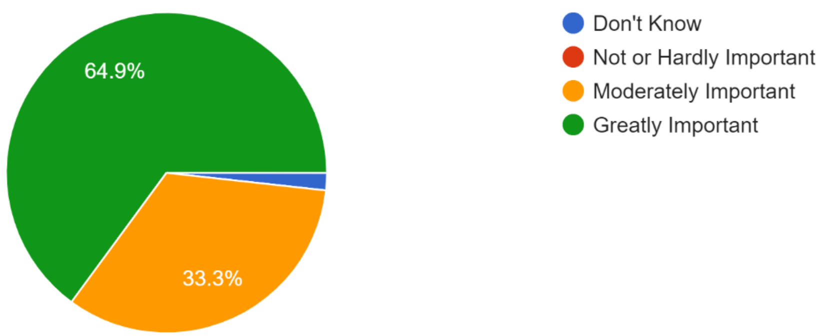
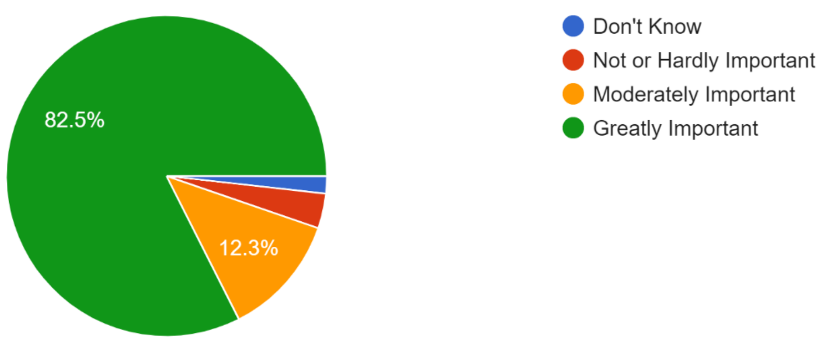
57 responses



How important are costs or adequate funding an impediment to taking action?
57 responses



Are there other impediments we should consider?

- Political pressure from waterfront landowners
- The sociocultural understandings of climate change
- MDEP and EPA need to get back out in the field!
- All the plans in the world are useless without accompanying funding. Nothing is impossible to the person (group) who doesn't have to pay for it.
- Lack of caring about natural resources and their perceived lack of importance.
- Local capacity for implementation of programs and projects
- Other priorities taking over public attention
- Not sure
- No
- Practicality given the current context of the Coastal Watershed of Buzzards Bay.
- Generally, public opinion. Literally, how do people *feel* in the new climate?
- Lack of socioeconomic indicators like the Economic Multiplier Effect in coastal economies from environmental actions
- Sufficient staff support
- Lack of uniform policies to protect resources over and above monetary and self interests
- The socioeconomic benefits and support of cultural values of diverse populations is critical to public engagement and support fort addressing climate vulnerability. Science and monitoring have to be converted into information products useful to diverse constituent groups
- Bureaucracy, apathy
- Need for local champions and municipal climate coordinating committees

Any other comments or suggestions about our climate vulnerability assessment?

- Need to consider Ecological Economics tools and Scenario Planning approaches for evaluating the climate emergency
- My first impression is that most of these assessment criteria fall into an interdependent system and need to be considers as a whole, not as individual issues, because they influence one another.
- You might want to consider the East Coast Climate Scenario Analysis webinars which included: oceanography; marine biology and socioeconomic factors. The MIMES/MIDAS modeling framework might be a good support tool.
- It seems pretty comprehensive, there is a lot of overlap between the concerns.