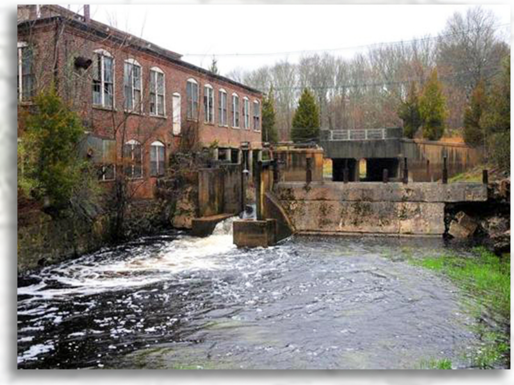
Bridgewater
MASSACHUSETTS



MUNICIPAL VULNERABILITY PREPAREDNESS (MVP) PLAN

SUBMITTED BY

GREEN INTERNATIONAL AFFILIATES, INC.
Civil and Structural Engineers

June, 2019

Building Strong Client Relationships Through Engineering Excellence

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EXECUTIVE SUMMARY

In September 2016, Governor Baker issued ***Executive Order No. 569 (EO 569), Establishing an Integrated Climate Change Strategy for the Commonwealth***. Under EO 569, the Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA) created the Municipal Vulnerability Preparedness (MVP) grant program, which provides support for cities and towns in Massachusetts to plan for resiliency and implement key climate change adaptation actions for resiliency. EO 569 was codified under the Environmental Bond Bill in 2018. The EOEEA grants require that MVP Plans be developed under the guidance of MVP certified providers who are trained to provide technical assistance to communities using the Community Resilience Building Framework. Bridgewater was awarded an MVP Grant to develop a resiliency plan and retained the services of Green International Affiliates, Inc. Green's Executive Vice President, Peter A. Richardson, P.E., CFM, and Project Manager, Danielle Spicer, P.E., are both certified MVP Providers. Mr. Richardson served as the lead facilitator at the required workshops.

The Town of Bridgewater recognizes its potential vulnerability and the importance of developing climate change preparedness plans and building resilience against the risks and hazards associated with climate change. Its location relative to the Atlantic Ocean is a key factor in its vulnerability. Bridgewater is located is within 30 miles of the eastern and southern Massachusetts coasts. This proximity causes the Town to experience major wind events (e.g., nor'easters and hurricanes). It is also located within the Taunton River Watershed, the longest undammed River in the New England. Every major road entering Bridgewater requires a bridge or culvert crossing either within the Town or in the abutting Town. Bridgewater's topography and geologic history has created many streams, wetlands, ponds, and lakes giving rise, in part, to its name.

For the development of this MVP Plan, the Town followed the Community Resilience Building (CRB) Framework and assembled an MVP Core Team. A Kick-off Meeting was held on November 29, 2018 and at the Kick-off meeting, the MVP Core Team established initial MVP Plan goals. Following the CRB Guidelines, the Town held two (2) ½-day, 4-hour workshops, for the development of the plan. The two (2) ½-day workshops were held on February 14, 2019 and February 21, 2019, respectively.

The Goals for the MVP Plan developed by the Core Team and the workshop participants during the first workshop are as follows:

Goals for Bridgewater's MVP Plan

1. Identify Climate Change Vulnerabilities, considering Infrastructural, Societal and Environmental factors and Develop Action Steps to build the Town's Resilience to extreme weather-related conditions in the future based on EOEEA climate change projections.

2. Develop an MVP Plan that satisfies the requirements of the MA EOEEA, such that it receives approval and makes the Town Eligible for Future MVP Action Grants

3. Develop an MVP Plan that compliments and builds upon the Town's previous conservation, recreation and revitalization efforts (existing Capital Improvement Plan, Bridgewater's Branding & Wayfinding Committee, Bridgewater Community Preservation Committee/CPA Plan, Comprehensive Master Plan Committee, Energy Committee, etc.).

4. Develop an MVP Plan that Minimizes Infrastructure Impacts from flood and other weather-related hazards

5. Develop an MVP plan that will encourage the Review and Upgrade of Bridgewater's current Zoning Regulations to prevent damage from flooding, current and future

6. Develop an MVP Plan that improves Stormwater Management (SWM) in Bridgewater

7. Review Emergency Management Plan with regards to potential hazards and vulnerable areas in Town, associated with climate change

8. Develop an MVP Plan that will help Control Waterborne Diseases, resulting from potential increased precipitation and flooding.

9. Develop an MVP Plan that will Promote Reduction of Bridgewater's Carbon Footprint

10. Include Public Education Program on potential Climate Change Impacts in Bridgewater's MVP Plan.

The first workshop also focused on identifying the Town's top hazards and vulnerabilities, as well as the Town's strengths and weaknesses. At the first workshop, participants determined that the top four natural hazards that need to be considered relative to future climate change projections are:

- Flooding
- Wind (including Blizzards/Nor'easters etc.)
- Winter Storms/Extreme Cold
- Drought/Extreme Heat.

In addition, the participants at the first workshop identified vulnerable areas in Town and the Town's strengths (and assets) under three categories, infrastructural, societal and environmental in light of climate change.

During the second workshop, participants focused on developing action steps that the Town should take to become more resilient to projected climate change conditions. The workshop participants developed specific action steps and prioritized the most vulnerable locations in Town to include them in the MVP plan. A list of Prioritized Action Steps is included below and in Section VI of this report.

An important finding to come out of the two workshops was that for the Town to truly know its vulnerability to climate change relative to the most significant natural hazard identified through the workshops (i.e. Flooding), hydrologic and hydraulic analyses of the Taunton River watershed based on projected climate change (rainfall) data is required. Updated flood maps prepared by the Federal Emergency Management Agency (FEMA) as part of the FEMA Countrywide Flood Insurance Study of July 17, 2012 and the July 16, 2015 Narragansett Watershed Study (prepared by US Geological Survey for FEMA) are intended to depict the current flood risk for the Taunton River, Town River, Matfield River, parts of Sawmill Brook, South Brook, Snows Brook, but these studies do not consider climate change. However, the updated FEMA hydraulic computer model(s) developed by FEMA for the Taunton River watershed can be requested by the Town and used to develop new hydrologic and hydraulic analyses of future conditions.

The workshop participants worked diligently to identify multiple areas of concern related to climate change and its possible effects on the Town of Bridgewater, from the state of current regulations and ordinances, to energy sources and communication and education issues, related to climate change and building the Town's resilience. Once the Town's MVP Plan is approved by EOEEA, Town of Bridgewater will be eligible for future MVP grants.

Recommended Action Steps to Improve Resiliency to Climate Change in Bridgewater

As a result of the Community Building Resilience workshops for Bridgewater, the action steps were reviewed and developed. The action steps have been prioritized in Table 1 below as follows:

High MVP Priority
Medium MVP Priority
Low MVP Priority

Table 1: Recommended Action Steps to Improve Resiliency to Climate Change in Bridgewater

PROJECT NO.	MITIGATION ACTION	TIMEFRAME	RESPONSIBLE ORGANIZATION	POTENTIAL FUNDING SOURCE	ESTIMATED COST
1	**Obtain Effective hydraulic computer models from FEMA and develop Town-wide Hydrologic and Hydraulic (H&H) models based on UMass climate change (CC) projections for the 2050's and 2090's.**	2019	Engineering	MVP Action Grant*	$25,000-$50,000
2	Develop a CC Resiliency Action Plan for the Wastewater Treatment Plant (WWTP) based on results of Project No. 1	2020	Wastewater	MVP Action Grant	$15,000
3	Develop a CC Resiliency Action Plan for the Town's water supply wells and treatment facilities based on results of Project No. 1	2020	Water	MVP Action Grant	$20,000
4	Review and update the Town's Stormwater Ordinance relative to CC Projections	2020	Planning	MVP Action Grant	$10,000
5	Review and update zoning requirements to address CC Resiliency	2020	Planning	MVP Action Grant	$10,000
6	Purchase and Install an emergency generator at the Senior Center and develop an Emergency Back-up Power Plan for other public facilities that serve vulnerable populations.	2019	Emergency Management	MVP Action Grant	$25,000
7	Develop a Town-wide emergency transport and food supply emergency action plan for vulnerable populations	2019	Emergency Management	MVP Action Grant	$10,000
8	Develop a Culvert and Bridge Improvement Master Plan based on results of Projects No. 1 and No.10	2020	DPW	MVP Action Grant	$50,000

Project No.	Mitigation Action	Timeframe	Responsible Organization	Potential Funding Source	Estimated Cost
9	High Street Dam Removal and Bridge Replacement	2020	DPW	Federal & MVP Action Grant	$2,000,000
10	Review Town evacuation plans and update emergency instructions for evacuation (incorporate them in Branding & Wayfinding strategy) based on CC projections and results of Project No. 1	2019	Emergency Management	MVP Action Grant	$10,000
11	Improve public safety and emergency communication abilities with vulnerable population centers	2020	Emergency Management	MVP Action Grant	$50,000
12	Develop a CC Resiliency Action Plan that incorporates nature-based solutions for Town parks and recreational areas.	2021	Planning, Conservation and Roadways	MVP Action Grant	$25,000
13	Update a Hazard Tree Removal and Replacement plan (including the old pine plantation and Town forest)	2021	Planning and Conservation	MVP Action Grant	$25,000
14	Protect agricultural land -Continue to implement Open Space and Recreation Plan 2017	2021	Planning and Conservation	MVP Action Grant	(see Open Space & Rec Plan)
15	Establish a Flood Plain and Stormwater Management Public Education Program based on results of Project No. 1.	2021	Planning and Conservation	MVP Action Grant	$10,000
16	Develop a public education program for vulnerable populations relative to climate change, its effects and ways to build social resiliency.	2021	Planning and Emergency Management	MVP Action Grant	$7,500
17	Develop a Landlord/Owner Communication Plan for multi-unit rental properties (3-family and up) to establish direct lines of communication for natural hazard emergencies	2021	Emergency Management	MVP Action Grant	$25,000

* MVP Action Grants typically include a Town cost share commitment of 25%

REPORT CITATION, WORKSHOP PARTICIPANTS, AND ACKNOWLEDGEMENTS

Report Citation: Town of Bridgewater Municipal Vulnerability Preparedness (MVP) Plan and Summary of Findings, prepared by Peter A. Richardson, P.E., LEED AP, ENV SP, CFM, Executive Vice President, and Danielle Spicer, P.E., LEED AP, ENV SP, Senior Project Manager, of Green International Affiliates, Inc.

Workshop Participants:

Workshop Number 1 – February 14, 2019	**Workshop Number 2 – February 21, 2019**
MVP Provider & Lead facilitator: Peter Richardson MVP Provider & Workshop facilitator: Danielle Spicer MVP Workshop facilitator: Oxana Fartushnaya Town Manager: Michael Dutton Town Engineer: Azu Etoniru Assistant Town Planner: Elijah Romulus Natural Resource Conservationist: Kitty Doherty Bridgewater Master Plan: Carlton Hunt Bridgewater State University, Environmental Health and Safety: Patricia Delaney Town Clerk: Marilee Kenney Hunt Health Department: Eric Badger Highway Department: Paul Decosta Town of Bridgewater: Sandra M. Wright Inspector of Buildings/Zoning Enforcement Officer: Steven Solari	MVP Provider & Lead facilitator: Peter Richardson MVP Provider & Workshop facilitator: Danielle Spicer MVP Workshop facilitator: Oxana Fartushnaya Town Manager: Michael Dutton Town Engineer: Azu Etoniru Assistant Town Planner: Elijah Romulus Natural Resource Conservationist: Kitty Doherty Bridgewater Master Plan: Carlton Hunt Town Clerk: Marilee Kenney Hunt Police Department: Carl MacDermott III Fire Department: Tom Levy Elder Affairs: Lorraine Carrozza Inspector of Buildings/Zoning Enforcement Officer: Steven Solari PK Boston Law/Real Estate Development: Rob Pellegrini Bridgewater Community and Economic Development Director: Jennifer Burke Downtown Revitalization Ad Hoc Committee: Frank Sousa Citizen of Bridgewater: Eileen Hiney

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Harry Bailey - Conservation Commission/Taunton River Stewardship Council
Paul Tappen - Columbia Gas
Ron Ladue - Roadways Superintendent
Carl MacDermott, III - Lt., Police Dept.
Marilyn MacDonald – Chair, Conservation Commission
Thomas Levy – Chief, Fire Dept.
Michael Dutton – Town Manager

I. OVERVIEW

EXECUTIVE ORDER 569

In September 2016, Governor Baker issued Executive Order No. 569 (EO 569), Establishing an Integrated Climate Change Strategy for the Commonwealth. The executive order is based on the following Administration's findings:

- Climate change and extreme weather events present a serious threat to the environment, residents, communities, public safety, property, and the Commonwealth's economy.
- The Global Warming Solutions Act (GWSA) calls for certain steps to reduce greenhouse gas (GHG) emissions limits and prepare for the impacts of climate change for 2020 and 2050, but no interim limits for 2030 and 2040.
- The Commonwealth can provide leadership by reducing its own emissions from state operations, planning and preparing for impending climate change, and enhancing the resiliency.
- The transportation sector continues to be a significant contributor to GHG emissions and is the only sector identified in the GWSA with a volumetric increase in GHG emissions.
- The generation and consumption of energy continues to be a significant contributor to GHG emissions in the Commonwealth, and there is significant potential for reducing emissions through continued diversification of our energy supply and adoption of a comprehensive energy plan.
- State agencies and authorities, as well as cities and towns, must prepare for the impacts of climate change by assessing vulnerability and adopting strategies to increase the adaptive capacity and resiliency of infrastructure and other assets.
- The Executive Office of Public Safety and Security and its constituent agencies, including the Massachusetts Emergency Management Agency, have deep institutional expertise in preparing for, responding to, and mitigating damage from natural hazards.
- Only through an integrated strategy bringing together all parts of state and local government will Massachusetts be able to address these threats effectively.

EO 569 was made law in 2018 as part of the Environmental Bond Bill.

MUNICIPAL VULNERABILITY PREPAREDNESS (MVP) GRANT PROGRAM

The Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA - https://www.mass.gov/orgs/executive-office-of-energy-and-environmental-affairs) created the position of Assistant Secretary of Climate Change and appointed Katie Theoharides as Assistant Secretary. Under Katie's leadership, EOEEA also created the Municipal Vulnerability Preparedness (MVP) grant program. The following excerpt taken from the EOEEA website (https://www.mass.gov/service-details/mvp-program-information) describes the purpose of the MVP grant program:

The Municipal Vulnerability Preparedness grant program (MVP) provides support for cities and towns in Massachusetts to plan for resiliency and implement key climate change adaptation actions for resiliency. The state awards communities with funding to complete vulnerability assessments and develop action-oriented resiliency plans. The program helps communities to:

- Define extreme weather and natural and climate related hazards
- Understand how their community may be impacted by climate change with a Massachusetts specific climate change clearinghouse with the latest science and data: link to http://www.resilientma.org/
- Identify existing and future vulnerabilities and strengths
- Develop and prioritize actions for the community

- Identify opportunities to take action to reduce risk and build resilience
- Implement key actions identified through the planning process

MVP certified providers are trained in workshops across the state to provide technical assistance to communities in completing the assessment and resiliency plan using the Community Resilience Building Framework. Towns and cities will then be able to choose the provider of their choice from a list of certified providers. Communities who complete the MVP program become certified as an MVP community and are eligible for MVP Action grant funding and other opportunities.

COMMUNITY RESILIENCE BUILDING FRAMEWORK

Under the MVP Program, Massachusetts communities will prepare MVP Plans for their community using a proven, workshop-based model developed by The Nature Conservancy (TNC), called the Community Resilience Building Framework (https://www.communityresiliencebuilding.com/). Under the MVP Grant program, the MVP Plan development must be led by a certified MVP Provider. Bridgewater retained the services of Green International Affiliates, Inc., whose Executive Vice President, Peter A. Richardson, P.E., CFM, and Project Manager, Danielle Spicer, P.E. are both certified MVP Providers. Mr. Richardson served as the lead facilitator for the project.

OTHER RECENT MITIGATION DEVELOPMENTS

In 2005, the National Institute of Building Sciences (NIBS) Multi-hazard Mitigation Council released a study, entitled Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities, which determined that for every $1 of natural hazard mitigation funded by the Federal Emergency Management Agency (FEMA) between 1993 and 2003, the country avoided $4 in future losses from natural disasters. Towards the end of last year, the NIBS released a 2017 Interim Report that shows that investing in mitigation has resulted in an even greater benefit than was previously determined in the 2005 study. The 2017 interim report found that for Federal Mitigation Grants, there is a $6 benefit or savings for every $1 spent.

The 2017 study also found that where more stringent codes are used, there is a $4 benefit or savings for every $1 spent. The 2017 NIBS Interim report looked at number of disaster types, including floods, wind, earthquakes and wildfires, and all of them have a positive benefit cost ratio for mitigation investment. In particular, flood mitigation had the highest benefit cost ratio (7:1). The full 2017 NIBS study can be found at https://www.nibs.org/page/mitigationsaves.

Since the 2005 NIBS report was released, the US has experienced several devastating disasters, including major hurricanes (i.e. Katrina, Sandy, Harvey, Irma, and Maria) and the extensive wildfires in California. Funding for mitigation projects has decreased even though the benefits of mitigation have been clearly known for some time. As a result of not being more proactive, the United States is now looking at some of the highest collective losses from natural disasters in our nation’s history.

While Massachusetts evaluates its vulnerability to climate change through the Governor’s EO 569 - Establishing an Integrated Climate Change Strategy for the Commonwealth, increased investment in flood mitigation would be an obvious cost-effective strategy, especially when considering the new B/C ratio of 7:1 from the NIBS 2017 study.

Multiplying Probability by Consequences is a simple way to estimate Risk. New 2018 climate change data from the Northeast Climate Science Center at the University of Massachusetts indicates an increase in the probability of more extreme weather events that will cause more flooding. Bridgewater should consider its vulnerability (i.e. Risk) relative to future flooding probabilities. Considering the residential/commercial development occurring in future flood-prone areas (i.e. increased consequences), Bridgewater is likely increasing its risk unless it offsets these two risk factors with more proactive mitigation efforts.

TOWN OF BRIDGEWATER'S SUSTAINABILITY AND RESILIENCY EFFORTS

When the Town became aware of the MVP Program, developing an MVP Plan was the next logical step in Bridgewater's planning efforts, and as such, the Town applied for and received a grant from the Commonwealth to develop an MVP Plan.

Town of Bridgewater adopted the Old Colony Hazard Mitigation Plan (OCHMP) on October 6, 2015, as part of the 15 active communities within the Old Colony Region. Old colony Planning Council (OCPC) collected and analyzed natural hazard data from local officials, such as emergency managers, planners, public work personnel, police and fire departments, building inspector and health agents. The Goals and Actions within this plan were developed as local vulnerabilities were identified and concerns were being raised by emergency responders and local officials. The regional goal of the OCHMP is to "reduce the loss of life, property, infrastructure, and environmental and cultural resources from natural disaster"[13 (see End Notes on pg. 37 (TYP))].

Town of Bridgewater has taken steps towards preserving it's natural open space by adopting a Community Preservation Act (CPA) as a mechanism to preserve open space, historic properties and affordable housing initiatives. In addition, the Town's Open Space Committee assists in evaluating opportunities to acquire open space to preserve Bridgewater's character, protect water resources, provide public access to recreational land and preserve important wildlife habitat, among other tasks.

The Town has also established an Energy Committee that is responsible for town's energy conservation efforts and promoting renewable energy.

In addition, the Town of Bridgewater engaged Weston & Sampson to complete a 2017 Comprehensive Water Management Plan (CWMP). The plan has identified areas in Town for infrastructure investments and improvements.

Another ongoing effort in Bridgewater, that is largely discussed in Open Space and Recreation Plan 2017, is to stem the loss of farmland to development. As an effort to preserve remaining farmland, since the year of 2000 the Town purchased the Hogg Farm, historic Keith Homestead and Farm on the shores of Lake Nippenicket and adjacent land, acquired a Conservation Restriction to protect the Murray-Needs farm on North Street. Additionally, the Town of Bridgewater enrolled approximately 352 acres of Town's land in state Chapter 61B (Open Space and Recreational Land) state program, approximately 847 acres – in Chapter 61A (Farmland) program[9]. In addition, there are approximately 220 acres of private agricultural land currently enrolled in the state Chapter 61A program[2]. The Chapter 61B program is one of three current use tax programs (Ch. 61–forestry, 61A–agriculture, 61B–open space and recreational land use) that give landowners an opportunity to reduce their property taxes in exchange for providing their community with many public benefits, such as clean water, wildlife habitat, rural character, and local food and wood products.

Bridgewater residents and Town officials recognize the importance of the Town's location within the Taunton River watershed and the natural hazards associated with it, especially potential flood damage. Majority of the major access roads into and out of the Town are via bridges over the Taunton River, the Town River or the Matfield River, which could present problems if flood elevations increase in the future.

TOWN PROFILE, GEOGRAPHY AND HISTORY

(Information in this section has been adapted from the Old Bridgewater Historical Society Bridgewater Timeline and History (https://www.oldbridgewater.org), US Census Bureau, Bridgewater Open Space and Recreation Plan 2017)

The Town of Bridgewater is a 27.2 square mile growing residential, suburban community in Plymouth County, located along the Taunton River and several other rivers and brooks that feed into the Taunton River's main stem. Located approximately 25 miles south of Boston and 35 miles east of Providence, Rhode Island, the Town is bordered by the Towns of West Bridgewater from the northwest, East Bridgewater from the northeast, Raynham from the west, Halifax from the east and Middleborough from the south[1]. Bridgewater had a total population of 27,478 as of July 1, 2017, according to the US Census Bureau.

Bridgewater was incorporated as a Town in 1656, having earlier been the Plymouth Colony. The earliest known human residents were the Wampanoag Indians and then the Pilgrims who landed at Plymouth Rock and began the settlement of Plymouth, Massachusetts, also known as Plymouth Colony, in the fall of 1620.

In the 1600's, residents relied on marshlands for agriculture, peat and hatch. This area of land was initially called "Duxburrow New Plantation", and on June 3, 1656 the general court of Massachusetts incorporated Duxburrow New Plantation, also known as Duxbury Plantation, to establish Bridgewater, Massachusetts[1]. The Town boundaries included what is now known as West and East Bridgewater, present day Bridgewater and Brockton (formerly known as North Bridgewater).

In the 1800's and beginning of 1900s, the Town's economy was largely dependent on iron work factories, one of which, Bridgewater Iron Works, is a nationally registered historical industrial site. The Town also had multiple paper mills, saw mills, and a boot & shoe factory. The old boot & shoe factory no longer manufactures shoes, it still houses numerous businesses and storage units to this day. Bridgewater still has numerous iron works companies still in business[1].

The Old Colony Correctional Center, Bridgewater State Hospital, and the Bridgewater Teacher's College (present day the Bridgewater State University) were driving the economic growth in Town in the mid-1900s.

Agriculture, the dairy industry, and scattered long-term industries drove Bridgewater's growth in the 20th Century. Late in the 20th century, agriculture declined with reduced profitability and rising land values for development[2].

Bridgewater retains some of its historic character and unique landscape of its early industrial and agricultural heritage, that are prominent throughout the community, particularly in the downtown central common area. Home to one of the premiere public schools in Massachusetts, Bridgewater State University was founded in 1840, offering a variety of programs. Bridgewater maintains a caring, friendly, small-town, community atmosphere[2].

RIVERS, LAKES AND PONDS

(Information in this section has been adapted from the Bridgewater Open Space and Recreation Plan 2017, Nunckatessett Greenway Project (http://www.nunckatessettgreenway.org/explore/bridgewater), The Taunton River Wild & Scenic Stewardship Council (http://www.tauntonriver.org/), The Taunton River Watershed Alliance (http://savethetaunton.org/), Massachusetts Division of Ecological Restoration (https://www.mass.gov/news/high-street-dam-removal-feasibility-study-bridgewater), Massachusetts Department of Conservation and Recreation (https://www.mass.gov/service-details/hockomock-swamp-acec)

Bridgewater is located in one of the most historically and ecologically significant river systems in the region. The 562 square miles Taunton River Watershed is the second largest watershed in Massachusetts and is home to 38 cities and towns. It is also one of the most diverse and intact coastal riverine ecosystems in southeastern New England. Taunton River is a natural treasure of southeastern Massachusetts, which recently received a national Wild & Scenic River Designation.[4]

According to *the Taunton Wild & Scenic River Stewardship Council*, historically, it played a central role in battles between the Native American Wampanoag people and the English settlers. During the 1800's and early 1900's, the Taunton River provided power to a variety of industries in the region, including prosperous herring industry, paper mills, grist mills and timber mills. Even though the Upper Taunton River is considered to be an urban river, yet it is "abundant with many species of fish, vegetation and wildlife. It is also considered an undiscovered gem by many canoeing and kayaking enthusiasts" [4].

The Taunton River originates at the junction of the Town and Matfield Rivers in Bridgewater and flows northerly – northwesterly to the mouth of the Quequechan River in Fall River. The resulting Taunton River essentially wraps around Bridgewater forming its eastern and southern boundaries. Taunton River and its major tributaries, Matfield and Town Rivers, within the Town of Bridgewater contribute to groundwater supply at the Town wells, and during the dry season groundwater is replenished by stream flow[2].

Other Bridgewater's water resources include Hockomock Swamp and adjacent Lake Nippenickett, which were designated as the largest freshwater wetland system in the State in 1990 - the Hocomock Swamp Area of Critical Environmental Concern; Titicut Swamp, Carver's Pond with its surrounding wetlands; Hockomock River, Town River, multiple streams (Snows Brook, Sawmitt Brook, Beaver Brook, Spring Brook), small ponds, flood areas and multiple wetlands are also present and playing an important role in the Town's life and economic development.

The largest of the Town's lakes and ponds include Nippenickett Lake, Carver's Pond and Nunkets Pond. Most of the land in Bridgewater, MA has been formed by a variety of glacial deposits. These include two major aquifers that underlie the entire Town center in a continuous layer of freshwater. The 35-acre Carver's Pond is part of the recharge area above one of those aquifers in which turn supports 5 wells as part of the Town water supply. The surrounding wetlands help to clean the surface water, therefore improving water quality in the aquifer below[3].

Bridgewater has a wetlands ordinance that extends local jurisdiction beyond state and federal wetland regulations and further restricts development in wetland areas. Protecting wetlands is an essential component to mitigating flood risk. Wetlands provide a habitat for wildlife and they also serve as a space to absorb surface water. Impacting wetlands with development can negatively impact the groundwater level.

GOVERNMENT

An Open Town Meeting, led by a Board of Selectmen, was the form of Government in the Town of Bridgewater until 2011. It is now led by seven Precinct Councilors and two "at-large councilors" for a total of nine Councilors, with an appointed Town Manager, Assessor, Tax Collector/Treasurer. The Town Clerk and Library Trustees are also elected. Bridgewater is one of thirteen Massachusetts municipalities that have been granted city forms of government but wish to remain being called "The Town of" in their official names.

WATER SUPPLY

(Information in this section has been adapted from the Bridgewater Water Department Annual Water Quality Report (January 2017 – December 2017) and the Bridgewater Open Space and Recreation Plan 2017)

Bridgewater's water supply comes from groundwater sources that are located in 3 aquifers. The first aquifer supports 4 wells located on High Street near the Matfield River, the second aquifer - 5 wells located near Carver's Pond, and the third aquifer contains 2 wells located on Plymouth Street. "The wells range in depth from 40-60 feet and are constructed in the sand and gravel deposits over a bedrock. The water is delivered to customers through approximately 130 miles of water mains ranging in size from 2-16 inches"[8].

The Town's Water Department has an ownership of over 50 acres of land at Carver's Pond, over 18 acres on High Street and about 20 acres on Plymouth Street to protect Bridgewater's water sources. In addition, the Town has 2 storage tanks with a total capacity of 4.7 million gallons to help maintain system-wide pressure while also providing water during peak demands and fire emergencies[8].

Mass DEP has completed a Source Water Assessment and Protection (SWAP) Report for Town's water supply system in 2003. A susceptibility (to potential contamination by microbiological pathogens and chemicals) ranking of "high" was assigned to the system[8].

SWAP report recommendation included public education, partnering with local businesses to ensure proper storage, handling and disposal of hazardous wastes, monitoring progress on any remedial actions at known contamination sites, developing wellhead protection plan. Source protection is a key element in providing good quality water.

HISTORICAL PROPERTIES

(Information in this section has been adapted from the Bridgewater Open Space and Recreation Plan 2017 and the Massachusetts Cultural Resource Information System (MACRIS) database)

Bridgewater currently has 378 historic resources documented at the MA Cultural Resource Information System database[2]. Bridgewater Industrial/Transportation Corridor located in the northwestern part of Town bordering West Bridgewater includes the Stanley Iron Works district associated with the factory and its buildings on High Street and the Stanley Works Dam, also known as the Town River Dam. Both the Stanley Iron Works and the McElwain School are included on the National Register of Historic Places.

The Town of Bridgewater also has a local Bridgewater Center Historic District that was established by the Town in 2001. This area, according to the Massachusetts Historical Commission, "has been the focus of Bridgewater political, religious, educational, commercial, and social life since early 18th century." Located in this district, Bridgewater Academy Building, Bridgewater Memorial Library, First Trinitarian Congregational Church, Bridgewater Hotel, First Parish Church, New Jerusalem Church among other locally recognized historic places were mentioned by the participants of the workshop on numerous occasions with regards to identifying Bridgewater's strengths and vulnerabilities. Forty-nine of the Town's historic resources were constructed in the 18th century.

PARKS AND RECREATION

(Information in this section has been adapted from the Bridgewater Open Space and Recreation Plan 2017, Nunckatessett Greenway Project (http://www.nunckatessettgreenway.org/explore/bridgewater) and the Wildlands Trust(https://wildlandstrust.org/great-river-preserve))

The Town of Bridgewater is very involved in preserving open space and providing passive and active recreational opportunities for the Town's residents and visitors. Conservation restrictions (held by state, local and non-profit organizations) cover many of the Town's open spaces especially along the Taunton River on the east and NIP area (Lake Nippenicket) on the west side of the Town.

Taunton River itself is a major recreational resource, offering fishing, swimming and kayaking. It is a nationally-designated Wild and Scenic River with outstanding natural cultural, and recreational values, keeping them in free-flowing condition for the enjoyment of present and future generations[2].

Bridgewater's recreation facilities and open spaces are spread throughout the Town, such that the Town's population has easy access to recreational resources. Bridgewater's lakes and ponds offer recreation opportunities including fishing, boating, and skating. The following list represents some of these assets:

- Lake Nippenicket is a shallow 500-acre lake, located in the northeastern area of the Town, that provides recreational opportunities, including boating and fishing (no swimming).
- Carver's Pond is the Town's major water supply and 35-acre conservation area, surrounded by land and paths that allow passive recreational use, such as boating and hiking.
- Skeeter Mill Pond, located downstream from Carver's Pond, has fishing access and benches, provided by property owners for public use.
- Titicut Park in the southern part of Bridgewater provides access to the Taunton River and seasonal camping. The area has been studied for native American history and is considered to have been inhabited by the first people for many centuries. It is also located on the tidal section of the Taunton River and has a history of boat construction and launching in the early 1800's.
- Crescent Street fields and Marathon Park are widely used for recreation purposes.
- Stanley Iron Works Park is also listed in the Town recreational interests providing picnicking and hiking opportunities, with a possibility to add a carry-in boat launch.
- Town River Landing site is a part of former Highway Department yard, that provides boat launch access to the Town River from Spring Street
- Stiles and Hart Conservation Area is currently open for passive recreation, but the Town is interested in reviewing some opportunities for adding canoe landing, a foot bridge and parking to increase recreational use of the area.
- Tuckerwood Conservation Area, located in a quiet residential neighborhood, provides great opportunity for hiking along the 2,000 square feet of river frontage[2].
- 35-acre Wyman Meadow is also listed as one the Town's protected riverside properties. It currently offers passive recreation, providing access to trails and the Taunton River. The site also houses a Town Well field.
- Great River Preserve is yet another recent effort of the Wildlands Trust and the Massachusetts Department of Fish and Game, who acquired around 230 acres along the upper Taunton River in Bridgewater. The Preserve provides public access for walking and nature study of the pristine river frontage along one of the most scenic and undisturbed stretches of the entire Taunton River[12].

In addition, Bridgewater is a member of the Bay Circuit Trail project, which connects over 50 communities by the 100-mile Trail, that originated with a concept of having an arc of parks and conservation land linked by continuous trails, waterways, and scenic drives from the North Shore to Duxbury Bay. The Bay Circuit Trail within Bridgewater extends alone the Town River from West Bridgewater into Bridgewater and includes the Stanley Iron Works Park on the Town River[2]. efforts are underway to provide wayfinding and connections to the Styles and Hart Park and hiking trails on Bridgewater State University property[2]. . Nunckatessett Greenway is a part of the Bay Circuit Trail, and it provides recreational, environmental, social, and educational opportunities, while also stimulating economic activity in Bridgewater[3].

The Parks and Recreation Department also maintains the Legion Field Park (baseball/softball fields, basketball court, football field, playground, soccer field), Scotland Field Park (baseball/softball field, basketball court and playground), the Olde Scotland Links (a public golf course in Bridgewater) and Crescent Street Fields (girls' softball fields).

II. SUMMARY OF FINDINGS

Following the Community Resilience Building (CRB) Framework, the Town assembled an MVP Core Team and held a Kick-off Meeting on November 29, 2018. At the Kick-off meeting, the MVP Core Team decided to conduct the two (2) ½-day, 4-hour workshop approach, as opposed to holding one (1) full-day, 8-hour work shop. The two ½-day workshops were held February 14, 2019 and February 21, 2019, respectively.

The MVP Core Team developed a list of potential workshop participants and determined materials necessary for successful workshops. A public notice describing the workshops was posted on the Town's website and published in two newspaper articles about the MVP process, one in *The Bridgewater Independent* on January 29, 2019 and another one in *The Enterprise* on January 30, 2019. The articles included workshops announcement with the workshop dates and contact details for anyone interested to being involved.

The first workshop focused on identifying the goals for the Town's MVP plan, identifying the top hazards and vulnerabilities, as well as the Town's strengths and weaknesses in light of climate change and its visual effects. Based on the results of the first workshop, the second workshop focused on developing action steps to increase the Town's Climate Change resiliency.

Refer to Appendix A for list of workshop attendees, meeting notes, presentations and copies of matrices and work maps.

TOP HAZARDS AND VULNERABLE AREAS FOR BRIDGEWATER

The first workshop on February 14, 2019 opened with a presentation explaining the MVP Process. The participants were asked to identify and discuss the Town's previous mitigation efforts, if any. Climate change projections developed by Northeast Climate Science Center at the University of Massachusetts Amherst were also presented. These primarily focused on increased average temperatures, increased precipitation and potentially sea level rise in southern part of Bridgewater. GIS mapping based on TNC's CRB process and templates graphically presented the UMass climate change projections, Workshop participants were then separated into two groups to review and discuss the information. The groups were instructed to determine what they considered the top four hazards facing the Town.

TOP FOUR NATURAL HAZARDS FOR BRIDGEWATER TO CONSIDER AS A RESULT OF CLIMATE CHANGE PROJECTIONS

The results from each group were compared and found to be similar. An open discussion of the participants developed consensus on the following top four natural hazards:

1. **Flooding:** The participants agreed that the number one natural hazard for the Town is flooding and has been for decades. The Town's location along the major Taunton River watershed and its tributaries along with multiple wetland areas and high ground water table, makes Bridgewater highly vulnerable to flooding, especially in the vicinity of several bridges, other roadway features crossing intermittent streams, and streets with poor drainage. It was determined that flooding issues will only be exacerbated by climate change.

2. **Wind (including Nor'easters, tornados, etc.):** The workshop participants agreed that Bridgewater's location makes it susceptible to destructive effects of strong winds, especially tornados, hurricanes and nor'easters. They felt that wind-related events including those during the winter have caused power outages and fallen tree damage previously and anticipated these hazards becoming more extreme in the future with climate change.

3. **<u>Winter Storms/Extreme Cold:</u>** Winter storms and extreme cold temperatures were considered a great natural hazard in Bridgewater. Given the climate change scenarios provided during the workshop, the participants concluded winter storms with heavy wet snow and winds have an increasing potential to take down trees and utility wires. The participants noted more frequent extreme cold temperatures raised concerns regarding potential loss of power or other damage to natural resources and infrastructure in Bridgewater.

4. **<u>Droughts/Extreme Heat:</u>** The Town has experienced issues with heat and drought in the past. It was concluded that with climate change, extreme temperatures in both directions will become more common, and with warmer temperatures, increased potential for droughts will exist.

VULNERABLE AREAS AND ATTRIBUTES

After identifying the top four hazards, the two groups reconvened to identify vulnerable areas. This assessment was aided by maps depicting the Town's Flood Plains. The participants used the CRB matrix template and their local knowledge of the Town to develop a list of vulnerabilities. Each group considered the Town's vulnerabilities as they relate to three categories: Infrastructural, Societal, and Environmental. Note that a number of items identified as vulnerabilities based on certain attributes were also considered strengths in other attributes. The strength attributes will be discussed in Section V.

After the breakout groups had developed their lists, the groups reconvened to compare results and through consensus, developed a consolidated list of vulnerabilities for each category as is summarized in Table 2 below:

Table 2: Vulnerable Areas and Attributes for Bridgewater based on Climate Change Projections

INFRASTRUCTURAL	SOCIETAL	ENVIRONMENTAL
• *Dams* • *Bridges/Roads/Culverts* • *Wastewater and Water Treatment Facilities* • *Town Wells, Water Tanks and Water System* • *Drainage System* • *Shelter Buildings* • *Electrical Distribution System* • *Public Transportation Infrastructure/MBTA Station* • *Zoning Regulations* • *Telecommunications* • *Fire Department* • *Bridgewater Correctional Complex (incl. State Hospital)* • *Transfer Station*	• *Senior and Vulnerable Population Facilities and Housing* • *Densely Populated Neighborhoods* • *Roche Bros. Supermarket* • *BSU* • *Recreational Fields & Parks* • *Intra-Town Communications*	• *Stormwater Ordinance* • *Existing Septic Systems within Flood Zone* • *Farm Land Loss to Residential Development* • *Old Pine Plantations/Aging Trees (Town Forest)* • *Waterborne Diseases* • *Sea Level Rise* • *Wastewater Treatment Plant* • *Town Wells/Water Supply* • *Wetlands* • *Hockomock Swamp* • *Water Resources (Ponds, Lakes and Rivers)* • *High Street Dam Removal*

INFRASTRUCTURAL

Dams

There is a major concern among the participants about the condition of the High Street (Jenkins Pond) Dam, Carver's Pond Dam, Sturtevant (South Street) Dam, Water Street (South Brook) Dam and Mill Street Dam. High Street Dam had been previously studied for its possible removal. The High Street Dam Removal Feasibility Study has been conducted by the Nature Conservancy in partnership with the Department of Ecological restoration (DER) and the Division of Marine Fisheries as a part of the Town River Restoration - High Street Dam Removal Provisional Project. The High Street Dam is a privately-owned dam, that serves no purpose for its current owner and obstructs natural fish passage.

Bridges/ Roads/Culverts

Since Bridgewater is located entirely within the Taunton River watershed, and it is surrounded by the rivers or other waterbodies from every side, the only way to enter and exit Town is using a bridge. There are over a dozen major bridges in Town. There is a great concern in Bridgewater about the capacity and current condition of said bridges to operate during peak flood events and sea level rise.

There is also a number of culverts that are under capacity such that roads overtop and create dangerous situations where vehicles may try to pass through flood waters. In some cases, the overtopping causes road closures which impedes emergency access to certain areas.

Wastewater and Water Treatment Facilities

The Town's presently has an advanced Wastewater Treatment Plant and an additional Carver's Pond Water Treatment Plant, that raised a great deal of discussion during the workshop. The major concern among the workshop participants was whether the present wastewater treatment plant is capable to properly treat the amount of sewage flow during the peak precipitation and wet season, with an additional factor of population growth and projected increase in precipitation in the near future.

Town Wells, Water Tanks and Water System

The Town's has 11 wells and 2 water tanks that are located within 3 aquifers. Some are located in the Flood Plain and are susceptible to flood damage and contamination from flood waters. In addition, these aquifers have recharge areas tapped during a six-month drought. The supplies are protected by ownership of land around the wells and by the Town's Aquifer Protection District zoning ordinance[2,8]. Concerns raised during the workshop included the capacity of the water tanks to store enough water supply for the Town during emergencies. In addition, the Town wells are dependent on electric water pumps, which also raised concerns among the participants of the workshop, whether the Town will have enough water supply in case of long-term power loss caused by a weather-related emergency.

Drainage System

The Town has developed an inventory of its storm drainage system(s) as part of its "MS4" permit. Funding limitations results in drainage systems not being able to be cleaned as often as they should be. Older systems are not designed for 10-year or 25-year storms per current engineering practice, let alone increased precipitation that is projected from climate change, such that older systems are under capacity.

Shelter Buildings

One concern relative to the shelter buildings in Town designated for emergency situations is that most of them are located in, or right next to, the FEMA Flood Plain of the Taunton River, Town River, Matfield River and their tributaries. Evaluation of the capacity of those buildings to operate in case of emergencies is necessary in order to build Town's resiliency to climate change.

Electrical Distribution System

Much of the electric grid in Bridgewater is located overhead on utility poles. These wires are often susceptible to damage caused by wind or they can be impacted by trees during severe winter snow storms, ice storms, and summer thunderstorms, all of which are typically accompanied by heavy wind and extreme precipitation.

Public Transportation Infrastructure/MBTA Station

The Town of Bridgewater serves as home to Bridgewater State University (BSU), which has approximately 3,000 students residing on campus and over 7,000 students that commute. MBTA (Lakeville Line) Station is located on campus of BSU. As discussed during the workshop, the participants noted the Station's important role in Town and being a vulnerable infrastructural location that needs to be addressed within the framework of building Bridgewater's climate change resiliency.

Zoning Regulations

The current zoning ordinance defines the exact boundaries of the Flood Plain District by the 100-year base flood elevations shown on the FIRM and further defined by the Plymouth County Flood Insurance Study (FIS) report, dated July 16, 2015. However, the updated Bridgewater's Zoning Regulations do not address development in vulnerable areas (i.e. low elevation spots, high groundwater table locations, areas susceptible to flooding) that are not shown on the FEMA maps.

Telecommunications

Much of the telecommunication network in Bridgewater is located overhead on utility poles. These wires are often susceptible to damage caused by wind or they can be impacted by downed trees during severe winter snow storms, ice storms, summer rainstorms, accompanied by heavy wind and extreme precipitation. BTV Cable 9 TV Studio, is located in the Town center by the Town River and was discussed during the workshop as being a vulnerable infrastructural location in in the event of excessive precipitation and flooding.

Fire Department

One vulnerability related to Bridgewater's Fire Department mentioned during the workshop is its location in the Town center, which makes it difficult to get through heavy traffic during emergency calls due to the confluence of 5 major intersections.

Bridgewater Correctional Complex (including State Hospital)

The vulnerability of Bridgewater Correctional Complex facilities is mostly related to the infrastructure, which, in turn, causes safety concerns for the Town residents. The State Hospital had an incident where perimeter fence fell down during severe weather event.

Transfer Station

Located on Bedford Street in close proximity to Sawmill Brook, the present transfer station is surrounded by wetlands and is at risk of flooding. This part of Sawmill Brook does not have an updated Hydrologic and Hydraulic (H&H) analyses, it has not been re-studied by FEMA as a part of 2015 Narraganset Watershed Study. The latest H&H analyses for this portion of the Sawmill Brook was completed in November 1996 by Green International Affiliates, Inc. for FEMA under Contract No. EMW-93-C-4144.

SOCIETAL

Senior and Vulnerable Population Facilities and Housing

The Bridgewater Senior Center, Bridgewater Housing Authority, Senior Housing, Bridgewater Nursing Home and Bridge Center for People with Disabilities were discussed by the workshop participants as being vulnerable societal features in the community. Elderly residents and people with disabilities may require special care and assistance during extreme weather events, especially with any loss of basic utility services, such as electric service.

Densely Populated Neighborhoods

The Kingswood, Waterford, Axis, Fox Run and Village Gate neighborhoods are fairly new developments that were built within or in very close proximity to the Flood Plains without considering the current or projected flood risks. These neighborhoods are densely populated and require attention in light of potential climate change impacts, to prepare them for possible emergencies, evacuation and improve their climate change resiliency. The Deerfield neighborhood was specifically identified by the workshop participants as the densely populated development that experiences frequent flooding issues. It is located in the western part of Bridgewater in close proximity to Snows Brook. This part of Snows Brook has not been re-studied by FEMA as a part of 2015 H&H analyses. The latest H&H analyses for this portion of the Snows Brook was completed in November 1978 by Sverdrup & Parcel and Associates, Inc., for FEMA, under Contract No. H-403F.

Roche Bros. Supermarket

Bridgewater's only large supermarket located in the Town center was discussed by the workshop participants as a vulnerable societal asset in Town. Its location in a low elevation spot along the Town River makes it susceptible to flooding.

Bridgewater State University

Bridgewater State University (BSU) plays a major role in Town's economy and development, as it is home to approximately 3,000 students residing on campus and 7,000 commuters every day. It also serves as an employer for some Bridgewater residents. BSU was discussed by the workshop participants as a vulnerable location in case of emergency, as it adds a large number of young people to the population of Bridgewater and has to be considered while improving the Town's preparedness and resilience.

Recreational Fields & Parks

Considering the Town's location within the Taunton River watershed, participants felt that climate change, with projected sea level rise and increased precipitation events could threaten the recreational fields and opportunities, especially passive recreational areas along the rivers.

Intra-Town Communications

Communication between the Town officials, volunteers, stakeholders and the population of Bridgewater was discussed by the workshop participants. The participants recommended an assessment of communication tools to ensure effective and efficient Intra Town communications be included in the MVP Plan. Specifically noted was communications among the Town officials and representatives of different organizations who service vulnerable populations. (i.e. BSU, State Hospital, Senior Center).

ENVIRONMENTAL

Stormwater Ordinance

ARTICLE XXXIX Maintenance of Storm Water Drain Facilities of the Town Ordinance lists its purpose of protecting the public health, safety and welfare by ensuring the routine maintenance of detention basins and other open storm water drainage facilities within subdivisions which have been approved under MGL

Chapter 41. The ordinance is outdated (2002) and does not address development in vulnerable areas of Bridgewater.

Existing Septic Systems within Flood Zone

In general, Bridgewater has a high-water table (shallow depth to groundwater). Many septic systems are old and were not installed high enough above the seasonal high-water table. Also, many older septic system are located in Flood Plains and potentially increase the risk of contaminating groundwater aquifers or being contaminated during wet weather and especially flood conditions. This risk will be intensified with increased precipitation and flooding as projected.

Farm Land Loss to Residential Development

Between the years of 1971 and 2013, acreage of farmland in Bridgewater declined from close to 3,000 acres to just over 1,000 acres[2]. Those developments and increased impervious surfaces from housing development contribute to the potential hazards discussed in this report. These need to be addressed in the Bridgewater MVP plan.

Old Pine Plantations/Town Forest/ Aging Trees

The workshop participants also discussed the need to evaluate aging trees and old pine plantation, and to prepare removal and tree planting plan for loss of trees. The aging trees and the old pine plantation are currently creating extra hazards, associated with falling trees and damages to utility poles and properties in Town, especially along the roadways.

Waterborne Diseases

Increased temperatures and precipitation projected for the future could result in increased mosquito populations and increased spread of disease transmitted by mosquitos and other organisms who thrive in wet environments. Bridgewater has an extensive acreage of wetlands; therefore, this item is a high priority to include in the MVP Plan.

Sea Level Rise

The Taunton River is currently tidal from its mouth in Mount Hope Bay in Fall River (part of Narraganset Bay) to a point just downstream of Vernon Street in Bridgewater, MA under normal tide conditions. The Massachusetts Office of Coastal Zone Management (CZM) has published Sea Level Rise (SLR) projections that range from 0.7 feet to 6.6 feet by the year 2100. Looking at the highest SLR scenario (6.6 feet), the Mean High Water (MHW) level in Fall River would increase from about 4.5 feet to 11.1 feet and the current FEMA Base Flood Elevation (BFE, or the 100-year flood) would increase from 12 feet NAVD (North American Vertical Datum) to 18.6 feet NAVD. Therefore, under the highest SLR projection scenario, by the year 2100, the tidal influence from Narragansett Bay could extend to within a mile of Route 104 on the Taunton River under normal high-tide conditions and to almost within a mile of Broad Street (State Route 18) in the Town River under a “100-year flood” scenario. This highest projected SLR scenario would also extend tidal flooding to a point almost as far as Bridge Street on the Matfield River and would extend backwater effects upstream in all the tributaries to the Taunton River that have stream beds below elevation 18.6 feet NAVD.

Wastewater Treatment Facilities

The Town’s present Wastewater Treatment Plant raised many concerns during the workshop. It’s an important hazard in the environmental category, since its ability to operate is directly coincided with the quality of the environment and public health. The plant’s ability to property function during excessive precipitation events without discharging untreated sewage needs to be addressed in building Bridgewater’s climate resiliency.

Town Wells, Water Tanks and Water System

The Town's has 11 wells and 2 water tanks that are located within 3 aquifers. Some are located in the Flood Plain and are susceptible to flood damage and contamination from flood waters. In addition, these aquifers have recharge areas tapped during a six-month drought. The supplies are protected by ownership of land around the wells and by the Town's Aquifer Protection District zoning ordinance[2,8]. Concerns raised during the workshop included the capacity of the water tanks to store enough water supply for the Town during emergencies.

Wetlands

The Town's has an estimated 3,048 acres in wetlands, including the above mentioned ACEC Hockomock Swamp. The hydrology of wetlands is very dependent on precipitation and evaporation; therefore, they will be directly and indirectly impacted by the effects of climate change. The alterations in precipitation and temperature might threaten sensitive habitats, as well as water quantity and quality. Increased temperatures and precipitation projected for the future could also result in increased mosquito populations and increased spread of diseases transmitted by mosquitos and other waterborne diseases.

Hockomock Swamp

The Hockomock Swamp is an important wetland and is protected against inappropriate development by the ACEC designation. The swamp reduces flooding by storing water and also provides some recharge to underlying aquifers, thereby contributing to drinking water supplies, and helping to maintain stream flow[2]. The southern part of the Lake is in the Raynham's Aquifer protection district. Since the Hockomock Swamp is the largest wetland in Bridgewater, it brought concerns within the workshop participants with regards to flooding and potential loss of wildlife habitat as a result of the projected climate change.

Water Resources (Ponds, Lakes and Rivers)

Town River, Matfield River, Taunton River are the main water courses in Town. However, there are several smaller streams and intermittent channels through out Bridgewater. The major water bodies are Carvers Pond and Lake Nippenicket. They have been affected by urbanization and developments throughout the Town's history, and they play an important role in the Town's water supply and recreational opportunities. With the Town's population growth has come increased concerns with water quality, water supply and management of water resources, stormwater and wastewater. more developments have been built, including the neighborhoods in vulnerable locations within the Flood Plains of major water resources in Bridgewater.

High Street Dam Removal

High Street Dam and Bridge had been a topic of discussion in Bridgewater for a few years now. The High Street Dam is a privately-owned dam, that serves no purpose for its current owner and obstructs natural fish passage, therefore, having a negative environmental impact. As a part of the Town River Restoration, The Nature Conservancy, the Department of Ecological restoration (DER), the Division of Marine Fisheries, the NOAA Restoration Center, the U.S. Fish and Wildlife Service, and other stakeholders conducted the High Street Dam Removal Feasibility Study in January 2018 and presented the results at a public meeting in April 2018. The project seeks to restore the Town River (the primary tributary to the Wild & Scenic Taunton River), strengthen coastal ecosystem and community resilience, and reduce vulnerability to the impacts of extreme weather events, climate hazards, and changing environmental conditions by removing the obsolete High Street Dam (a.k.a. Jenkins Pond Dam; National ID: MA00327; c. 1919) and replacing the undersized, 200-year-old High Street Bridge (c.1790) in Bridgewater, Massachusetts. DER intends to facilitate preparation of final engineering design plans and complete the regulatory permitting process for the controlled removal of the High Street Dam, replacement of the High Street Bridge with a structure sized to accommodate climate change, and protection of other nearby public and private infrastructure14. The project team, which includes the Town of Bridgewater, is currently seeking state and federal funding to advance preliminary designs for the dam removal and bridge replacement[6].

Participants determine the top four hazards and identify vulnerabilities using the CRB Workshop guidelines at the first workshop

III. CURRENT CONCERNS AND CHALLENGES PRESENTED BY HAZARDS

As anticipated, flooding was the number one hazard that presents the largest concerns and challenges in Town. The latest FEMA FIS countrywide study of July 17, 2012 covers the geographic area of Plymouth County, Massachusetts, including Bridgewater. The areas studied by detailed method included Taunton River, Matfield River from the confluence with Taunton River to 275 feet upstream of Bridge Street in Bridgewater, Town River from its confluence with Taunton River to its confluence with Lake Nippenicket Tributary; Sawmill Brook from its confluence with Taunton River to approximately 4,826 feet upstream of Bedford Street in Bridgewater; Snows Brook from its confluence with Taunton River in to 50 feet upstream of Forest Street in Bridgewater; South Brook from its confluence with Town River to 25 feet upstream of Bedford Street in Bridgewater; Tributary A to Sawmill Brook from its confluence with Sawmill Brook to approximately 80 feet upstream of Colonial Drive in Bridgewater. Additionally, there was a riverine flooding analysis for the July 16, 2015 conducted by USGS for the Narragansett Watershed Study, which updated the hydrologic and hydraulic engineering data for the Taunton River. The remaining water bodies for the latest FEMA FIS were studied by approximate methods[10].

From the FEMA data, the Town has some updated information to assess vulnerabilities and future risks related to climate change; however, additional analyses are needed to understand the future risks.

High Street Dam is one of the present concerns in Bridgewater. Rated as "unsafe" and as a "significant hazard" by the MA Office of Dam Safety, as well as serving no purpose for its current owner[6], it also threatens the undersized 200-year-old High Street Bridge. The Nature Conservancy, in partnership with the Division of Ecological Restoration and the Division of Marine Fisheries, completed an engineering feasibility study to investigate the removal of the High Street Dam (a.k.a. Jenkins Pond Dam) on the Town River in Bridgewater. According to the Nature Conservancy, DER, and Division of Marine Fisheries, the dam and bridge impede migratory fish passage and interrupts natural river processes[6], while the bridge contributes to local flooding as it currently passes only 30 percent of the required flood flows needed to meet current bridge design standards according to the MassDOT 2013 LRFD Bridge Manual. The bridge is located on a major thoroughfare and emergency route between the communities of Bridgewater, East Bridgewater, Halifax, and West Bridgewater that supports an Annual Average Daily Traffic (AADT) rate of 5,700 (MassDOT, 2004)[14]. According to Mass DER, state and federal funds for the preliminary design of the dam removal and bridge replacement are needed, and Brightwater along with the project team are currently researching their options.

Bridgewater's other dams (Mill Street Dam, South Street Pond Dam, Carver's Pond Dam, Water Street /South Brook Dam) have also raised concerns among the workshop participants, as these structures have not been studied as thoroughly yet and, therefore, there could be potential infrastructural or environmental vulnerabilities. Hazards could be associated with them as well.

Yet another concern associated with flooding is that undersized culverts and bridges have become hydraulic controls that impound flood waters. Because flood maps were developed with culverts and bridges in place that now act as hydraulic controls, regulatory Flood Plains do not match the natural Flood Plain that would have existed without these crossings and development occurred based on the "hydraulically-controlled" condition, which assumes hydraulic structures remain in place and do not fail during a flood. In many cases, developments were constructed at lower elevations, than they should have been, preventing culverts and bridges from being increased in size to allow for more natural movement of streams (natural stream morphology) without negative consequences to existing developments (e.g. culvert on Water Street).

There is also a major concern in Town about the capacity of the Town wells to provide enough drinking water in case of emergency that would lead to power outage, when the water pumps are dependent on electricity.

Finally, there was a concern raised at the workshop for the need to conduct Town wide structural evaluations of private rental properties (regulatory rental properties – three (3) families and up) for vulnerabilities to be discussed in this report and to establish direct line of communication of findings between Town and landlords/owners.

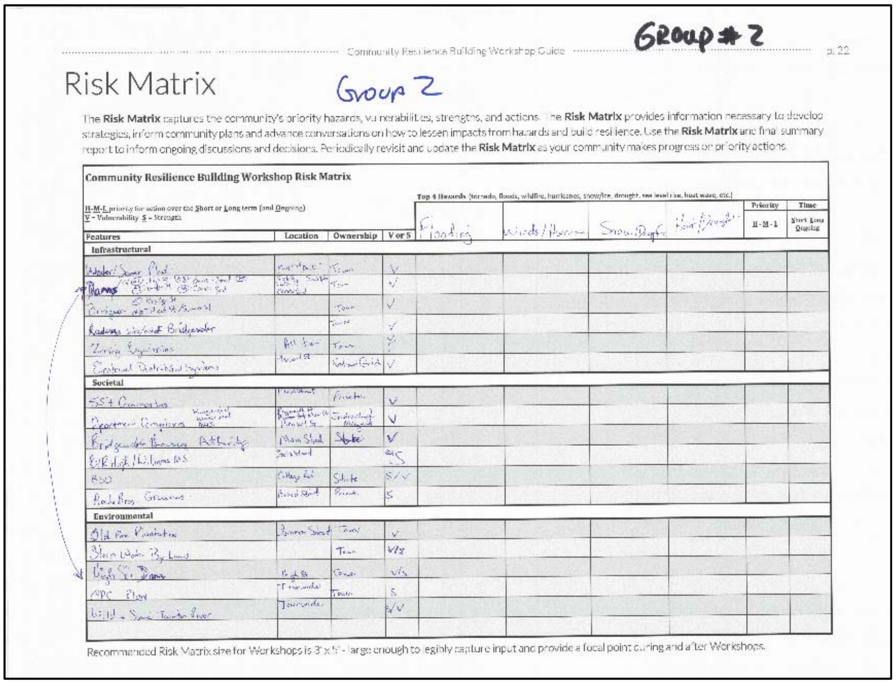

Figure 1: Typical Risk Matrix used by participants during workshops

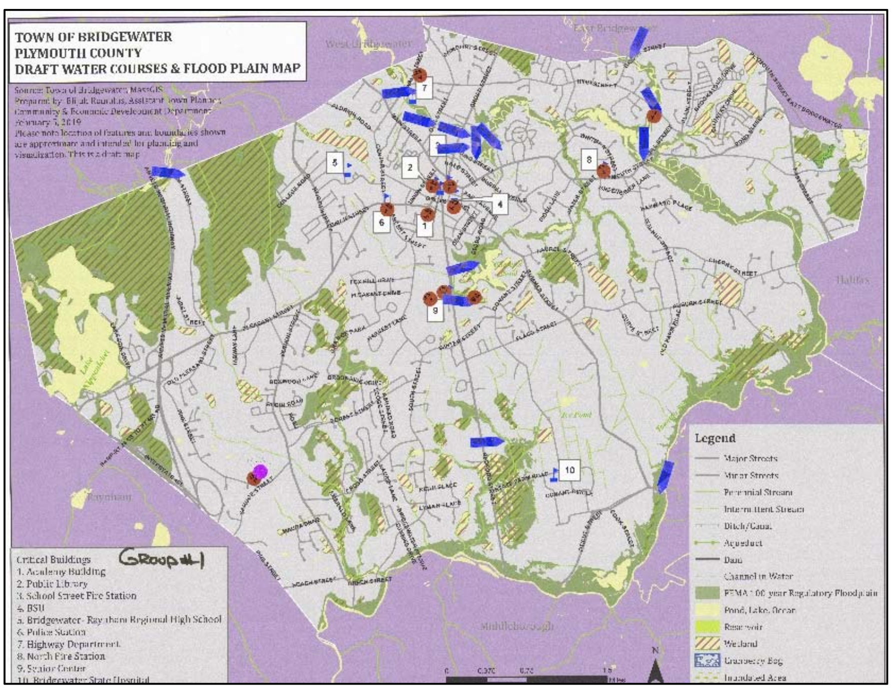

Figure 2: Town wide Map identifying specific vulnerable areas

IV. SPECIFIC CATEGORIES OF CONCERNS AND CHALLENGES

INFRASTRUCTURAL

Dams

The Town of Bridgewater has four (4) dams that formed the existing landscape and influenced the development of Town historically:

- High Street Dam
- Mill Street Dam
- South Street Pond (Sturtevant) Dam
- Carver's Pond Dam
- Water Street /South Brook Dam

As described in Section III of this report, High Street Dam (a.k.a. Town River Dam or Jenkins Pond Dam) has been causing concerns in Town for a while. The current private owner of the Dam no longer has use for it and it was also rated unsafe and hazardous by the MA Office of Dam Safety. In addition, The High Street Dam Removal Feasibility study described earlier suggests that the dam at its current condition and location threatens the old High Street Bridge and the bridge contributes to local flooding as it currently passes only 30 percent of the required flood flows needed to meet current bridge design standards according to the MassDOT 2013 LRFD Bridge Manual14. Both the dam and bridge obstruct migratory fish passage, disturbs natural river processes, and contribute to local flooding.

In contrast, the *Bridgewater Open Space and Recreation Plan (2017)* suggests that the dam removal will likely "lessen the current width of the reservoir and alter the current ecosystems. The implementation of this study will have potential impacts on the existing Iron Works Parkland design and the local riparian landscape behind the Lincoln Club, in addition to other considerations including ownership of the egress/access to Iron Works Parkland, storm water management issues, fishery management, historical preservation, Bay Circuit Trail enhancement, and possible funding for further restoration of the Stone Building."

Since the FEMA flood study for the Taunton River watershed within Bridgewater is based on a hydrologic analysis performed in 2012-2015, the future flood risk to the dams and bridges should be re-evaluated using EOEEA climate change projection data.

Bridges/ Roads/Culverts

As discussed earlier in Section III of this report, not all streams in Bridgewater were updated as a result of the July 17, 2012 Countrywide FEMA FIS analyses for Plymouth County and the July 16, 2015 Narragansett Watershed studies, hence, the actual flood risk for certain streams may be underestimated by the current FEMA flood studies. In order for the Town to truly understand its vulnerability and risks related to flooding for the next 50-100 years relative to bridges, culverts, and roadways, hydrologic and hydraulic analyses based on EOEEA's climate change projection data for Taunton River watershed are needed. The FEMA hydraulic computer model(s) (i.e. USACE HEC-RAS) developed for the portions of Taunton River watershed that were updated in 2012 and 2015 can be run with higher projected flood flows to determine future flood risk. For flooding sources that were not included in the 2012 and 2015 FEMA Studies, new hydrologic and hydraulic analyses will be required for the Town to understand its future flood risk in these Flood Plains.

Also, many culverts and bridges were installed before the National Flood Insurance Program (NFIP, which includes FEMA flood mapping) and the Massachusetts Wetlands Protection Act were in place and did not consider the natural stream morphology or the function of the Flood Plain. In many cases these roadway crossings have now created hydraulic controls and have been factored into flood mapping such that structures have been built based on these hydraulic controls being in place. In other words, changing the hydraulic characteristics of a roadway crossing (culvert or bridge) to allow streams and Flood Plains to pass through more naturally, could have negative consequences for structures built downstream since the roadway now acts as "dam" or hydraulic control and detains water upstream. Eventually though, because these roadways were not designed to function as dams, they will be prone to overtopping and possible breaches or washouts, if discharges become too great in the future.

The specific bridges in Town that were mentioned by the workshop participants are:

- High Street Bridge over Town River
- Summer Street Bridge over Taunton River
- Bridge Street Bridge over Matfield River
- Broad Street Bridge over Town River
- Oak Street Bridge (Old Stone Bridge) over Town River
- Titicut Street Bridge over Taunton River
- Cherry street Bridge over Taunton River
- Elm Street Bridge over Town River

The Town has more than a dozen bridges over streams and rivers. Bridgewater is surrounded by the Town and Matfield Rivers from the north, Taunton River from the northeast, east and south, and by the Hockomock Swamp from the west. Residents and visitors of Bridgewater must use these bridges to travel into/out of Town with limited detour ability, such that bridges play a crucial role in Town's infrastructure. See Appendix B for a Map of Bridgewater Infrastructural Assets.

The specific roads and culverts in Town that were mentioned by the workshop participants are:

- Water Street – low spot, flooding issues;
- Roadways into/out of Bridgewater – flooding issues at the river/stream crossings;
- State Farm Road (parallel to Sawmill Brook) - flooding issues;
- Roadways along the Middleborough Town Line – flooding issues.

Appendix B provides an overall map of the bridges and dams within the Town.

Wastewater and Water Treatment Facilities

According to the OSRP 2017, existing Wastewater Treatment Plant does not have sufficient capacity to serve the areas presently proposed for service. During extreme precipitation weather events the plant receives up to 1.2 million of gallons per day (MGD), while the total capacity to treat wastewater is only 1.44MGD[2].

The real risk of flooding at the current Wastewater Treatment Plant and at the Carver's Pond Water Treatment Plant is unknown until a model is run with climate change projections.

Town Wells, Water Tanks and Water Systems

Bridgewater has 2 water storage tanks and 11 Town wells. The water tank on Great Hill has a storage capacity of 990,000 gallons and the capacity of the one on Sprague's Hill is 4,000,000 gallons. Together both tanks give a storage capacity of 2 days based on the recent maximum day's consumption of 2.2 MGD, and 2.9 days capacity based on 2007 average consumption of 1.73 MGD[2].

Same as for the items above, the real risk of flooding at the current 11 Town wells and 2 water tanks is unknown until a model is run with climate change projections. Another issue discussed during the workshop was the capacity of the Town wells to provide enough water in case of increased time period of drought in the future, since the total safe yield of the water system in Bridgewater is only 2.4 MGD[2].

(MS4) Drainage Systems

The Town needs either a town-wide stormwater computer model of its drainage systems or individual hydraulic grade line analyses of each system to better understand system capacities/deficiencies and prioritize which systems have the most critical need for upgrade. Increased precipitation in the future will cause local street flooding where drainage systems are undersized, which could impact adjacent homes/businesses. Since Bridgewater adopted a "Complete Streets" Policy in 2016[2], future "Complete Streets" projects will be able to incorporate "Green Infrastructure" components that will help mitigate potential stormwater runoff impacts due to climate change, namely peak flow, water quality, and heat island effects.

Shelter Buildings (Public Safety)

Flooding issues near public buildings needs to be studied further, as those building play an important role for the Town residents in the events of major disasters and emergencies. Since the flood study for the Taunton River watershed within Bridgewater is based on a hydrologic analysis performed in 2012-2015, the actual flood risk to the Shelter Buildings (Academy Building, Memorial Building, Public Library Building, Regional High School, Williams Middles School, Bridgewater Middle School, Marriott Hotel, Senior Center, Conant Health Center) can be evaluated in consideration of climate change projections for the next 50-100 years using FEMA hydraulic computer model and EOEEA climate change projection data. This projected hydrologic and hydraulic analysis for the Taunton River Watershed is required for the Town to truly evaluate its risk at these critical infrastructure locations.

Electrical Distribution System

Relocating critical portions of the electric grid in Town underground would reduce the risk of outages during winter and summer storms and periods of wind blasts but may be cost prohibitive. Future electric demand during extreme heat situations may exceed the capacity of systems if they are not upgraded.

Public Transportation Infrastructure/MBTA Station

Located on the campus of Bridgewater State University approximately 300 feet northwest of the South Brook, the MBTA Station plays a very important role for commuting students and staff, as well as for Town residents and visitors. A new hydrologic and hydraulic analysis for the South Brook that considers climate change projections is required for the Town to truly evaluate its risk at this critical infrastructure location. The Town is considering moving the MBTA Station downtown.

Zoning Regulations

Zoning Regulations in Bridgewater are not currently addressing the issue of new development in vulnerable areas. A review of the present zoning ordinance is necessary to address this issue and make changes with regards to the projected climate change effects and to build Town's resiliency.

Telecommunications

Located in the Town center by the Town River, Cable TV Studio was discussed as a vulnerable infrastructural location in in the event of excessive precipitation and flooding.

Similar to the items discussed above, the real risk of flooding at the current Cable TV station is unknown until a model is run with climate change projections. Relocation critical portions of related utility poles and assessing the rest of the telecommunications network within Bridgewater is necessary to prepare the Town for weather related damages to the telecommunication network but may be cost prohibitive.

Bridgewater Correctional Complex (including State Hospital)

Improving public safety communication technology and working with the State to address the potential effects of climate change and safety issues of the outdated infrastructure on property (e.g. the fence fell down on the State Hospital property during the severe weather event) may be beneficial in order to make improvements and provide public safety on and off the property.

Transfer Station

Located on Bedford Street in close proximity to Sawmill Brook, the present transfer station is surrounded by wetlands and is at risk of flooding. This part of Sawmill Brook does not have an updated H&H analyses, it has not been re-studied by FEMA as a part of 2015 Narraganset Watershed Study. The latest H&H analyses for this portion of the Sawmill Brook was completed in 1996, it is outdated and the real risk of flooding at this location is unknown until a new H&H study for this porting of the Sawmill Brook is completed and the model is run with climate change projections.

SOCIETAL

Senior and Vulnerable Population Facilities and Housing

Communicating with and getting access to Bridgewater Senior Center, Senior Housing, Bridgewater Nursing Home and Bridge Center for People with Disabilities as well as to low-income housing areas in emergency situations is challenging and response time can sometimes mean the difference between life and death. There is no hospital in 24/7 Emergency Room Hospital in Bridgewater itself.

Back-up generators for Senior Center are currently included in the Bridgewater's Capital Improvement Plan. There is an urgent necessity to assess other facilities with vulnerable populations with regards to the back-up generators and energy availability in case of emergency.

Densely Populated Neighborhoods

There was a list of new densely populated developments in Bridgewater that were built in vulnerable to flooding locations without considering the current or projected flood risk in mind.

- Kingswood apartment complex was built very close to wetlands and a tributary stream to the Town River;
- Waterford Village apartments were built on Town River and very close to wetlands;
- Axis at Lakeshore apartments were built on Lake Nippenicket very close to wetlands and within the Hockomock Swamp ACEC;
- Fox Run Condominiums were also built very close to wetlands in low elevation area.
- Deerfield Neighborhood was built very close to Snows Brook's Flood Plain. Deerfield Drive development is experiencing frequent flooding issues. This part of Snows Brook has not been re-studied by FEMA as a part of 2015 H&H analyses. Since the latest H&H analyses for this portion of the Snows Brook was completed in 1978, it is outdated and the real risk and extent of flooding at this location is unknown until a new H&H study for this porting of the Snows Brook is completed and the model is run with climate change projections.

These neighborhoods are densely populated and require attention in light of potential climate change impacts. Elevating homes or buying out the most flood-prone properties in the discussed neighborhoods are potential solutions to become more resilient to increased flooding in these areas but may be both cost prohibitive and unacceptable to residents. The Town is planning to work on improving communication with vulnerable areas and to both inform and educate residents about environmental issues related to main water courses that are affecting their homes and neighborhoods.

Roche Bros. Supermarket

The location of the Town's only supermarket in a low elevation spot along the Town River makes it susceptible to flooding. However, the actual risk and extent of flooding is unknown until a model is run with climate change projections.

Bridgewater State University

Bridgewater University adds a major number of people to the Town's population every year. The need to improve communication between Town officials and the University is necessary in order to build the Town's preparedness for emergency situations related to the projected effects of climate change. There is also a need to include the University in decision making processes for implementing emergency instructions and evacuation plans, since the university has a large population of students and staff.

Recreational Fields

Considering the Town's location within a major watershed, Bridgewater residents feel that climate change is threatening its recreational fields. Therefore, there is a need to evaluate vulnerabilities of parks and recreational fields for future use.

Intra-Town Communications

Re-evaluation of the communication methods in Bridgewater is necessary to improve communication of Bridgewater stakeholders and vulnerable populations. The Town is planning to work on improving public safety communication technology (through Police, Fire and Roadways/DPW) and to evaluate available tools to improve communication among the vulnerable populations during emergencies.

ENVIRONMENTAL

Stormwater Ordinance

The revision of the outdated storm water ordinance is necessary to address the projected effects of climate change and build the Town's resilience.

Existing Septic Systems within Flood Zone

Most septic systems are privately owned and making upgrades to older systems that aren't currently failing to make them more sustainable to flooding and increased water table elevations projected in the future (i.e. raising them up, which may require pumping systems) will be cost prohibitive and resisted by owners.

Farm Land Loss to Residential Development

Even though the Town has put a lot of effort in addressing the farm land loss and preserving agricultural land, the farm loss is still an on-going vulnerability in Bridgewater Community. The agricultural preservation initiatives need to be continued.

Old Pine Plantations/Aging Trees/Town Forest

Increasing tree maintenance to keep tress clear of wires is costly and may be resisted by taxpayers/ratepayers and RMLD if they are unable to pass on the cost. However, evaluation of hazard trees within Town and preparation of the tree removal and planting plan is necessary.

Waterborne Diseases

The effects of increased temperatures and precipitation on the rise of waterborne diseases and mosquito population are needed to be studied more in order to learn the extent of the problem and find ways to address it.

Sea Level Rise

To prepare Bridgewater for the projected effects of sea level rise, in-depth evaluation of low elevation areas in consideration of climate change projections for the next 50-100 years using FEMA hydraulic computer model and EOEEA climate change projection data of all the vulnerable areas within a Flood Plain of the Taunton River is necessary.

Wastewater Treatment Facilities

Although Bridgewater is not a coastal community, the Taunton River is tidal all the way into Bridgewater. The real risk of flooding and extent of potential damages at the current Wastewater Treatment Plant and at the Carver's Pond Water Treatment Plant is unknown until a model is run with climate change projections.

Town Wells, Water Tanks and Water System

During the periods of draught, the Town wells' capacity to produce enough water supply for the Town needs to be assessed in order to build Bridgewater's climate change resilience and preparedness. Evaluation of the Town's water system and water tanks capacity to provide enough storage in consideration with potentially increased periods of draughts and population growth is also essential.

Hockomock Swamp

Since the Hockomock Swamp is the largest wetland in Bridgewater, the actual risk and extent of flooding and potential loss of wildlife habitat as a result of the projected climate change is unknown until a model is run with climate change projections.

Wetlands and Hockomock Swamp

Increased hydrology in wetlands could result in increased wetland vegetation, invasive species encroachment and increased mosquito populations. Increased maintenance costs may occur to keep ahead of these changing conditions.

Water Resources (Ponds, Lakes and Rivers)

If climate change projections are realized in the future, there will be a constant demand from people living in the Flood Plains for the Town to do something about the flooding. However, it will not be possible for the Town to control flooding along these water bodies in a way that meets any kind of acceptable cost-benefit ratio, that it would be acceptable from an environmental permitting standpoint and would not impact Flood Plains either upstream or downstream. Many structures were built too low in Flood Plains before the NFIP and FEMA flood maps existed and these Flood Plains will likely increase with climate change.

High Street Dam

There are still many factors that need to be researched, assessed and considered with regards to the High Street Dam removal and restoration of the Town River's natural fish passage, such as the extent of alteration of the current ecosystems and potential impacts on the existing Stanley Iron Works Park design and infrastructure, storm water management issues, fishery management, historical preservation and also potential flooding and weakening of already unstable dams.

V. CURRENT STRENGTHS AND ASSETS IN BRIDGEWATER

Certain Infrastructural, Societal, and Environmental items the workshop participants identified as vulnerabilities on the one hand, were also identified as strengths and assets to the Town in different aspects. Therefore, a number of the Town's strengths and assets presented below were discussed previously relative to different attributes that the participants recognized as vulnerabilities.

Table 3: Current Strengths and Assets in Bridgewater related to Climate Change Resiliency

INFRASTRUCTURAL	SOCIETAL	ENVIRONMENTAL
• *Wastewater Treatment Plant* • *Water Supply/Town Wells* • *Shelter Buildings* • *Zoning Ordinances* • *Highway Department/Highway Barn* • *MBTA Station*	• *Senior and Vulnerable Population Facilities & Healthcare Facilities* • *Vulnerable Population Assistance Programs* • *Public Safety* • *Roche Bros. Supermarket* • *Open Space (Parks, Recreational Fields, Golf Course)* • *Social Media* • *Lucini Bus Service* • *Emergency Staging*	• *Water Resources (Rivers, Lakes, Ponds and Wetlands, incl. Hockomock Swamp)* • *Open Space and Parks, Hiking Trails* • *Watershed Alliances and Associations* • *Wildland Trust* • *Farmland/Agricultural Restriction Land* • *NRTB (Natural Resources Trust of Bridgewater)* • *Aquifer Protection District* • *Flood Plain District* • *High Street Dam Removal Study*

INFRASTRUCTURAL

Wastewater Treatment Plant

While the workshop participants were concerned about Wastewater Treatment Plant's capacity to treat water and soil limitations for on-site septic systems (such restricted lands cover as much as 45% of the community), the Wastewater Treatment Plant in Bridgewater is treating an average flow of 800,000-900,000 gallons a day, with a capacity to treat up to 1.44 MGD. Upgrade of the facility is currently being planned.

Water Supply/Town Wells

While the capacity of 11 Town wells to provide enough water supply for Bridgewater considering population growth and potential effects of climate change (i.e. increased periods of draught and flooding) was questioned during the workshop, the location of Bridgewater allows the Town to add additional Town wells, since the Town's water supply comes from groundwater sources that are located in 3 aquifers, which provides redundancy.

Shelter Buildings

Aside from the concern about the location of Academy, Memorial, Public Library, Public Schools, Conant Community Health Center, Bridgewater State University buildings within the areas potentially vulnerable to flooding, the Town's shelter buildings are generally in good condition and well maintained. These facilities can be used as emergency shelters if necessary.

Zoning Regulations

Even though present zoning ordinances are not addressing the issue of new development in vulnerable areas with regards to the projected climate change effects, the zoning bylaw in Bridgewater (last revised in October, 2018) adopted the Flood Plain District Ordinance D-2015-006 on 6/23/2015, the purpose of the Flood Plain District is to regulate and restrict development of lands subject to seasonal or periodic flooding for residence or other purposes in such a manner as to endanger the health or safety, to protect, preserve and maintain the water table and water recharge areas within the Town, to assure the continuation of the natural flow pattern of the water courses within the Town in order to provide adequate and safe floodwater storage capacity to protect persons and property against the hazards of flood inundation[10].

Roadway Department/Roadway Barn

Even though the Department's location near the High Street Dam makes it dependent on the safety and operation of the High Street Bridge and the roadway within it, the Highway Barn along with its access road seem to be located outside of the 100- and 200-year flood zone of Town River, which means that in case of weather-related emergency the Highway Department will be able to continue to operate.

MBTA Station

Existence of railroad connection in Town is a major strength. It allows more residents to safely evacuate or come in to Town without using the roadways that could be damaged or closed during extreme weather events.

SOCIETAL

Senior and Vulnerable Populations and Healthcare Facilities

While Bridgewater does not have a hospital within the Town itself (except for the State Criminal Hospital), there are very good hospitals located close by. That said, there are smaller group homes and elderly care facilities that provide good care to vulnerable populations and provide good channels of communication with first responders whose assistance may be necessary during a severe weather-related event. In addition, there are Healthcare Facilities in Town, including the Conant Center, Urgent Care and Pediatric Care facilities, which can be utilized in the event of emergency.

Vulnerable Populations Assistance Program:

There are several active churches in Town that the participants felt would respond during emergencies to help people in need, offer shelter and support sustainability efforts in the Town. There are existing initiatives, such as Food Pantry at the Central Square Congregational Church, and the "Meals-on-Wheels" Program and Congregate Lunches, run by the Senior Center and Bridgewater Elder Affairs, delivering food to the seniors that cannot make it to the Center.

Public Safety

Bridgewater Fire Department and an additional Fire Station are major recognized strengths in Town. While the only concern expressed by the workshop participant was that traffic in the Town center sometimes prevents the Fire Department vehicles to travel to the emergency destinations faster, the two fire stations are available for emergency situations 24/7.

Bridgewater Police Department is also available for emergencies 24/7, which is a major strength for the community of Bridgewater.

Bridgewater also formed a Community Emergency Response Team (CERT) that has volunteer citizens on staff, who are educated about disaster preparedness for the hazards that may impact the area and trained in basic disaster response skills.

The Reverse 911 system provides emergency messages to residents when necessary.

Roche Bros. Supermarket

Even though Roche Bros. Supermarket was discussed as being located in a vulnerable location because of the flooding issues, it is still a major societal strength for the Town of Bridgewater to have a large supermarket, that will be able to provide necessities to the public during extreme weather events.

Open Space (Parks, Recreational Fields, Golf Course)

Bridgewater has been largely involved it preserving an open space for over a decade now. The Town recognized the importance of Open Space, including protected conservation land, parks and recreational fields, for the Town's development and public health and safety.

The Town has an updated Open Space and Recreation Plan (2017) that puts a lot of stress on protection of existing open space and its importance for public health and safety as well as the Town's growth and development. In addition, the Town participates in the State Chapter 61 program (Chapters 61 for forestlands, 61A for agriculture land and 61B for recreational land) that give preferential tax treatment to landowners who maintain their property as open space for timber production, agriculture or recreation.

Social Media

Educational opportunities offered through Bridgewater social media can include Stormwater, Flood Plain and MVP material. Social media improves communication within different groups of society and builds the foundation for improving communication and educating the public about on-going efforts going on in Town.

Lucini Bus Service

Lucini Bus Transportation has been active in the community since 1959, serving school transportation and charter needs in Town. Workshop participants mentioned the Lucini Bus services as a community's strength since it promotes mobility among vulnerable population groups and offers a variety of transportation services for the community. It is a great asset to have in Town for emergency situations.

Emergency Staging

Regional equipment is coordinated though the Fire Department and staged in Bridgewater.

ENVIRONMENTAL

Water Resources (Rivers, Lakes, Ponds and Wetlands, ACEC - The Hockomock Swamp)

Although certain water bodies within the Town have flood risks associated with them that create vulnerabilities for the Town, these same water bodies are also important environmental resources for the Town. Rivers and brooks, lakes, ponds and wetlands provide wildlife and aquatic habitat, recreational opportunities, and scenic vistas that all add to the quality of life in Bridgewater. A vast variety of wetlands - including the biggest wetland in the State, the ACEC Hockomock Swamp - provide wildlife habitat, flood storage and biological processes that improve water quality from stormwater runoff.

Open Space, Parks and Hiking Trails

Public open space and parks provide recreational opportunities for residents and in some cases, serve as passive uses in Flood Plains that can store flood waters without resulting in costly flood damage. Bridgewater is prioritizing its Open Space preservation, and this initiative should be continued, with more opportunities to help the Town with the MVP program.

Watershed Alliances & Associations

There are two active watershed associations involved in Bridgewater, the *Taunton River Wild & Scenic Stewardship Council*, which is mostly made up of residents living in 10 communities and designated to maintaining the Taunton Wild & Scenic River Status and promoting educational and recreational opportunities for 10 communities within the watershed. The *Taunton River Watershed Alliance (TRWA)* is a larger regional group of concerned residents, businesses, and organizations "united to restore and properly manage water and related natural resources within the Taunton River Watershed". Both groups are strong advocates for environmental protection of Bridgewater's water resources and improving water quality. The TRWA is involved in the River and Stream Continuity Project conducted by the University of Massachusetts, the Massachusetts Division of Ecological Restoration, the Nature Conservancy and American Rivers. As a part of this project over 500 crossings, located in 27 cities and Towns, were assessed within the Taunton River watershed. The Stream Continuity Report – Culvert Study on the findings of the surveys was jointly developed by TRWA and Mass Audubon. It highlights crossings that are most in need of replacement and areas of high ecological value that are impacted by restrictive crossings and also identifies sources of assistance to cities and Towns that pursue crossing replacement projects.

Wildlands Trust

Wildlands Trust "works throughout Southeastern Massachusetts to conserve and permanently protect native habitats, farmland, and lands of high ecological and scenic value that serve to keep our communities healthy and our residents connected to the natural world." In 2009 Wildland Trust and the Massachusetts Department of Fish and Game acquired 230 acres of land along the upper Taunton River in Bridgewater. The 125-acre portion of the acquisition is now known as the Great River Preserve at Conihasset and it includes a range of the most unique habitats and features along the river.

Farm Land/Agricultural Restriction Land

The Town has started a few local initiatives and programs to prevent farm land loss. For example, the purchase of the Hogg Farm in 2000 for municipal and recreational use, the purchase of the historic Keith Homestead and Farm on the shores of Lake Nippenicket and adjacent land in 2011 for historic preservation and open space/recreational uses and gaining a Conservation Restriction to protect the Murray-Needs farm on North Street in 2015. In addition, there are approximately 220 acres of private agricultural land currently enrolled in the state Chapter 61A program[2].

Natural Resources Trust of Bridgewater (NRTB)

The Natural Resources Trust of Bridgewater is a local land trust that was established to acquire and preserve the natural resources and wildlife in the Town of Bridgewater and abutting communities, maintain the rural character and charm of the Towns, protect the river corridor and wetland areas, preserve open space and wildlife habitat, and provide for recreational areas. The Trust is operating in harmony with each Town's Open Space and Recreation Plan.

Aquifer Protection District

Another strength for the Bridgewater community is the establishment of the Aquifer Protection District in the Zoning Ordinance, which preserves, protects and maintains the existing and potential groundwater supply as well as surface water quality of Bridgewater for present and future generations health, safety and general welfare[11].

Flood Plain District

Establishing a Flood Plain District as an overlay district in the latest update of the Zoning Ordinance (last revised in October 2018), Bridgewater made a strong step towards regulating and restricting development of lands subject to seasonal or periodic flooding for residence or other purposes, therefore, recognized the importance of flood zone[11].

High Street Dam Removal Study

Both High Street Dam and High Street Bridge obstruct migratory fish passage, disturbs natural river processes, and the bridge contributes to local flooding. The High Street Dam Removal and Fish Passage Feasibility Study was conducted by the Nature Conservancy in partnership with the DER and the Division of Marine Fisheries as a part of the Town River Restoration - High Street Dam Removal Provisional Project, since the High Street Dam is one of the two major dams on the Town River and the first dam from the ocean on the Town River. According to DER, its removal would reconnect over 10 miles of riverine from the ocean on the Town River[6,14].

Appendix C provides an overall map of the vulnerable facilities within the Town, as well as facilities and areas that were also determined to be strengths and assets.

VI. TOP RECOMMENDATIONS TO IMPROVE RESILIENCE TO HAZARDS

At the second workshop, participants reviewed the top four hazards developed at the first workshop (namely: Flooding; Wind; Winter Storms/Extreme Cold; and Drought/Extreme Heat), in conjunction with the vulnerabilities and strengths they had identified and came up with action steps for the Town to take to become more resilient to the potential effects of climate change. Table 1 in the Executive Summary section of this report lists the recommended action steps the Town should take going forward to become more resilient to climate change and sustainable to extreme weather and geological events.

WORKSHOP'S HIGHEST PRIORITY RECOMMENDATIONS FOR BRIDGEWATER

The highest priority recommendation to come out of the workshops is the need for a town-wide hydrologic and hydraulic analyses using available FEMA model and EOEEA climate change projection data. This step is necessary to evaluate the flooding impacts from increased precipitation in the future. The FEMA Flood Insurance Study for the Taunton River, as revised in July 2015 based on the H&H study completed for Narraganset Watershed Study, should be the starting point for further Town study.

Additionally, the Town could study and build their own hydraulic computer model for the remaining segments of streams that were not restudied by detailed methods for the updated FIS, if funding is made available.

A lesser priority that the workshop groups came up with was developing a plan to evaluate rental properties (of 3 family and up) for vulnerabilities and establishing a direct line of communication of findings with the Town officials and landlords and owners.

As a result of the Community Building Resilience workshops for Bridgewater, the action steps were reviewed and developed. The action steps have been prioritized in Table 1 below as follows:

High MVP Priority
Medium MVP Priority
Low MVP Priority

Table 1: Recommended Action Steps to Improve Resiliency to Climate Change in Bridgewater

PROJECT NO.	MITIGATION ACTION	TIMEFRAME	RESPONSIBLE ORGANIZATION	POTENTIAL FUNDING SOURCE	ESTIMATED COST
1	**Obtain Effective hydraulic computer models from FEMA and develop Town-wide Hydrologic and Hydraulic (H&H) models based on UMass climate change (CC) projections for the 2050's and 2090's.**	2019	Engineering	MVP Action Grant*	$25,000-$50,000
2	Develop a CC Resiliency Action Plan for the Wastewater Treatment Plant (WWTP) based on results of Project No. 1	2020	Wastewater	MVP Action Grant	$15,000

Project No.	Mitigation Action	Timeframe	Responsible Organization	Potential Funding Source	Estimated Cost
3	Develop a CC Resiliency Action Plan for the Town's water supply wells and treatment facilities based on results of Project No. 1	2020	Water	MVP Action Grant	$20,000
4	Review and update the Town's Stormwater Ordinance relative to CC Projections	2020	Planning	MVP Action Grant	$10,000
5	Review and update zoning requirements to address CC Resiliency	2020	Planning	MVP Action Grant	$10,000
6	Purchase and Install an emergency generator at the Senior Center and develop an Emergency Back-up Power Plan for other public facilities that serve vulnerable populations.	2019	Emergency Management	MVP Action Grant	$25,000
7	Develop a Town-wide emergency transport and food supply emergency action plan for vulnerable populations	2019	Emergency Management	MVP Action Grant	$10,000
8	Develop a Culvert and Bridge Improvement Master Plan based on results of Projects No. 1 and No.10	2020	DPW	MVP Action Grant	$50,000
9	High Street Dam Removal and Bridge Replacement	2020	DPW	Federal & MVP Action Grant	$2,000,000
10	Review Town evacuation plans and update emergency instructions for evacuation (incorporate them in Branding & Wayfinding strategy) based on CC projections and results of Project No. 1	2019	Emergency Management	MVP Action Grant	$10,000
11	Improve public safety and emergency communication abilities with vulnerable population centers	2020	Emergency Management	MVP Action Grant	$50,000
12	Develop a CC Resiliency Action Plan that incorporates nature-based solutions for Town parks and recreational areas.	2021	Planning, Conservation and Roadways	MVP Action Grant	$25,000
13	Update a Hazard Tree Removal and Replacement plan (including the old pine plantation and Town forest)	2021	Planning and Conservation	MVP Action Grant	$25,000

PROJECT NO.	MITIGATION ACTION	TIMEFRAME	RESPONSIBLE ORGANIZATION	POTENTIAL FUNDING SOURCE	ESTIMATED COST
14	Protect agricultural land -Continue to implement Open Space and Recreation Plan 2017	2021	Planning and Conservation	MVP Action Grant	(see Open Space & Rec Plan)
15	Establish a Flood Plain and Stormwater Management Public Education Program based on results of Project No. 1.	2021	Planning and Conservation	MVP Action Grant	$10,000
16	Develop a public education program for vulnerable populations relative to climate change, its effects and ways to build social resiliency.	2021	Planning and Emergency Management	MVP Action Grant	$7,500
17	Develop a Landlord/Owner Communication Plan for multi-unit rental properties (3-family and up) to establish direct lines of communication for natural hazard emergencies	2021	Emergency Management	MVP Action Grant	$25,000

* MVP Action Grants typically include a Town cost share commitment of 25%

ENDNOTES

[1] *Old Bridgewater Historical Society Bridgewater Timeline and History (https://www.oldbridgewater.org)*
[2] *Bridgewater Open Space and Recreation Plan (2017) (https://www.bridgewaterma.org)*
[3] *Nunckatessett Greenway Project (http://www.nunckatessettgreenway.org/explore/bridgewater)*
[4] *The Taunton River Wild & Scenic Stewardship Council (http://www.tauntonriver.org/)*
[5] *The Taunton River Watershed Alliance (http://savethetaunton.org/)*
[6] *Mass.gov DCR (https://www.mass.gov/news/high-street-dam-removal-feasibility-study-bridgewater)*
[7] *Mass.gov DCR (https://www.mass.gov/service-details/hockomock-swamp-acec)*
[8] *Bridgewater Water Department Annual Water Quality Report (January 2017 – December 2017)*
[9] *Bridgewater Chapter Lands (2014)*
[10] *FEMA Flood Insurance Study number 25023CV001C for Plymouth County, Massachusetts (initial 07/17/2012; last revised 11/04/2016)*
[11] *Zoning By-Laws Latest Revision (October 12, 2018), Town of Bridgewater, Massachusetts*
[12] *Wildlands Trust (https://wildlandstrust.org/great-river-preserve)*
[13] *Natural Hazard Mitigation Plan for the Old Colony Region (May, 2015) Trust (https://wildlandstrust.org/great-river-preserve)*
[14] *Town River Restoration Project Summary (Bridgewater, MA)*

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APPENDIX A – COMPLETED RISK MATRIX

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.org

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

H-**M**-**L** priority for action over the **S**hort or **L**ong term (and **O**ngoing)

V = Vulnerability **S** = Strength

Features	Location *	Ownership	V or S	FLOODING	WIND	WINTER STORMS/EXTREME COLD	DROUGHT/EXTREME HEAT	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
DAMS AND BRIDGES									
HIGH STREET DAM	D	PRIVATE DAM, TOWN ROAD	V	1, 9	N/A	N/A	12	H	S
STURTEVANT (SOUTH STREET) DAM	A	TOWN	V	1	N/A	N/A	N/A	H	S
PLYMOUTH STREET/MILL STREET DAM	C	TOWN	V	1	N/A	N/A	N/A	H	S
SUMMER STREET BRIDGE	viii	TOWN	V	1, 10	N/A	N/A	N/A	H	S
BRIDGE STREET BRIDGE	iv	TOWN	V	1, 10	N/A	N/A	N/A	H	S
BROAD STREET BRIDGE	ii	TOWN	V	1, 10	N/A	N/A	N/A	H	S
OAK STREET BRIDGE (OLD STONE BRIDGE)	i	TOWN	V	1, 10	N/A	N/A	N/A	H	S
ELM STREET BRIDGE	Elm Street over Town	TOWN	V	1, 10	N/A	N/A	N/A	H	S
TITICUT ST BRIDGE	ix	TOWN	V	1, 10	N/A	N/A	N/A	H	S
CHERRY STREET BRIDGE	vi	TOWN	V	1, 10	N/A	N/A	N/A	H	S
WATER/WASTEWATER ASSETS									
CARVER'S POND WATER TREATMENT PLANT	12	TOWN	V / S	3	3	3	3	H	S
CARVER'S POND (WATER SUPPLY & DAM)	B	TOWN	V	1, 3	N/A	N/A	3	H	S
WASTEWATER TREATMENT PLANT & SECONDARY WW TREATMENT FACILITY	11, 12	TOWN	V / S	2	2	2	2	H	S
WATER SUPPLY - MATFIELD RIVER (4), CARVER'S POND (5), PLYMOUTH ST (2); WATER TANKS - SPRAY HILL/GREY HILL DR	12, 5, a, b	TOWN	V/ S	1,3	N/A	N/A	3	H	S
PUBLIC BUILDINGS/FACILITIES									
TRANSFER STATION	14	TOWN	V	1	N/A	N/A	N/A	M	O
FIRE DEPARTMENT - DOWNTOWN	3	TOWN	S / V	11				L	O
NORTH FIRE STATION	8	TOWN	S	10, 11				L	O
HIGHWAY DEPT/BARN	7	TOWN	S	1, 10, 11	11			L	O
POLICE STATION	6	TOWN	S	7, 10,11				H	O
ACADEMY BUILDING AKA TOWN HALL - EMERGENCY SHELTER	1	TOWN	S	10, 11, 16				H	O

MEMORIAL BUILDING - EMERGENCY SHELTER	2	TOWN	S	10, 11, 16				H	O
PUBLIC LIBRARY BUILDING - EMERGENCY SHELTER	2	TOWN	S	10, 11, 16				H	O
BRIDGEWATER-RAYNHAM HIGH SCHOOL - RED CROSS CENTER	5	TOWN	S	10, 11, 16				L	O
PUBLIC ROADWAYS									
DEERFIELD NEIGHBORHOOD	Deerifield Drive	TOWN	V	1, 10, 11, 16	N/A	N/A	N/A	H	O
WATER STREET (FLOODING ISSUE - LOW SPOT)	Water Street near South Brook	TOWN	V	1, 2, 5	N/A	N/A	N/A	H	S
ROADWAYS INTO/OUT OF BRIDGEWATER	Along the Middleborough T.L.	TOWN	V	1, 10, 11, 16	10, 11, 16	10, 11, 16	16	H	O
PRIVATELY OWNED FACILITIES									
BRIDGEWATER CORRECTIONAL COMPLEX/STATE HOSPITAL	10	STATE	V	1	16	16	16	L	O
MBTA STATION LAKEVILLE LINE	13	STATE	V / S	1, 10, 11, 16	10, 11, 16	10, 11, 16	10, 11, 16	H	O
ELECTRICAL DISTRIBUTION SYSTEM	Pleasant Street	NAT.GRID	V	1	13	13	N/A	H	S
CABLE TV STATION	Spring St	PRIVATE	V	8, 9, 14				M	O
CONANT COMMUNITY HEALTH CENTER	9	PRIVATE	V / S	6, 8, 9, 14				H	O
UNIVERSITY DORMS/FACILITIES	4	BSU	S	8, 9, 14				L	O
ZONING REGULATIONS									
ZONING REGULATIONS	Townwide	TOWN	V / S	1, 5	5	5	5	H	L

*** Please refer to Appendix B - Map of Bridgewater Infrastructural Assets for approximate location**

Community **R**esilience **B**uilding Risk Matrix

www.CommunityResilienceBuilding.org

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

H-**M**-**L** priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

Features	Location	Ownership	V or S	FLOODING	WIND	WINTER STORMS/EXTREME COLD	DROUGHT/EXTREME HEAT	Priority H - M - L	Time Short Long Ongoing
Societal									
LIVING FACILITIES									
SENIOR CENTER	1	TOWN	S / V	6, 7, 10, 11, 16				H	O
THE BRIDGE CENTER (FOR PEOPLE WITH SPECIAL NEEDS)	4	PRIVATE (NON-PROFIT)	S / V	7, 10, 11, 16				H	O
AFFORABLE HOUCING (40B) COMMUNITY AND 55 AND OLDER DENSELY POPULATED DEVELOPMENTS	Brookstone Drive, Country Drive	PRIVATE	V	7, 10, 11, 16, 17				H	O
BRIDGEWATER HOUSING AUTHORITY	2	STATE	V	7, 10, 11, 16				H	O
BRIDGEWATER NURSING HOME	3	PRIVATE	V	7, 10, 11, 16, 17				H	O
APARTMENT COMPLEXES (KINGSWOOD, WATERFORD, AXIS, FOX RUN, VILLAGE GATE)	6, 7, 8, 9, 10	PRIVATE	V	1, 4, 5, 11				H	S
NEW DEVELOPMENTS	Townwide	PRIVATE	V	1, 4, 5, 15, 16	16			H	O
FOOD CENTERS/SERVICES									
ROCHE BROS. SUPERMARKET IN TOWN CENTER	11	PRIVATE	S / V	1, 7, 10, 11, 16	7, 10, 11, 16			H	O
"MEALS-ON-WHEELS" PROGRAM FOR SENIORS	1	TOWN	S	7, 10, 11, 16				M	O
FOOD PANTRIES	Churches: St. Thomas, Central Square	PRIVATE	S / V	7, 10, 11, 16				H	O
EMERGENCY ROOMS/SHELTERS									
EMERGENCY SHELTERS - SCOOLS: REGIONAL HS/ WILLIAMS MS/ BRIDGEWATER MS (SHELTER PLANS)	5, South Street, Mt. Prospect St	TOWN	S	10, 11, 16				H	O
EMERGENCY SHELTERS (MARRIOTT HOTEL)	Pleasant St	PRIVATE	S	10, 11, 16				H	O
NO 24/7 EMERGENCY ROOM IN TOWN	TBD	N/A	V	10, 11, 16				L	O
EMERGENCY STAGING	Spring Street Parking Lot	STATE/TOWN	S	10, 11, 16				M	O
PUBLIC RECREATION FACILITIES									
HIKING TRAILS	North Street	TOWN	S	14				L	L
GOLF COURSE	Olde Scotland Links 13	TOWN	V / S	1, 12, 14	12, 14			M	L
RECREATIONAL FIELDS	13	TOWN	S / V	1, 12, 14	12, 14			M	L
MEDICAL FACILITIES									
HEALTHCARE ACCESS: BEDFORD ST, PLEASANT STREET (PEDIATRIC)	Pleasant Street Bedford Street	PRIVATE	S	10, 11, 16				H	O

URGENT CARE	Campus Plaza	PRIVATE	S	**10, 11, 16**		H	O
TRANSPORTATION							
LUCINI BUS SERVICE	Townwide	PRIVATE	S	**10, 11, 16**		L	O
COMMUNICATION FACILITIES/SYSTEMS							
BRIDGEWATER SOCIAL MEDIA - FACEBOOK PAGE	Townwide	PRIVATE	S	**7, 10, 11, 16**		M	O
REVERSE 911 SYSTEM & BLAST TEXTS	Townwide	TOWN	S	**7, 10, 11, 16**		M	O
INTRA-TOWN COMMUNICATIONS	Townwide	TOWN	V / S	**10, 11**		H	O
POLICE DEPARTMENT DISPATCH 24/7	Townwide	TOWN	S	**10, 11**		H	O
FIRE DEPARTMENTS DISPATCH 24/7	Townwide	TOWN	S	**10, 11**		H	O
CITIZENS EMERGENCY RESPONSE TEAM - FIRST RESPONDERS TEAM 24/7	Townwide	TOWN	S	**10, 11**		H	O
STAKEHOLDER GROUPS							
BSU (3,000 ON CAMPUS and 7,000 COMMUTING)	12	STATE	S / V	**1**	**7, 10, 11, 16**	H	O
TAUNTON RIVER WATERSHED ALLIANCE	Taunton River Watershe	PRIVATE (NON-PROFIT)	S	**15, 16**	**16**	M	L
THE TAUNTON RIVER STEWARDSHIP/WILD & SCENIC RIVER	Taunton River	FEDERAL	S	**1, 16**		M	O

*** Please refer to Appendix C - Map of Bridgewater Societal and Environmental Assets for approximate location**

Community **R**esilience **B**uilding Risk Matrix

www.CommunityResilienceBuilding.org

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

H-**M**-**L** priority for action over the **S**hort or **L**ong term (and **O**ngoing)

V = Vulnerability **S** = Strength

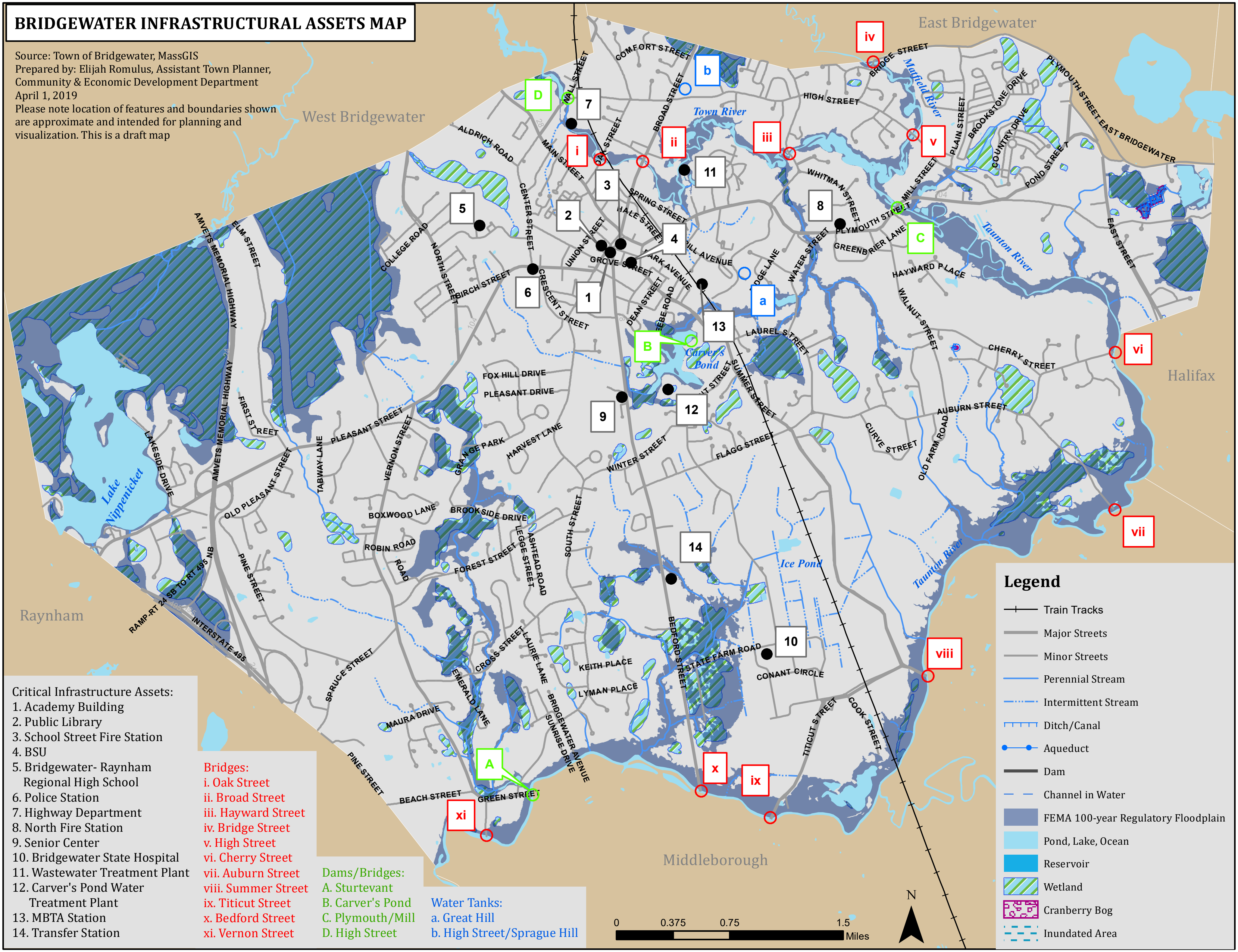
Features	Location	Ownership	V or S	FLOODING	WIND	WINTER STORMS/EXTREME COLD	DROUGHT/EXTREME HEAT	Priority H - M - L	Time Short Long Ongoing
Environmental									
WATER BODIES									
HOCKOMOCK SWAMP = FLOOD STORAGE	Around Lake Nippenick	STATE	V / S	1, 4, 5, 15, 16	N/A	N/A	15, 16	H	O
WILD & SCENIC TAUNTON RIVER	Townwide	FEDERAL	S / V	1, 4, 5, 15, 16	N/A	N/A	15, 16	H	O
WATER RESOURCES (PONDS, LAKES, RIVERS)	Townwide	TOWN	S / V	1, 12	N/A	4,5	15, 16	H	O
TOWN WETLANDS (MULTIPLE)	Townwide	TOWN	S / V	1, 12	N/A	4, 5	15, 16	H	O
AGRICULTURAL/FARMLANDS/LAND TRUSTS									
OLD PINE PLANTATIONS - AGING TREES (TOWN FOREST)	NW of Summer Street and Flagg St	TOWN	V	1, 13	13			M	S
FARM LAND LOSS TO RESIDENTIAL DEVELOPMENT	Townwide	N/A	V	4, 5, 16				M	L
NRTB (NATURAL RESOURCES TRUST OF BRIDGEWATER)	Townwide	TOWN	S	1, 14	14			M	O
TOWN FOREST	Townwide	TOWN	S	14				M	O
TOWN PARKS (6) / CONSERVATION LAND PRESERVED OPEN SPACE	Townwide	TOWN	S	14				M	O
WILDLAND TRUST	Great River Preserve Auburn St	PRIVATE (NON-PRPOFIT)	S	14				M	O
FARMLAND/AGRIC. RESTRICTION LAND	Townwide	TOWN/STATE	S	14				M	O
AQUIFERS									
TOWN WELLS (11)/DRINKING WATER SOURCE	4-High St; 5 - Carver's Pond;2-Plymouth St	TOWN	V / S	1, 4, 5, 16	4, 5, 16			H	O
SHALLOW GROUNDWATER / HIGH WATER TABLE	Townwide	N/A	V / S	1	N/A	4, 5	15, 16	H	O
AQUIFER PROTECTION DISTRICT	Townwide	TOWN	S	4, 5				H	L
STUDIES/ZONING ORDINANCE									
STORM-WATER ORDINANCE	Townwide	TOWN	V	1, 4, 5, 15, 16	4, 5, 15, 16			H	L
EXISTING SEPTIC SYSTEMS WITHIN FLOOD ZONE (STORMWATER BYLAW)	Townwide	TOWN	V	1,5	N/A	N/A	14	H	O
SEA LEVEL RISE @ SOUTHERN PORTION OF TOWN	Townwide	N/A	V	1, 16	16			M	O

*** Please refer to Appendix C - Map of Bridgewater Societal and Environmental Assets for approximate location**

APPENDIX B – MAP OF BRIDGEWATER INFRASTRUCTURAL ASSETS

BRIDGEWATER INFRASTRUCTURAL ASSETS MAP

Source: Town of Bridgewater, MassGIS
Prepared by: Elijah Romulus, Assistant Town Planner, Community & Economic Development Department
April 1, 2019
Please note location of features and boundaries shown are approximate and intended for planning and visualization. This is a draft map



Critical Infrastructure Assets:
1. Academy Building
2. Public Library
3. School Street Fire Station
4. BSU
5. Bridgewater- Raynham Regional High School
6. Police Station
7. Highway Department
8. North Fire Station
9. Senior Center
10. Bridgewater State Hospital
11. Wastewater Treatment Plant
12. Carver's Pond Water Treatment Plant
13. MBTA Station
14. Transfer Station

Bridges:
i. Oak Street
ii. Broad Street
iii. Hayward Street
iv. Bridge Street
v. High Street
vi. Cherry Street
vii. Auburn Street
viii. Summer Street
ix. Titicut Street
x. Bedford Street
xi. Vernon Street

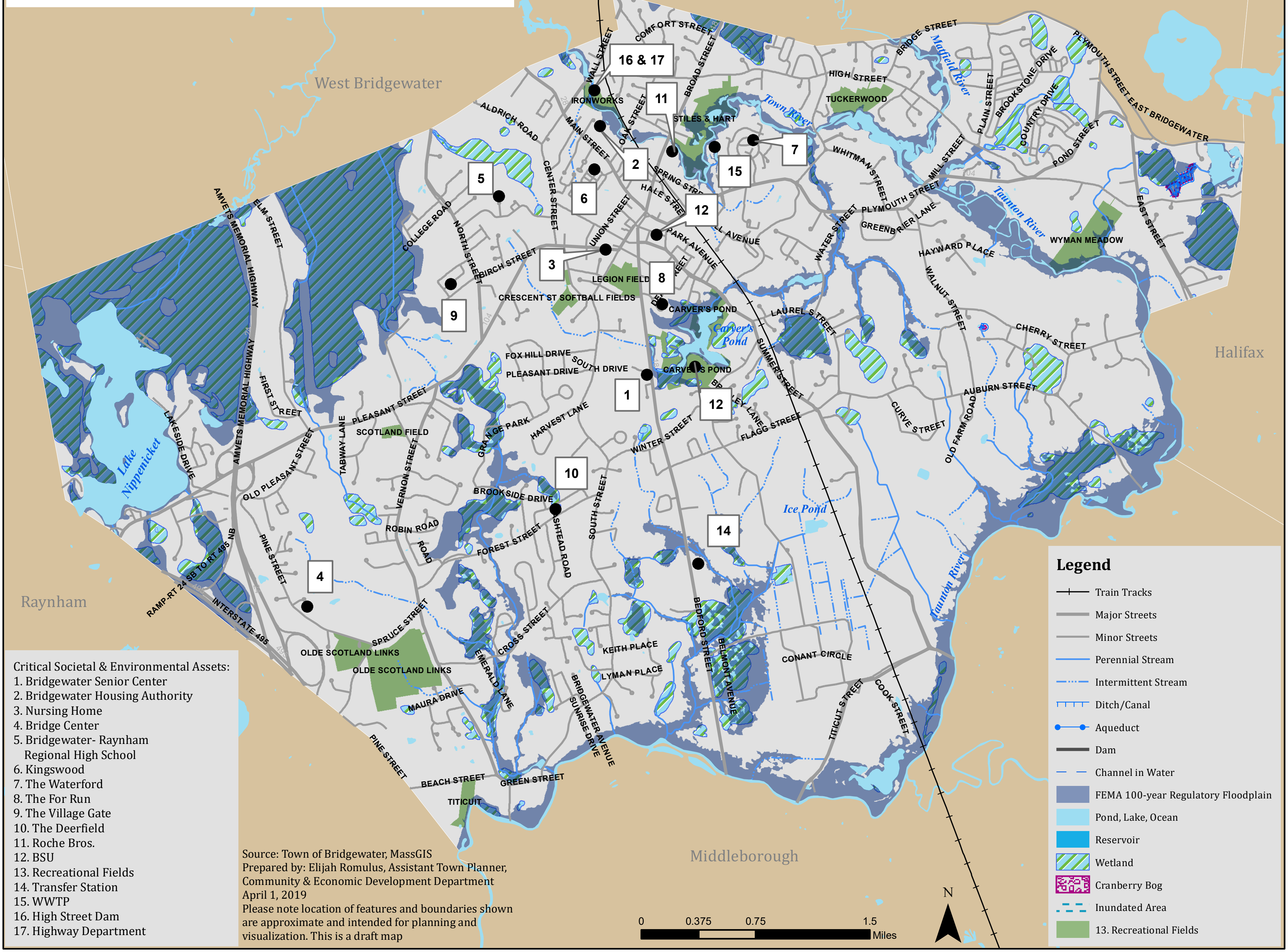
Dams/Bridges:
A. Sturtevant
B. Carver's Pond
C. Plymouth/Mill
D. High Street

Water Tanks:
a. Great Hill
b. High Street/Sprague Hill

APPENDIX C – MAP OF BRIDGEWATER

SOCIETAL AND ENVIRONMENTAL ASSETS

BRIDGEWATER SOCIETAL & ENVIRONMENTAL ASSETS MAP



APPENDIX D – WORKSHOP MATERIALS

MVP CORE TEAM KICK OFF MEETING

Bridgewater Municipal Vulnerability Preparedness (MVP) Plan

Peter A. Richardson, P.E., CFM, LEED AP, ENV SP
Danielle Spicer, P.E., LEED AP, ENV SP
(State Certified MVP Providers)

November 29, 2018

GREEN INTERNATIONAL AFFILIATES, INC.

Building Strong Client Relationships Through Engineering Excellence

Agenda

1. Introductions – MVP Core Team
2. Overview of MVP Program
3. Previous Related Mitigation Planning Efforts
4. Defining and Setting Goals for the Town's MVP Plan
5. Schedule Workshops and Invitation Process
6. Preparation of Materials for Workshops
7. Questions/Discussion
8. Adjourn

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Overview of MVP Program

- Governor Baker's E.O. No. 569: Establishing an Integrated Climate Change Strategy for the Commonwealth – 09/16/16
- E.O. 569 Created Assistant Secretary of Climate Change Position (appointed Katie Theoharides)
- E.O. 569 Created Municipal Vulnerability Preparedness (MVP) Program and grants for Town's to prepare plans based on EOEA (UMASS) Climate Change Projections
- Preparation of MVP Plan must follow CRB Framework

Climate Change Projections

- UMASS Climate Research Center Report
- Climate Change Projections from EOEA for Development of MVP Plans

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Preparation of MVP Plan

Community Resilience Building

Workshop Guide

www.CommunityResilienceBuilding.com

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Scope of Work

1. Support the municipal core team to prepare for the workshop(s):
2. Conduct (1) 8 hour workshop or (2) 4 hour works and provide lead facilitation and small group facilitation
3. Package workshop outcomes and generate the final report:
4. Help the community plan for next steps

   - Hold a public listening session by June 23, 2018

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Defining and Setting Goals for the Town's MVP Plan

Upon successful completion of the CRB process and clearly defined efforts to begin implementation (including conducting at least 1 public session), municipalities will be designated as a **"Municipal Vulnerability Preparedness Program Climate Community,"** or **"MVP Climate Community"** which may lead to increased standing in future funding opportunities and follow-on opportunities.

Schedule Workshops and Invitation Process

When, Where and Who's Invited?

- Workshop No 1 (4-hours) - Assess vulnerabilities
- Workshop No. 2 (4-hours) – Develop Actions

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Preparation of Materials for Workshops

1. Room with tables and ability to break into groups
2. GIS Maps with Critical Facilities and known Hazards
3. Previous Mitigation Action Items
4. Flipcharts, post its, markers etc.
5. Set Ground Rules

Questions

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MASSACHUSETTS CLIMATE CHANGE PROJECTIONS

Researchers from the Northeast Climate Science Center at the University of Massachusetts Amherst developed downscaled projections for changes in temperature, precipitation, and sea level rise for the Commonwealth of Massachusetts. The Executive Office of Energy and Environmental Affairs has provided support for these projections to enable municipalities, industry, organizations, state government and others to utilize a standard, peer-reviewed set of climate change projections that show how the climate is likely to change in Massachusetts through the end of this century.

Temperature and Precipitation Projections

The temperature and precipitation climate change projections are based on simulations from the latest generation of climate models[1] from the International Panel on Climate Change and scenarios of future greenhouse gas emissions.[2] The models were carefully selected from a larger ensemble of climate models based on their ability to provide reliable climate information for the Northeast U.S., while maintaining diversity in future projections that capture some of the inherent uncertainty in modeling climate variables like precipitation. The medium (RCP 4.5) and high (RCP 8.5) emission scenarios were chosen for possible pathways of future greenhouse gas emissions. A moderate scenario of future greenhouse gas emissions assumes a peak around mid-century, which then declines rapidly over the second half of the century, while the highest scenario assumes the continuance of the current emissions trajectory.

Fourteen climate models have been run with 2 emission scenarios each, which lead to 28 projections. The values cited in the tables below are based on the 10-90th percentiles across the 28 projections, so they bracket the *most likely* scenarios. For simplicity, we use the terms "…expected to…," and "…will be…," but recognize that these are estimates based on model scenarios and are *not predictive forecasts*. The statewide projections comprising county- and basin-level information are derived by statistically downscaling the climate model results.[3] They represent the best estimates that we can currently provide for a range of anticipated changes in greenhouse gases. Note that precipitation projections are generally more uncertain than temperature.

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[1] These latest generation of climate models are included in the Coupled Model Intercomparison Project Phase 5 (CMIP5), which formed the basis of projections summarized in the IPCC Fifth Assessment Report (2013).

[2] Future greenhouse gas emissions scenarios are typically expressed as "Representative Concentration Pathways" (RCPs). They indicate emissions trajectories that would lead to certain levels of radiative forcing by 2100, relative to the pre-industrial state of the atmosphere; RCP4.5 equates to +4.5W m^{-2}, and RCP 8.5 would be +8.5W m^{-2}. In effect, they represent different pathways that society may or may not follow, to reduce emissions through climate change mitigation measures.

[3] The Local Constructed Analogs (LOCA) method (Pierce et al., 2014) was used for the statistical downscaling of the statewide projections.

The downscaled temperature and precipitation projections for the Commonwealth are provided at three geographic scales (Table 1) for annual and seasonal temporal scales (Table 2), and can be accessed through the Massachusetts Climate Change Clearinghouse website (www.massclimatechange.org). The statewide projections are included in this guidebook, but temperature and precipitation projections at each of the Commonwealth's major basins are accessible on the website and as a supplemental PDF to this guide.

These climate projections are provided to help municipal officials, state agency staff, land managers, and others to identify future hazards related to, or exacerbated by changing climatic conditions. For the Municipal Vulnerability Preparedness (MVP) program participants, we recommend using climate projections downscaled to the major basin scale (Table 1) as there are regional differences across several climate indicators (Table 3). These projections can help MVP communities to think through how future hazards in their community may change, given projected changes in temperature and precipitation.

Regardless of geographic scale, rising temperatures, changing precipitation, and extreme weather will continue to affect the people and resources of the Commonwealth throughout the 21st century. A first step in becoming more climate-resilient is to identify the climate changes your community will be exposed to, the impacts and risks to critical assets, functions, vulnerable populations arising from these changes, the underlying sensitivities to these types of changes, and the background stressors that may exacerbate overall vulnerability.

Table 1: Geographic scales available for use for Massachusetts temperature and precipitation projections

Geographic Scale	Definition
Statewide	Massachusetts
County	Barnstable, Berkshire, Bristol, Dukes, Essex, Franklin, Hampden, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, Worcester
Major basins[4]	Blackstone, Boston Harbor, Buzzards Bay, Cape Cod, Charles, Chicopee, Connecticut, Deerfield, Farmington, French, Housatonic, Hudson, Ipswich, Merrimack, Millers, Narragansett Bay & Mt. Hope Bay, Nashua, North Coastal, Parker, Quinebaug, Shawsheen, South Coastal, Sudbury-Assabet-Concord (SuAsCo), Taunton, Ten Mile, Westfield, and Islands (presented here as Martha's Vineyard basin and Nantucket basin)

Table 2: Definition of seasons as applied to temporal scales used for temperature and precipitation projections

Season	Definition
Winter	December-February
Spring	March-May
Summer	June-August
Fall	September-November

[4] Many municipalities fall within more than one basin, so it is advised to use the climate projections for the basin that contains the majority of the land area of the municipality.

Table 3: List and definitions of projected temperature indicators

Climate Variable	Climate Indicator	Definition
Temperature	Average temperature	Average annual or seasonal temperature expressed in degrees Fahrenheit (ºF).
	Maximum temperature	Maximum annual or seasonal temperature expressed in degrees Fahrenheit (ºF).
	Minimum temperature	Minimum annual or seasonal temperature expressed in degrees Fahrenheit (ºF).
	Days with Tmax > 90 ºF	Number of days when daily maximum temperature exceeds 90ºF.
	Days with Tmax > 95 ºF	Number of days when daily maximum temperature exceeds 95ºF.
	Days with Tmax > 100 ºF	Number of days when daily maximum temperature exceeds 100ºF.
	Days with Tmin < 32 ºF	Number of days when daily minimum temperature is below 32 ºF.
	Days with Tmin < 0 ºF	Number of days when daily minimum temperature is below 0 ºF.
	Heating degree-days (base 65 ºF)	Heating degree-days (HDD) are a measure of how much and for how long outside air temperature was lower than a specific base temperature. HDD are the difference between the average daily temperature and 65°F. For example, if the mean temperature is 30°F, we subtract the mean from 65 and the result is 30 heating degree-days for that day. HDD serves as a proxy that captures energy consumption required to heat buildings, and is used in utility planning and building design.[5]
	Cooling degree-days (base 65 ºF)	Cooling degree days (CDD) are a measure of how much and for how long outside air temperature was higher than a specific base temperature. CDD are the difference between the average daily temperature and 65°F. For example, if the temperature mean is 90°F, we subtract 65 from the mean and the result is 25 cooling degree-days for that day. CDD serves as a proxy that captures energy consumption required to cool buildings, and is used in utility planning and building design. [6]
	Growing degree-days (base 50 ºF)	Growing degree days (GDD) are a measure of heat accumulation that can be correlated to express crop maturity (plant development). GDD is computed by subtracting a base temperature of 50°F from the average of the maximum and minimum temperatures for the day. Minimum temperatures less than 50°F are set to 50, and maximum temperatures greater than 86°F are set to 86. These substitutions indicate that no appreciable growth is detected with temperatures lower than 50° or greater than 86°.[7]

[5] For seasonal or annual projections, HDD are summed for the period of interest. For example, for winter HDD, one would sum the HDD for December 1 through February 28. Degree-days are not the equivalent of calendar days and thus why it is possible to have more than 365 degree-days.
[6] For seasonal or annual projections, CDD are summed for the period of interest. For example, for summer CDD, one would sum the CDD for June 1 through August 31. Degree-days are not the equivalent of calendar days and thus why it is possible to have more than 365 degree-days.
[7] Definition adapted from National Weather Service. Degree-days are not the equivalent of calendar days and thus why it is possible to have more than 365 degree-days.

Table 4: List and definitions of projected precipitation indicators

Climate Variable	Climate Indicator	Definition
Precipitation	Total precipitation	Total annual or seasonal precipitation expressed in inches.
	Days with precipitation >1 inch	Extreme precipitation events measured in days with precipitation eclipsing one inch.
	Days with precipitation > 2 inch	Extreme precipitation events measured in days with precipitation eclipsing two inches.
	Days with precipitation > 4 inch	Extreme precipitation events measured in days with precipitation eclipsing four inches.
	Consecutive dry days	For a given period, the largest number of consecutive days with precipitation less than 1 mm (0.039 inches).

Impacts from Increasing Temperatures

Warmer temperatures and extended heat waves could have very significant impacts on public health in our state, as well as the health of plants, animals and ecosystems like forests and wetlands. Rising temperatures will also affect important economic sectors like agriculture and tourism, and infrastructure like the electrical grid.

Annual air temperatures in the Northeast have been warming at an average rate of 0.5°F (nearly 0.26°C) per decade since 1970. Winter temperatures have been rising at a faster rate of 0.9°F[8] per decade on average. Even what seems like a very small rise in average temperatures can cause major changes in other factors, such as the relative proportion of precipitation that falls as rain or snow.

In Massachusetts, temperatures are projected to increase significantly over the next century. Winter average temperatures are likely to increase more than those in summer, with major impacts on everything from winter recreation to increased pests and challenges to harvesting for the forestry industry.

Beyond this general warming trend, Massachusetts will experience an increasing number of days with extreme heat in the future (Table 3). Generally, extreme heat is considered to be over 90 degrees F, because at temperatures above that threshold, heat-related illnesses and mortality show a marked increase.

Extreme heat can be especially damaging in urban areas, where there is often a concentration of vulnerable populations, and where more impervious surfaces such as streets and parking lots

[8] NOAA National Centers for Environmental information, Climate at a Glance: U.S. Time Series, Average Temperature, published December 2017, retrieved on December 21, 2017 from http://www.ncdc.noaa.gov/cag/

and less vegetation cause a “heat island” effect that makes them hotter compared to neighboring rural areas.
Urban residents in Massachusetts – especially those who are very young, ill, or elderly, and those who live in older buildings without air conditioning – will face greater risks of serious heat-related illnesses when extreme heat becomes more common. Extreme heat and dry conditions or drought could also be detrimental to crop production, harvest and livestock.

While warmer winters may reduce burdens on energy systems, more heat in the summer may put larger demands on aging systems, creating the potential for power outages. The number of cooling degree days is expected to increase significantly by the end of the century adding to this strain. In addition, heat can directly stress transmission lines, substations, train tracks, roads and bridges, and other critical infrastructure.

Impacts from Changing Precipitation Conditions

Rainfall is expected to increase in spring and winter months in particular in Massachusetts, with increasing consecutive dry days in summer and fall. More total rainfall can have an impact on the frequency of minor but disruptive flooding events, especially in areas where storm water infrastructure has not been adequately sized to accommodate higher levels. Increased total rainfall will also affect agriculture, forestry and natural ecosystems.

More intense downpours often lead to inland flooding as soils become saturated and stop absorbing more water, river flows rise, and the capacity of urban storm water systems is exceeded. Flooding may occur as a result of heavy rainfall, snowmelt, or coastal flooding associated with high wind and wave action, but precipitation is the strongest driver of flooding in Massachusetts. Winter flooding is also common in the state, particularly when the ground is frozen. The Commonwealth experienced 22 flood-related disaster declarations from 1954 to 2017 with many of these falling in winter or early spring, or during recent hurricanes.

The climate projections suggest that the frequency of high-intensity rainfall events will trend upward. Overall, it is anticipated that the severity of flood-inducing weather events and storms will increase, with events that produce sufficient precipitation to present a risk of flooding likely increasing. A single intense downpour can cause flooding and widespread damage to property and critical infrastructure. The coast will experience the greatest increase in high-intensity rainfall days, but some level of increase will occur in every area of Massachusetts.

Intense rainfall in urbanized areas can cause pollutants on roads and parking lots to get washed into nearby rivers and lakes, reducing habitat quality. As rainfall and snowfall patterns change, certain habitats and species that have specific physiological requirements may be affected.

Climate projections for Massachusetts indicate that in future decades, winter precipitation could increase, but by the end of the century most of this precipitation is likely to fall as rain instead of snow due to warmer winters. There are many human and environmental impacts that could result from this change including reduced snow cover for winter recreation and tourism, less spring snow melt to replenish aquifers, higher levels of winter runoff, and lower spring river flows for aquatic ecosystems.

A small projected decrease in average summer precipitation in Massachusetts could combine with higher temperatures to increase the frequency of episodic droughts, like the one experienced across the Commonwealth in the summer of 2016.

Droughts will create challenges for local water supply by reducing surface water storage and the recharge of groundwater supplies, including private wells. More frequent droughts could also exacerbate the impacts of flood events by damaging vegetation that could otherwise help mitigate flooding impacts. Droughts may also weaken tree root systems, making them more susceptible to toppling during high wind events.

Table 5: Statewide projected changes of temperature and precipitation variables by the middle and end of the century, based on climate models and the medium and high pathways of future greenhouse gas emissions. Projected changes for each climate indicator are given as a 30-year mean relative to the 1971-2000 baseline, centered on the 2050s (2040-2069) and the 2090s (2080-2099).[9] The values cited are the range of the most likely scenarios (10-90th percentile).

Climate Indicator		Observed Value 1971-2000 Average	Mid-Century Projected and Percent Change in 2050s (2040-2069)	End of Century Projected and Percent Change in 2090s (2080-2099)
Average Temperature	Annual	47.6 °F	Increase by 2.8 to 6.2 °F Increase by 6 to 13 %	Increase by 3.8 to 10.8 °F Increase by 8 to 23 %
	Winter	26.6 °F	Increase by 2.9 to 7.4 °F Increase by 11 to 28 %	Increase by 4.1 to 10.6 °F Increase by 15 to 40 %
	Spring	45.4 °F	Increase by 2.5 to 5.5 °F Increase by 6 to 12 %	Increase by 3.2 to 9.3 °F Increase by 7 to 20 %
	Summer	67.9 °F	Increase by 2.8 to 6.7 °F Increase by 4 to 10 %	Increase by 3.7 to 12.2 °F Increase by 6 to 18 %
	Fall	50 °F	Increase by 3.6 to 6.6 °F Increase by 7 to 13 %	Increase by 3.9 to 11.5 °F Increase by 8 to 23 %
Maximum Temperature	Annual	58.0 °F	Increase by 2.6 to 6.1 °F Increase by 4 to 11 %	Increase by 3.4 to 10.7 °F Increase by 6 to 18 %
	Winter	36.2 °F	Increase by 2.5 to 6.8 °F Increase by 7 to 19 %	Increase by 3.5 to 9.6 °F Increase by 10 to 27 %
	Spring	56.1 °F	Increase by 2.3 to 5.4 °F Increase by 4 to 10 %	Increase by 3.1 to 9.4 °F Increase by 6 to 17 %
	Summer	78.9 °F	Increase by 2.6 to 6.7 °F Increase by 3 to 8 %	Increase by 3.6 to 12.5 °F Increase by 4 to 16 %
	Fall	60.6 °F	Increase by 3.4 to 6.8 °F Increase by 6 to 11 %	Increase by 3.8 to 11.9 °F Increase by 6 to 20 %
Minimum Temperature	Annual	37.1 °F	Increase 3.2 to 6.4 °F Increase by 9 to 17 %	Increase by 4.1 to 10.9°F Increase by 11 to 29 %
	Winter	17.1 °F	Increase by 3.3 to 8.0 °F Increase by 19 to 47 %	Increase by 4.6 to 11.4 °F Increase by 27 to 66 %
	Spring	34.6 °F	Increase by 2.6 to 5.9 °F Increase by 8 to 17 %	Increase by 3.3 to 9.2 °F Increase by 9 to 26 %
	Summer	56.8 °F	Increase by 3 to 6.9 °F Increase by 5 to 12 %	Increase by 3.9 to 12 °F Increase by 7 to 21 %
	Fall	39.4 °F	Increase by 3.5 to 6.5 °F Increase by 9 to 16 %	Increase by 4.0 to 11.4 °F Increase by 10 to 29 %

[9] A 20-yr mean is used for the 2090s because the climate models end at 2100.

Table 5 Continued

Climate Indicator		Observed Value 1971-2000 Average	Mid-Century Projected and Percent Change in 2050s (2040-2069)	End of Century Projected and Percent Change in 2090s (2080-2099)
Days with Tmax > 90°F	Annual	5 days	Increase by 7 to 26 days	Increase by 11 to 64 days
	Winter	0 days	No change	No change
	Spring	< 1 day[10]	Increase by 0 to 1 days	Increase by 0 to 4 days
	Summer	4 days	Increase by 6 to 22 days	Increase by 9 to 52 days
	Fall	< 1 day[9]	Increase by 0 to 3 days	Increase by 1 to 9 days
Days with Tmax > 95°F	Annual	< 1 day[9]	Increase by 2 to 11 days	Increase by 3 to 35 days
	Winter	0 days	No change	No change
	Spring	< 1 day[9]	No change	Increase by 0 to 1 days Increase by
	Summer	< 1 day[9]	Increase by 2 to 10 days	Increase by 3 to 32 days
	Fall	< 1 day[9]	Increase by 0 to 1 day	Increase by 0 to 3 days
Days with Tmax > 100°F	Annual	< 1 day[9]	Increase by 0 to 3 days	Increase by 0 to 13 days
	Winter	0 days	No change	No change
	Spring	0 days	No change	No change
	Summer	< 1 day[9]	Increase by 0 to 3 days	Increase by 0 to 12 days
	Fall	0 days	No change	Increase by 0 to 1 day
Days with Tmin < 32°F	Annual	146 days	Decrease by 19 to 40 days	Decrease by 24 to 64 days
	Winter	82 days	Decrease by 4 to 12 days	Decrease by 6 to 25 days
	Spring	37 days	Decrease by 6 to 15 days	Decrease by 9 to 20 days
	Summer	< 1 day[9]	No change	No change
	Fall	27 days	Decrease by 8 to 13 days	Decrease by 8 to 20 days
Days with Tmin < 0°F	Annual	8 days	Decrease by 4 to 6 days	Decrease by 4 to 7 days
	Winter	8 days	Decrease by 3 to 6 days	Decrease by 4 to 6 days
	Spring	< 1 day[9]	No change	No change
	Summer	0 days	No change	No change
	Fall	< 1 day[9]	No change	No change

[10] Over the observed period, there were some years with at least 1 day with seasonal Tmax over (or Tmin under) a certain threshold while in all the other years that threshold wasn't crossed seasonally at all.

Table 5 Continued

Climate Indicator		Observed Value 1971-2000 Average	Mid-Century Projected and Percent Change in 2050s (2040-2069)	End of Century Projected and Percent Change in 2090s (2080-2099)
Heating Degree-Days (Base 65°F)	Annual	6839 degree-days	Decrease by 773 to 1627 degree-days Decrease by 11 to 24 %	Decrease by 1033 to 2533 degree-days Decrease by 15 to 37 %
	Winter	3475 degree-days	Decrease by 259 to 681 degree-days Decrease by 7 to 20 %	Decrease by 376 to 973 degree-days Decrease by 11 to 28 %
	Spring	1822 degree-days	Decrease by 213 to 468 degree-days Decrease by 12 to 26 %	Decreases by 283 to 727 degree-days Decrease by 16 to 40 %
	Summer	134 degree-days	Decrease by 63 to 101 degree-days Decrease by 47 to 76 %	Decrease by 76 to 120 degree-days Decrease by 65 to 89 %
	Fall	1407 degree-days	Decrease by 282 to 469 degree-days Decrease by 20 to 33 %	Decrease by 289 to 752 degree-days Decrease by 21 to 53 %
Cooling Degree-Days (Base 65°F)	Annual	457 degree-days	Increase by 261 to 689 degree-days Increase by 57 to 151 %	Increase by 356 to 1417 degree-days Increase by 78 to 310 %
	Winter	0 degree-days	Increase by 0 to 5 degree-days	Increase by 0 to 5 degree-days
	Spring	17 degree-days	Increase by 15 to 48 degree-days Increase by 88 to 277 %	Increase by 18 to 110 degree-days Increase by 103 to 636 %
	Summer	397 degree-days	Increase by 182 to 519 degree-days Increase by 46 to 131 %	Increase by 260 to 1006 degree-days Increase by 65 to 253 %
	Fall	40 degree-days	Increase by 40 to 139 degree-days Increase by 100 to 350 %	Increase by 69 to 297 degree-days Increase by 175 to 750 %
Growing Degree-Days (Base 50°F)	Annual	2344 degree-days	Increase by 531 to 1210 degree-days Increase by 23 to 52 %	Increase by 702 to 2347 degree-days Increase by 30 to 100 %
	Winter	5 degree-days	Increase by 1 to 13 degree-days Increase by 21 to 260 %	Increase by 4 to 27 degree-days Increase by 74 to 563 %
	Spring	259 degree-days	Increase by 88 to 226 degree-days Increase by 34 to 87 %	Increase by 104 to 450 degree-days Increase by 40 to 174 %
	Summer	1644 degree-days	Increase by 253 to 618 degree-days Increase by 15 to 38 %	Increase by 342 to 1124 degree-days Increase by 21 to 68 %
	Fall	429 degree-days	Increase by 172 to 394 degree-days Increase by 40 to 92 %	Increase by 216 to 745 degree-days Increase by 50 to 174 %

Table 5 Continued

Climate Indicator		Observed Value 1971-2000 Average	Mid-Century Projected and Percent Change in 2050s (2040-2069)	End of Century Projected and Percent Change in 2090s (2080-2099)
Days with Precipitation Over 1”	Annual	7 days	Increase by 1 to 3 days	Increase by 1 to 4 days
	Winter	2 days	Increase by 0 to 1 days	Increase by 0 to 2 days
	Spring	2 days	Increase by 0 to 1 days	Increase by 0 to 1 days
	Summer	2 days	Increase by 0 to 1 days	Increase by 0 to 1 days
	Fall	2 days	Increase by 0 to 1 days	Increase by 0 to 1 days
Days with Precipitation Over 2”	Annual	1 day	Increase by 0 to 1 days	Increase by 0 to 1 days
	Winter	< 1 day[11]	Increase by < 1 day[10]	Increase by < 1 day[10]
	Spring	< 1 day[10]	Increase by < 1 day[10]	Increase by < 1 day[10]
	Summer	< 1 day[10]	Increase by < 1 day[10]	Increase by < 1 day[10]
	Fall	< 1 day[10]	Increase by < 1 day[10]	Increase by < 1 day[10]
Days with Precipitation Over 4”	Annual	< 1 day[10]	Increase by < 1 day[10]	Increase by < 1 day[10]
	Winter	0 days	No change	Increase by < 1 day[10]
	Spring	0 days	Increase by < 1 day[10]	Increase by < 1 day[10]
	Summer	< 1 day[10]	Increase by < 1 day[10]	Increase by < 1 day[10]
	Fall	< 1 day[10]	Increase by < 1 day[10]	Increase by < 1 day[10]
Total Precipitation	Annual	47 inches	Increase by 1 to 6 inches Increase by 2 to 13 %	Increase by 1.2 to 7.3 inches Increase by 3 to 16 %
	Winter	11.2 inches	Increase by 0.1 to 2.4 inches Increase by 1 to 21 %	Increase by 0.4 to 3.9 inches Increase by 4 to 35 %
	Spring	12 inches	Increase by 0.1 to 2 inches Increase by 1 to 17 %	Increase by 0.4 to 2.7 inches Increase by 3 to 22 %
	Summer	11.5 inches	Decrease by 0.4 to Increase by 2 inches Decrease by 3 % to Increase by 17 %	Decrease by 1.5 to Increase by 1.9 inches Decrease by 13% to Increase by 16 %
	Fall	12.2 inches	Decrease by 1.1 to Increase by 1.4 inches Decrease by 9 to Increase by 12 %	Decrease by 1.7 to Increase by 1.4 inches Decrease by 14 to Increase by 11 %
Consecutive Dry Days	Annual	17 days	Increase by 0 to 2 days	Increase by 0 to 3 days
	Winter	11 days	Decrease by 1 to Increase by 1 days	Decrease by 1 to Increase by 2 days
	Spring	11 days	Decrease by 1 to Increase by 1 day	Decrease by 1 to Increase by 1 day
	Summer	12 days	Decrease by 1 to Increase by 2 days	Decrease by 1 to Increase by 3 days
	Fall	12 days	Increase by 0 to 3 days	Increase by 0 to 3 days

[11] Over the observed period, there were some years with at least 1 day with seasonal precipitation over a certain threshold while in all the other years that threshold wasn’t crossed seasonally at all.

TAUNTON BASIN

MUNICIPALITIES WITHIN TAUNTON BASIN:
Abington, Attleboro, Avon, Berkley, Bridgewater, Brockton, Carver, Dighton, East Bridgewater, Easton, Fall River, Foxborough, Freetown, Halifax, Hanson, Holbrook, Kingston, Lakeville, Mansfield, Middleborough, New Bedford, North Attleborough, Norton, Pembroke, Plainville, Plymouth, Plympton, Raynham, Rehoboth, Rochester, Rockland, Sharon, Somerset, Stoughton, Swansea, Taunton, West Bridgewater, Whitman, and Wrentham

Many municipalities fall within more than one basin, so it is advised to use the climate projections for the basin that contains the majority of the land area of the municipality.

TAUNTON BASIN

Taunton Basin		Observed Baseline 1971-2000 (°F)	Projected Change in 2030s (°F)	Mid-Century Projected Change in 2050s (°F)	Projected Change in 2070s (°F)	End of Century Projected Change in 2090s (°F)
Average Temperature	Annual	49.9	+2.0 to +3.8	+2.7 to +5.9	+3.1 to +8.6	+3.4 to +10.5
	Winter	30.0	+2.2 to +4.4	+2.9 to +6.7	+3.5 to +8.8	+3.9 to +10.1
	Spring	47.3	+1.7 to +3.4	+2.4 to +5.4	+2.6 to +7.5	+3.1 to +9.2
	Summer	69.6	+1.7 to +3.9	+2.2 to +6.3	+2.8 to +9.6	+3.4 to +11.6
	Fall	52.1	+2.1 to +4.5	+3.4 to +6.3	+3.2 to +9.0	+3.7 to +11.2
Maximum Temperature	Annual	60.3	+1.9 to +3.7	+2.5 to +5.9	+2.8 to +8.6	+3.1 to +10.4
	Winter	39.5	+1.8 to +4.2	+2.5 to +6.2	+3.0 to +8.1	+3.4 to +9.4
	Spring	58.0	+1.5 to +3.4	+2.0 to +5.2	+2.5 to +7.6	+3.0 to +9.0
	Summer	80.5	+1.6 to +3.8	+2.1 to +6.2	+2.7 to +9.7	+3.1 to +11.6
	Fall	62.7	+2.1 to +4.4	+3.3 to +6.4	+3.1 to +9.0	+3.4 to +11.3
Minimum Temperature	Annual	39.4	+2.1 to +3.9	+2.9 to +6.1	+3.4 to +8.6	+3.8 to +10.6
	Winter	20.5	+2.5 to +4.7	+3.2 to +7.3	+4.1 to +9.4	+4.4 to +10.8
	Spring	36.7	+1.8 to +3.5	+2.7 to +5.7	+2.7 to +7.4	+3.2 to +9.1
	Summer	58.6	+1.8 to +3.9	+2.4 to +6.5	+2.9 to +9.4	+3.6 to +11.5
	Fall	41.6	+2.1 to +4.7	+3.5 to +6.3	+3.3 to +9.0	+4.0 to +11.1

- The Taunton basin is expected to experience increased average temperatures throughout the 21st century. Maximum and minimum temperatures are also expected to increase throughout the end of the century. These increased temperature trends are expected for annual and seasonal projections.
- Seasonally, maximum summer and fall temperatures are expected to see the highest projected increase throughout the 21st century.
    - Summer mid-century increase of 2.1 °F to 6.2 °F (3-8% increase); end of century increase of 3.1 °F to 11.6 °F (4-14% increase).
    - Fall mid-century increase of 3.3 °F to 6.4 °F (5-10% increase); end of century increase by and 3.4 °F to 11.3 °F (5-18% increase).
- Seasonally, minimum winter and fall temperatures are expected to see increases throughout the 21st century.
    - Winter mid-century increase of 3.2 °F to 7.3 °F (16-35% increase); end of century increase by 4.4 °F to 10.8 °F (21-52% increase).
    - Fall mid-century of 3.5 °F to 6.3 °F (8-15% increase); end of century increase of 4 °F to 11.1 °F (10-27% increase).

TAUNTON BASIN

Taunton Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)	Mid-Century Projected Change in 2050s (Days)	Projected Change in 2070s (Days)	End of Century Projected Change in 2090s (Days)
Days with Maximum Temperature Over 90°F	Annual	7	+5 to +15	+7 to +29	+9 to +50	+12 to +65
	Winter	0	+0 to +0	+0 to +0	+0 to +0	+0 to +0
	Spring	1	+<1[93] to +1	+<1[93] to +1	+<1[93] to +2	+<1[93] to +3
	Summer	7	+5 to +13	+6 to +25	+8 to +42	+11 to +53
	Fall	<1[93]	+1 to +2	+1 to +4	+1 to +7	+1 to +10
Days with Maximum Temperature Over 95°F	Annual	1	+1 to +5	+2 to +11	+3 to +25	+4 to +38
	Winter	0	+0 to +0	+0 to +0	+0 to +0	+0 to +0
	Spring	<1[93]	+0 to +<1[93]	+<1[93] to +<1[93]	+<1[93] to +<1[93]	+<1[93] to +1
	Summer	1	+1 to +4	+2 to +10	+2 to +22	+3 to +34
	Fall	<1[93]	+<1[93] to +1	+<1[93] to +1	+<1[93] to +3	+<1[93] to +4
Days with Maximum Temperature Over 100°F	Annual	<1[93]	+<1[93] to +1	+<1[93] to +3	+<1[93] to +6	+<1[93] to +13
	Winter	0	+0 to +0	+0 to +0	+0 to +0	+0 to +0
	Spring	0	+0 to +<1[93]	+0 to +<1[93]	+0 to +<1[93]	+0 to +<1[93]
	Summer	<1[93]	+<1[93] to +1	+<1[93] to +3	+<1[93] to +6	+<1[93] to +12
	Fall	0	+0 to +<1[93]	+<1[93] to +<1[93]	+<1[93] to +<1[93]	+<1[93] to +1

- Due to projected increases in average and maximum temperatures throughout the end of the century, the Taunton basin is also expected to experience an increase in days with daily maximum temperatures over 90 °F, 95 °F, and 100 °F.
  - Annually, the Taunton basin is expected to see days with daily maximum temperatures over 90 °F increase by 7 to 29 more days by mid-century, and 12 to 65 more days by the end of the century.
  - Seasonally, summer is expected to see an increase of 6 to 25 more days with daily maximums over 90 °F by mid-century.
  - By end of century, the Taunton basin is expected to have 11 to 53 more days.

[93] Over the observed period, there were some years with at least 1 day with seasonal Tmax over a certain threshold while in all the other years that threshold wasn't crossed seasonally at all.

TAUNTON BASIN

Taunton Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)	Mid-Century Projected Change in 2050s (Days)	Projected Change in 2070s (Days)	End of Century Projected Change in 2090s (Days)
Days with Minimum Temperature Below 0°F	Annual	3	-1 to -2	-1 to -2	-1 to -2	-1 to -2
	Winter	3	-1 to -2	-1 to -2	-1 to -2	-1 to -2
	Spring	<1[94]	-0 to -0	-0 to -0	-0 to -0	-0 to -0
	Summer	0	-0 to -0	-0 to -0	-0 to -0	-0 to -0
	Fall	0	-0 to -0	-0 to -0	-0 to -0	-0 to -0
Days with Minimum Temperature Below 32°F	Annual	130	-13 to -28	-19 to -44	-23 to -57	-25 to -68
	Winter	78	-4 to -9	-5 to -16	-7 to -25	-8 to -31
	Spring	30	-4 to -11	-7 to -16	-8 to -19	-9 to -21
	Summer	0	-0 to -0	-0 to -0	-0 to -0	-0 to -0
	Fall	21	-5 to -10	-8 to -12	-8 to -16	-8 to -17

- Due to projected increases in average and minimum temperatures throughout the end of the century, the Taunton basin is expected to experience a decrease in days with daily minimum temperatures below 32 °F and 0 °F.
- Seasonally, winter, spring and fall are expected to see the largest decreases in days with daily minimum temperatures below 32 °F.
  - Winter is expected to have 5 to 16 fewer days by mid-century, and 8 to 31 fewer days by end of century.
  - Spring is expected to have 7 to 16 fewer days by mid-century, and 9 to 21 fewer days by end of century.
  - Fall is expected to have 8 to 12 fewer days by mid-century, and 8 to 17 fewer days by end of century.

[94] Over the observed period, there were some years with at least 1 day with seasonal Tmin under a certain threshold while in all the other years that threshold wasn't crossed seasonally at all.

TAUNTON BASIN

Taunton Basin		Observed Baseline 1971-2000 (Degree-Days)	Projected Change in 2030s (Degree-Days)			Mid-Century Projected Change in 2050s (Degree-Days)			Projected Change in 2070s (Degree-Days)			End of Century Projected Change in 2090s (Degree-Days)		
Heating Degree-Days (Base 65°F)	Annual	6130	-510	to	-1001	-710	to	-1479	-825	to	-1957	-907	to	-2325
	Winter	3167	-200	to	-403	-255	to	-616	-314	to	-794	-355	to	-931
	Spring	1644	-137	to	-290	-198	to	-458	-219	to	-612	-275	to	-71
	Summer	85	-29	to	-51	-38	to	-66	-43	to	-76	-48	to	-82
	Fall	1226	-141	to	-320	-252	to	-422	-229	to	-596	-253	to	-681
Cooling Degree-Days (Base 65°F)	Annual	580	+203	to	+411	+260	to	+706	+303	to	+1123	+365	to	+1439
	Winter	0	-1	to	+4	+0	to	+6	+0	to	+3	+0	to	+6
	Spring	20	+10	to	+26	+16	to	+49	+18	to	+81	+17	to	+108
	Summer	505	+126	to	+312	+164	to	+518	+209	to	+80	+259	to	+993
	Fall	55	+34	to	+90	+52	to	+163	+61	to	+250	+89	to	+328
Growing Degree-Days (Base 50°F)	Annual	2622	+378	to	+759	+506	to	+1190	+576	to	+1889	+665	to	+2362
	Winter	6	+1	to	+16	+2	to	+18	+7	to	+33	+7	to	+47
	Spring	297	+67	to	+132	+89	to	+232	+96	to	+361	+101	to	+472
	Summer	1800	+158	to	+360	+204	to	+580	+254	to	+879	+311	to	+1069
	Fall	518	+104	to	+272	+182	to	+406	+173	to	+604	+226	to	+766

- Due to projected increases in average, maximum, and minimum temperatures throughout the end of the century, the Taunton basin is expected to experience a decrease in heating degree-days, and increases in both cooling degree-days and growing degree-days.
- Seasonally, winter historically exhibits the highest number of heating degree-days and is expected to see the largest decrease of any season, but spring and fall are also expected to see significant change.
  - The winter season is expected to see a decrease of 8-19% (255 -616 degree-days) by mid-century, and a decrease of 11-29% (355 -931 degree-days) by the end of century.
  - The spring season is expected to decrease in heating degree-days by 12-28% (198-458 degree-days) by mid-century, and by 17-44% (275 -717 degree-days) by the end of century.
  - The fall season is expected to decreases in heating degree-days by 21-34% (252 -422 degree-days) by mid-century, and by 21-56% (253 -681 degree-days) by the end of century.
- Conversely, due to projected increasing temperatures, summer cooling degree-days are expected to increase by 33-103% (164 -518 degree-days) by mid-century, and by 51-197% (259 -993 degree-days) by end of century.

- Seasonally, summer historically exhibits the highest number of growing degree-days and is expected to see the largest decrease of any season, but the shoulder seasons of spring and fall are also expected to see an increase in growing degree-days.
    - The summer season is projected to increase by 11-32% (204 -580 degree-days) by mid-century, and by 17-59% (311 -1069 degree-days) by end of century.
    - Spring is expected to see an increase by 30-78% (89 -232 degree-days) by mid-century and 34-159% (101 -472 degree-days) by end of century.
    - Fall is expected to see an increase by 35-78% (182 -406 degree-days) by mid-century and 44-148% (226 -766 degree-days) by end of century.

TAUNTON BASIN

Taunton Basin		Observed Baseline 1971-2000 (Days)		Mid-Century		End of Century
			Projected Change in 2030s (Days)	Projected Change in 2050s (Days)	Projected Change in 2070s (Days)	Projected Change in 2090s (Days)
Days with Precipitation Over 1”	Annual	8	+<1[95] to +2	+1 to +3	+1 to +3	+1 to +4
	Winter	2	+<1[95] to +1	+<1[95] to +1	+<1[95] to +1	+<1[95] to +2
	Spring	2	+<1[95] to +1	+<1[95] to +1	+<1[95] to +1	+<1[95] to +2
	Summer	2	-0 to +<1[95]	-0 to +1	-0 to +1	-0 to +1
	Fall	2	-0 to +1	-0 to +1	-0 to +1	-0 to +1
Days with Precipitation Over 2”	Annual	1	-0 to +<1[95]	+<1[95] to +1	+<1[95] to +1	+<1[95] to +1
	Winter	<1[95]	-0 to +<1[95]	+<1[95] to +<1[95]	+<1[95] to +<1[95]	-0 to +<1[95]
	Spring	<1[95]	-0 to +<1[95]	+<1[95] to +<1[95]	-0 to +<1[95]	-0 to +<1[95]
	Summer	<1[95]	-0 to +<1[95]	-0 to +<1[95]	-0 to +<1[95]	-0 to +<1[95]
	Fall	<1[95]	-0 to +<1[95]	+<1[95] to +<1[95]	+<1[95] to +<1[95]	-0 to +<1[95]
Days with Precipitation Over 4”	Annual	<1[95]	-0 to +<1[95]	+<1[95] to +<1[95]	-0 to +<1[95]	-0 to +<1[95]
	Winter	0	-0 to +<1[95]	-0 to +<1[95]	-0 to +<1[95]	-0 to +<1[95]
	Spring	0	-0 to +<1[95]	-0 to +<1[95]	-0 to +<1[95]	-0 to +<1[95]
	Summer	<1[95]	-0 to +<1[95]	-0 to +<1[95]	-0 to +<1[95]	-0 to +<1[95]
	Fall	<1[95]	-0 to +<1[95]	-0 to +<1[95]	-0 to +<1[95]	-0 to +<1[95]

- The projections for expected number of days receiving precipitation over one inch are variable for the Taunton basin, fluctuating between loss and gain of days.
    - Seasonally, the winter season is generally expected to see the highest projected increase.
    - The winter season is expected to see an increase in days with precipitation over one inch of 0-1 days by mid-century, and an increase of 0-2 days by the end of century.
    - The spring season is expected to see an increase in days with precipitation over one inch of 0-1 days by mid-century, and of an increase of 0-1 days by the end of century.

[95] Over the observed period, there were some years with at least 1 day with seasonal precipitation over a certain threshold while in all the other years that threshold wasn’t crossed seasonally at all.

TAUNTON BASIN

Taunton Basin		Observed Baseline 1971-2000 (Inches)	Projected Change in 2030s (Inches)	Mid-Century Projected Change in 2050s (Inches)	Projected Change in 2070s (Inches)	End of Century Projected Change in 2090s (Inches)
Total Precipitation	Annual	47.5	-0.1 to +4.1	+0.3 to +5.4	+0.9 to +6.6	+0.4 to +7.3
	Winter	12.1	-0.3 to +1.5	+0.0 to +2.0	+0.2 to +2.7	+0.1 to +3.8
	Spring	11.9	-0.1 to +1.8	+0.0 to +2.0	+0.1 to +2.4	+0.2 to +2.6
	Summer	11.0	-0.6 to +1.1	-0.7 to +1.7	-1.7 to +2.4	-1.9 to +2.1
	Fall	12.4	-0.8 to +1.1	-0.9 to +1.5	-1.5 to +1.7	-1.7 to +1.4

- Similar to projections for number of days receiving precipitation over a specified threshold, seasonal projections for total precipitation are also variable for the Taunton basin.
  - The winter season is expected to experience the greatest change with an increase of 0-16% by mid-century, and of 1-32% by end of century.
  - Projections for the summer and fall seasons are more variable, and could see either a drop or increase in total precipitation throughout the 21st century.
    - The summer season projections for the Taunton or basin could see a decrease of 0.7 to an increase of 1.7 inches by mid-century (decrease of 6% to increase of 16%) and a decrease of 1.9 to an increase of 2.1 inches by the end of the century (decrease of 17% to increase of 19%).
    - The fall season projections for the Taunton basin could see a decrease of 0.9 to an increase of 1.5 inches by mid-century (decrease of 7% to increase of 12%) and a decrease of 1.7 to an increase of 1.4 inches by the end of the century (decrease of 14% to increase of 11%).

Taunton Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)	Mid-Century Projected Change in 2050s (Days)	Projected Change in 2070s (Days)	End of Century Projected Change in 2090s (Days)
Consecutive Dry Days	Annual	17	-0 to +1	-0 to +3	-1 to +3	-0 to +4
	Winter	11	-1 to +2	-1 to +2	-1 to +2	-1 to +2
	Spring	12	-1 to +1	-1 to +1	-1 to +1	-1 to +1
	Summer	14	-1 to +1	-1 to +2	-1 to +2	-1 to +3
	Fall	13	-0 to +2	-0 to +3	-0 to +3	-0 to +3

- Annual and seasonal projections for consecutive dry days, or for a given period, the largest number of consecutive days with precipitation less than 1 mm (~0.04 inches), are variable throughout the 21st century.
  - For all the temporal parameters, the Taunton basin is expected to see a slight decrease to an increase in consecutive dry days throughout this century.
  - Seasonally, the fall and summer seasons are expected to continue to experience the highest number of consecutive dry days.
    - The summer season is expected to experience a decrease of 1 day to an increase of 3 days in consecutive dry days by the end of the century.

Community Resilience Building

WORKSHOP GUIDE

www.CommunityResilienceBuilding.org

Introduction

The need for municipalities, corporations, organizations, and government agencies among others to build community resilience and adapt to extreme weather and hazards is now strikingly evident. Ongoing events continuously reinforce this urgency and compel leading communities to proactively plan and act. This leadership is to be commended as it reduces the vulnerability of residents, employees, students, infrastructure and the environment, and serves as an example of what is possible for other communities. As a response to this ever-increasing need and urgency, the ***Community Resilience Building Workshop*** was created.

Over the last decade the Community Resilience Building Workshop has been tried and tested, and is ***trusted by over one-hundred communities*** that are now on the right path to resilience. The Community Resilience Building Workshop is rooted in extensive experience working with communities by The Nature Conservancy, NOAA's Office for Coastal Management, and countless partners. The Community Resilience Building Workshop provides a ***friendly "anywhere at any scale"*** process for developing resilience action plans for communities including municipalities, agencies, organizations, and corporations (local to global). The Community Resilience Building Workshop employs a unique community-driven process, rich with information, experience, and dialogue, where the participants identify top hazards, current challenges, and strengths and then develop and prioritize actions to improve their community's resilience to all natural and climate-related hazards today, and in the future.

The core directive of the Community Resilience Building Workshop is to foster collaboration with and among community stakeholders that will advance the education, planning and ultimately implementation of priority actions. This directive is achieved through a ***carefully crafted, facilitated approach*** centered on a unique catalyst — the Risk Matrix. The Risk Matrix structures the capture and organization of community dialogue and helps to generate the momentum needed to advance resilience building. The Workshop's central objectives are to:

- define extreme weather and natural and climate-related hazards,
- identify existing and future vulnerabilities and strengths,
- develop and prioritize actions for the community and broader stakeholder networks, and
- identify opportunities for the community to advance actions to reduce risks and build resilience.

The following ***Community Resilience Building Workshop Guide*** is designed to provide clear instructions on how to lead your community towards improved resilience. This *Guidebook* carefully illustrates the essentials of the Community Resilience Building Workshop process as well as the "before" and "after" workshop considerations to help ensure immediate goals, outcomes, and strategic direction are realized within your community.

After nearly a decade in development with over one-hundred communities, we are very proud to offer this Community Resilience Building Workshop Guide. Please join other communities employing this tried, tested, and trusted Workshop approach. For further guidance, support, and coaching please ***contact Dr. Adam Whelchel and visit www.CommunityResilienceBuilding.org*** for more Workshop materials and examples from other communities that have successfully exercised the Community Resilience Building Workshop.

Overview of the Process (Steps & Tasks)

DURING WORKSHOP (steps B–F)

A. Prepare for the Workshop
1. Establish a core team with goals.
2. Engage stakeholders.
3. Prepare materials for workshop.
4. Decide on participant arrangements.

B. Characterize Hazards
1. Identify past, current, and future impacts.
2. Determine the highest-priority hazards.

C. Identify Community Vulnerabilities and Strengths
1. Identify infrastructural vulnerabilities and strengths.
2. Identify societal vulnerabilities and strengths.
3. Identify environmental vulnerabilities and strengths.

D. Identify and Prioritize Community Actions
1. Identify and prioritize infrastructural actions.
2. Identify and prioritize societal actions.
3. Identify and prioritize environmental actions.

E. Determine the Overall Priority Actions
1. Identify highest-priority actions.
2. Further define urgency and timing.

F. Put It All Together
1. Generate final workshop products.

G. Move Forward
1. Continue community outreach and engagement.
2. Secure additional data and information.
3. Inform existing planning and project activities.

Community Components
- Infrastructural
- Societal
- Environmental

(A) Prepare for the Workshop

Section A Objective: **In advance of a Community Resilience Building Workshop, lay groundwork for an effective and collaborative exchange amongst participants and eventual implementation of community-originated actions by a broader array of stakeholders. Initiate this pre-workshop section 2-6 months prior to the actual Workshop – depending on current state of community readiness.**

1 Establish a core team with goals.

Engage and secure consent of leadership (i.e., mayor, commissioner, CEO, or equivalent) to hold Workshop and assign key staff to core team, if appropriate. Establish core team—with clear roles and responsibilities—and organize the implementation of the Community Resilience Building Workshop. Define specific Workshop goals by asking why the community needs to discuss current and future impacts of hazards. In addition, predetermine how the community will use the information and decisions constructed during the Workshop. Finally, develop a reasonable timeline over which all Workshop steps ("before", "during", "after") will be completed. Reconnect with leadership once core team with goals/timeline is secure.

Core team reviews goals, responsibilities, and timelines before their Community Resilience Building Workshop. © *Adam Whelchel*

Goal Setting Questions:

- Will the CRB Workshop start a new conversation and identify next steps?
  Or: Will the CRB Workshop help to augment other specific planning needs such as natural hazard mitigation plans, master plans, supply-chain stability assessments, sustainability plans, capital improvements, equity/inclusion, and/or others?
- Will the CRB Workshop help to identify a list of at-risk neighborhoods, employers/employees, wetlands, and other community features across the entire community?
  Or: Will the CRB Workshop be focused on a single segment of a municipality, department within an agency, individual sector of a business, individual campus or system, and/or other?

Example Goals:

- The CRB Workshop will be a new initiative to immediately integrate community-derived priorities into a natural hazard mitigation plan and 5-year capital improvement budget.
- The CRB Workshop will augment an existing inter-department directive to meet both resilience and sustainability targets.
- The CRB Workshop will help build resilience by generating greater awareness, prioritization, and ideally launch action plans in five at-risk neighborhoods within three years.

2

Engage stakeholders (core team).

Identify stakeholders for Workshop engagement. Invite a wide range of people to participate based on their background, experience, authority, and where they work and live. Consider individuals or entities — across the entire community — affected in the past by hazards and likely to be impacted in the future? Consider individuals or entities that influence, guide, and/or have the authority to make decisions? Generate list of potential stakeholder, identify date for Workshop, develop outreach material if needed, and begin to secure Workshop participants. Allow six week between initial "save the date" invitations and Workshop. Typical Workshop formats include one day (6-8 hours) or two half-days (4 hrs. apiece) ideally spaced two weeks apart.

Stakeholder Guidance:

For ideas, start with this list of potential stakeholders:
http://coast.noaa.gov/data/digitalcoast/pdf/checklist-risk-vulnerability.pdf

Participant affiliation lists from other Workshops available at www.CommunityResilienceBuilding.org.

Get help on how to engage stakeholders from NOAA's *Introduction to Stakeholder Participation*:
http://coast.noaa.gov/data/digitalcoast/pdf/stakeholder-participation.pdf

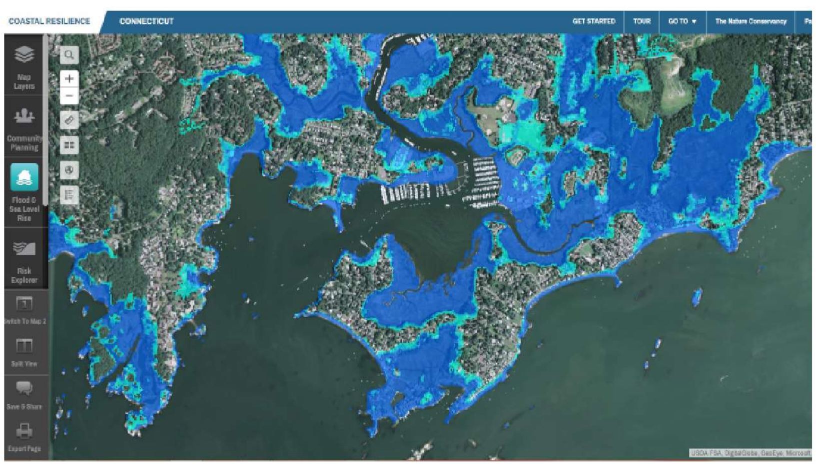
Committed stakeholders and community leaders engaged in their Community Resilience Building Workshops. © *Adam Whelchel*

3 Prepare materials for workshop (core team).

Gather and synthesize pertinent information related to the impacts of and responses to hazards in the community including:

- Existing maps and online tools, natural hazard mitigation plans, photos, historical information, damage assessments and claims, and people's stories to help the core team prepare.
- Consider sending a pre-workshop Community Characterization Survey to identified participants to efficiently capture core information about how the community currently perceives, assesses, and acts to reduce risks.

An additional approach, if situations and time permit, is a pre-workshop listening session for stakeholders to verbally and visually present their stories, photos, scientific information on hazards and future projections. Information shared can be synthesized with other materials in preparation for Workshop.



Historic Category-3 Hurricane (1938) with downscaled sea level rise projections.
Source: The Nature Conservancy's Coastal Resilience Tool ***(www.CoastalResilience.org)***.

Guidance:

A street map supported by aerial images serves as a basemap (3' x 5') during the Workshop upon which participants identify community features (i.e., schools, bridges, wetlands).

Helpful information to show on supporting maps include hazard extent (e.g., flooding, wildfire-prone areas), population density and percent below poverty, current and future land use and zoning, public amenities such as parks and ball fields, protected open space areas, roads, utilities, waterways, land cover, major employers, commercial and industrial areas, and natural resources (e.g., wetlands, floodplains, beaches, forests, coral reefs, etc.).

Review NOAA's *Introduction to Planning and Facilitating Effective Meetings*: https://coast.noaa.gov/digitalcoast/training/effective-meetings.html

Review TNC's Coastal Resilience (www.coastalresilience.org)

Review NOAA's Digital Coast (https://coast.noaa.gov/digitalcoast)
- Search "Coastal Flood Exposure Mapper"
- Search "Sea Level Rise Viewer"

Pre-workshop support materials are available at **www.CommunityResilienceBuilding.org**, including:

1) Steps/Tasks - timelines and activity lists,
2) Workshop invitation language and flyers,
3) Workshop Participant Worksheet and Guidance,
4) Community Characterization Survey questions,
5) Sample maps products and tools, and
6) Blank Risk Matrix.

4

Decide on participant grouping for workshop (core team).

Central to the successful application of the Community Resilience Building Workshop is to open (Section B-1) and close (Section E) the Workshop with large team (all participants) sessions; with small team sessions in between (Section B-2 through Section D). This "large-small-large" team dynamic allows for detailed input from individuals along with a collective synthesis for comprehensive community resilience building. The critical step of assigning participants to small teams depends on attendance with 40-50 participants and 6-8 people per small team (no more than 10) as the ideal. Careful consideration should be directed to diversifying small team membership based on rank, position, roles, responsibilities, and expertise of participants.

Grouping Options for Small Teams:

Single sector – Group participants by like sectors (i.e., infrastructure, emergency management, social services, natural resources, finance) to capture higher levels of detail on select issues. This approach works well if the core team is at a point where very detailed information on risks and actions for a single sector is required. The tradeoff is that a more comprehensive, mixed-sector discovery of actions will need to be synthesized by a large team (Section E) or after the Workshop by the core team (Section F & G).

Mixed sectors – Group participants from diverse sectors together to foster an exchange of different perspectives and actions for community resilience building. This approach helps participants see the connections comprehensively and develop common actions with co-benefits across sectors. In well-attended Workshops, it may be advantageous to have both single- and mixed-sector small teams to get both the detail and development of collaborative, comprehensive actions.

By location – Group participants by geographic location or structural units within an organization (i.e., department, division, agency) to facilitate deeper dialogue on specific aspects of the issue. Small team report-outs are critical here to ensure the various teams can listen for commonalities which ideally result in cross-jurisdictional or multi-organizational actions. This approach works well for Workshops with large and/or complex focus areas with multiple jurisdictions or overlapping governmental/corporate decision-making authority and processes.

Community Resilience Building Workshop participants collaboratively share experiences and create priority actions on the Risk Matrix. © *Adam Whelchel*

B Characterize Hazards

Section B Objective: Develop agreement among Workshop participants on top four hazards for facilitated discussions on vulnerabilities and strengths of the community's people, infrastructure, departments, supply chain, and natural resources among others.

1 Identify past, current, and future hazards (large team).

Direct participants to make a list of hazards (causes of impacts) that the community has dealt with, currently faces, and anticipates experiencing in the future (i.e., tornados, ice/wind storms, drought, wildfire, tsunamis, sea level rise, landslides, earthquakes, etc.). Utilize the following triggering questions to accelerate dialogue and surface initial agreement on top four hazards.

- What hazards have impacted your community in the past? Where, how often, and in what ways?
- What hazards are impacting your community currently? Where, how often, and in what ways?
- What effects will these hazards/changes have on your community in the future (5, 10, 25 years)?
- What is exposed to hazards and climate threats within your community?
- What have been the impacts to operations and budgets, planning and mitigation efforts?
- Others concerns or considerations related to impacts?

A **Hazard** is like the sun. The **Risk** from that hazard is sunburn. The **Vulnerability** includes the length of **Exposure** of skin to the sun. The **Action** to reduce risk from the hazard is to apply sunscreen or seek shade.

Top to bottom: © Rich Reid/TNC, © Devan King/TNC, © Jay Harrod/TNC

2 Determine top-priority hazards (small teams).

Divide into pre-determined small teams (see A-3 above). Drawing from the previous large team dialogue (Section B-1), identify the **Top 4 Hazards** that pose the greatest threat to the community currently and over the next decade or longer and against which the community should take action? After each small team reaches agreement, respectively, write the selections in the **Top 4 Hazards** section of the **Risk Matrix**. The Risk Matrix captures the community's Top 4 Hazards, vulnerabilities, strengths, and actions. The Risk Matrix provides information necessary to develop strategies, inform community plans and advance actions to lessen hazard impacts and build resilience.

Small team discusses Top 4 Hazards and Risk Matrix in a Community Resilience Building Workshop in Connecticut. *© Adam Whelchel*

Community Resilience Building Workshop Risk Matrix

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

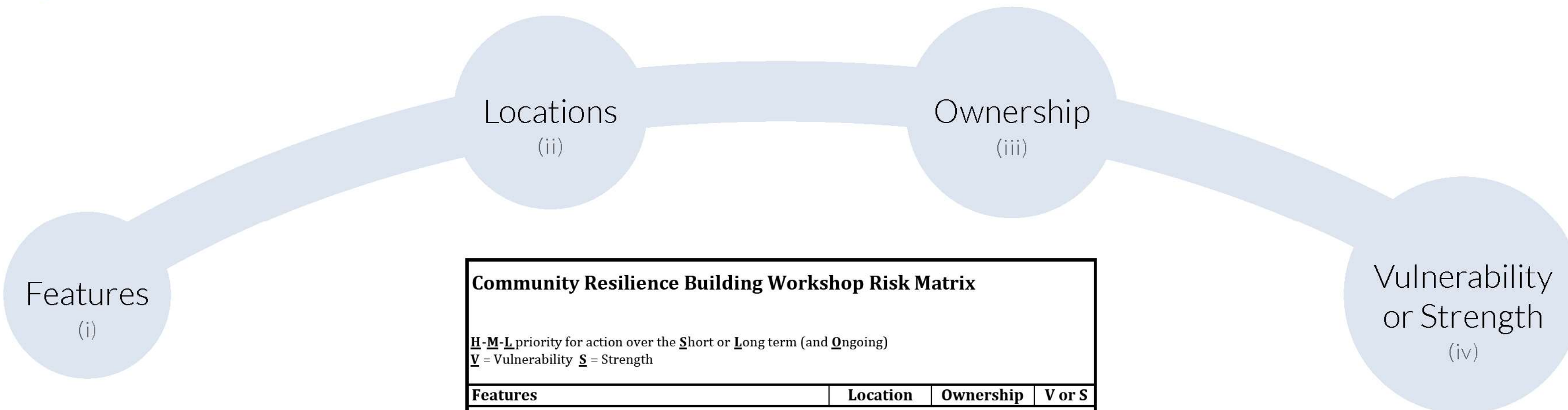
Top 4 Hazards (tornado, floods, wildfire, hurricanes, snow/ice, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Coastal Flooding	Extreme Precipitation Events	Heat Waves	Wind	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Societal									
Environmental									

In this example of a **Risk Matrix**, the small team decided that coastal flooding, extreme precipitation events, heat waves, and wind were the **Top 4 Hazards**. The small team then focused on the vulnerability and strengths of features and actions to address these Top 4 Hazards in their community.

C Identify Community Vulnerabilities and Strengths

Section C Objectives (small teams): **Develop a comprehensive understanding or profile of the community's (1) infrastructural, (2) societal, and (3) environmental components that are impacted by the Top 4 Hazards (B-2), as well as those features that help to make the community stronger and more resilient against these top hazards. The Risk Matrix captures the community's Top 4 Hazards, vulnerabilities, strengths, and actions. The Risk Matrix provides information necessary to develop strategies, inform community plans and advance actions to lessen hazard impacts and build resilience.**



Community Resilience Building Workshop Risk Matrix

H-**M**-**L** priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

Features	Location	Ownership	V or S
Infrastructural			
Societal			
Environmental			

Steps C1, C2 and C3 below focus on identifying intrastructural, societal and environmental vulnerabilities and strengths. Each step requires three tasks to complete the Risk Matrix: **(i)** identify features, **(ii)** describe feature locations, **(iii)** identify feature ownership, and **(iv)** identify each feature as a vulnerability or strength, or both.