North Reading
MASSACHUSETTS

MUNICIPAL VULNERABILITY PREPAREDNESS (MVP) PLAN

SUBMITTED BY

GREEN INTERNATIONAL AFFILIATES, INC.
Civil and Structural Engineers

May, 2018

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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 (EOEA) 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. The 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. North Reading was awarded an MVP Grant to develop a resiliency plan and retained the services of Green International Affiliates, Inc., whose Executive Vice President, Peter A. Richardson, P.E., CFM, is a certified MVP Provider. Mr. Richardson served as the lead facilitator at the required workshops and is the principal author of this report.

The Town of North Reading has been proactive over the past two decades relative to hazard mitigation, especially as it relates to reducing flood damage. Led by the efforts of recently retired Town Engineer, Michael P. Soraghan, P.E., the Town applied for, and received, several hazard mitigation grants from the Federal Emergency Management Agency (FEMA).

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 February 14, 2018 and at the Kick-off meeting, the MVP Core Team established the MVP Plan goals, and following the CRB Guidelines, held two (2) ½-day, 4-hour workshops, for the development of the plan. The two (2) ½-day workshops were held on March 21, 2018 and March 27, 2108, respectively. The Goals for the MVP Plan developed by the Core Team are as follows:

Goals for North Reading's MVP Plan

1. Identify Climate Change Vulnerabilities, considering Infrastructural, Societal and Environmental factors and Develop Action Steps to make the Town more Resilient and Sustainable to extreme weather-related conditions in the future based on EOEA climate change projections.

2. Develop an MVP Plan that compliments and builds upon the Town's previous mitigation efforts over the past two decades and the 2016 Hazard Mitigation Plan

3. Develop and MVP Plan that satisfies the requirements of the MA EOEA, such that it receives approval and makes the Town Eligible for Future MVP Grants

The first workshop focused on identifying the Town's top hazards and vulnerabilities, as well as the Town's strengths and weaknesses, while the second workshop focused on developing action steps that the Town should take to be more resilient to projected climate change conditions, taking into consideration previous action steps the Town has already developed as part of its 2016 Hazard Mitigation Plan.

At the first workshop, participants agreed that the top four natural hazards that need to be investigated relative to future climate change projections are: 1) Flooding; 2) Winter Storms/Blizzards/Nor'easters; 3) Wind and 4) Extreme Cold/Heat (including drought). The workshop participants also identified vulnerable areas in Town and the Town's strengths and Assets under three categories, infrastructural, societal and environmental.

At the second workshop, participants reviewed hazard mitigation action steps from the Town's FEMA approved 2016 Hazard Mitigation Plan (2016 HMP) and updated them in light if climate change projects. Participants also developed new action steps in addition to the 2016 HMP. A complete list of Prioritized Action Steps in included in Section VI of this report.

The Draft MVP Plan was presented at a Public Listening Session on May 17, 2018 and presented to the Board of Selectmen, who endorsed the plan, on May 21, 2018.

One of the most important findings to come out of the two workshops was that in order for the Town to truly know its vulnerability to climate change relative to the most significant natural hazard identified in Town (i.e. Flooding), flood maps that depict floodplains in the future are needed. The Town's current flood maps are outdated now, especially for the Ipswich River. Following the workshops, FEMA was contacted and reported that the Ipswich River Watershed will be restudied in approximately one year. Therefore, it will be several years before updated FEMA flood maps are available that depict the current flood risk for the Ipswich River floodplain, let alone future conditions.

Once the FEMA study is complete, the Town would be able to acquire the hydraulic computer model from FEMA and then perform its own hydrologic and hydraulic analyses using EOEA climate change projection data. The Town already has a hydraulic computer model for the Martins Brook watershed that could be used to run climate change projections now.

Once the Town's MVP Plan is approved by EOEA, North Reading will be eligible for future MVP grants.

REPORT CITATION, WORKSHOP PARTICIPANTS, AND ACKNOWLEDGEMENTS

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

Workshop Participants:

Workshop Number 1 – March 21, 2018	**Workshop Number 2 – March 27, 2018**
MVP Provider: Peter Richardson	MVP Provider: Peter Richardson
Emergency Management: Theo Kuliopulos	Emergency Management: Theo Kuliopulos
Martins Pond Association: Janet Niccosia	Planning Department: Danielle McKnight
Planning Department: Danielle McKnight	Conservation Commission: Leah Basbanes
Conservation Commission: Leah Basbanes	Water Department/DPW: Mark Clark
Water Department/DPW: Mark Clark	DPW: Chris Deming
DPW: Chris Deming	Town Engineer: Mike Soraghan
Town Engineer: Mike Soraghan	Police Department: Derek Howe
Health Department: Bob Bracey	School Department: Wayne Hardacker
Police Department: Derek Howe	GIS (NECE): Rebecca Dupont-Coutu
School Department: Wayne Hardacker	GIS (NECE): Bill Ross
GIS (NECE): Rebecca Dupont-Coutu	Facilities Department: Julie Spurr-Knight
Facilities Department: Julie Spurr-Knight	RMLD: Tom Ollila
Ipswich River Watershed Assoc.: Wayne Castonguay	Tufts University: Darya Marttis
RMLD: Tom Ollila	
Tufts University: Darya Marttis	

Acknowledgements: MVP Core Team

MVP Provider: Peter Richardson
Emergency Management: Theo Kuliopulos
Martins Pond Association: Janet Niccosia
Building Inspector: Jim DeCola
Planning Department: Danielle McKnight
Conservation Commission: Leah Basbanes
Water Department: Mark Clark
Town Engineer: Mike Soraghan
Fire Department: Barry Galvin
Health Department: Bob Bracey
Police Department: Mike Murphy/ Kevin Brennan
School Department: Wayne Hardacker
GIS (NECE): Bill Ross/Rebecca Dupont-Coutu
Facilities Department: Julie Spurr-Knight

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 contains five Sections intended to address the above referenced findings. Sections 1 and 2 are related to Greenhouse Gas (GHG) emissions. Sections 3 and 4, as summarized below, are related to making the Commonwealth more resilient to effects of Climate Change:

> ***Section 3.*** *The Secretary of Energy and Environmental Affairs and the Secretary of Public Safety shall coordinate efforts across the Commonwealth to strengthen the resilience of communities, prepare for the impacts of climate change, and to prepare for and mitigate damage from extreme weather events by publishing: A Climate Adaptation Plan that includes a statewide adaptation strategy; Guidance and strategies for state agencies and authorities, municipalities and regional planning agencies to proactively address these impacts through adaptation and resiliency measures; Clear goals, expected outcomes, and a path to achieving results; Approaches for the Commonwealth to lead by example to increase the resiliency of Government operations; Policies and strategies for ensuring that adaptation and resiliency efforts complement efforts to reduce GHG emissions and contribute towards meeting the emission limits in the GWSA; And strategies that conserve and sustainably use the Commonwealth's natural resources. Other requirements of Section 3 include establishing a framework for each Executive Office to assess its vulnerability to climate change and extreme weather events, to identify adaptation options for its agencies' assets, to establish a framework for each City and Town in the Commonwealth to assess local vulnerability to climate change and extreme weather events (and identify adaptation options for its assets), to provide*

technical assistance to Cities and Towns to complete vulnerability assessments/adaptation strategies, and to implement the Climate Adaptation Plan upon with updates at least every five years.

Section 4. *The Secretary of each Executive Office shall designate a Secretariat's Climate Change Coordinator to serve as the Secretariat's point person regarding climate change mitigation, adaptation and resiliency efforts who will: Assist in the development and implementation of the Climate Adaptation Plan; Assess the vulnerability to climate change and extreme weather events for the Coordinator's Executive Office and for each agency within the Coordinator's Executive Office and identify adaptation options for the assets of such Executive Office and agencies; And incorporate results from vulnerability assessments into existing policies and plans for the Executive Office and its agencies.*

Section 5 of EO 569 states that the Executive Order is to be reviewed no later than December 31, 2019, and every five years thereafter.

MUNICIPAL VULNERABILITY PREPAREDNESS (MVP) GRANT PROGRAM

Under EO 569, the Massachusetts Executive Office of Energy and Environmental Affairs (EOEA - 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, EOEA also created the Municipal Vulnerability Preparedness (MVP) grant program. The following excerpt taken from the EOEA 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. North Reading retained the services of Green International Affiliates, Inc., whose Executive Vice President, Peter A. Richardson, P.E., CFM, is a certified MVP Provider. Mr. Richardson served as the lead facilitator for the project and is the principal author of this report.

NORTH READING'S SUSTAINABILITY AND RESILIENCY EFFORTS

The Town of North Reading has been proactive over the past two decades relative to hazard mitigation, especially as it relates to reducing flood damage. Recently retired Town Engineer, Michael P. Soraghan, P.E., applied for the Town's first hazard mitigation grant from the Federal Emergency Management Agency (FEMA) in 1999 to construct a flood wall around the Town's Public Safety Complex and to address several problematic culverts in Town. Since 1999 under Mr. Soraghan's leadership, the Town has applied for and received several additional FEMA hazard mitigation grants, including grants for the Town to develop its first Flood Hazard Mitigation Plan (2002), an All-Hazards Mitigation Plan (2006) and the most recent update to the Town's Hazard Mitigation Plan (2016), as well as other culvert projects and additional improvements to the flood wall at the Public Safety Complex. In addition, the Town of North Reading applied for a grant in 2000 through FEMA's Cooperating Technical Partners (CTP) grant program to update its own Flood Insurance Study for the Martins Brook watershed, allowing the Town to have more accurate flood maps for flood prone areas within the watershed much faster than waiting for the next scheduled FEMA update. To date, North Reading is the only municipality in Region 1 (New England) to ever perform their own hydrologic and hydraulic analyses as part of a FEMA Flood Insurance Study.

However, even with updated flood maps for the Martins Brook watershed, North Reading has experienced flooding along the Ipswich River that has exceeded the effective FEMA 100-year floodplain on several occasions since 2000, since the flood maps for the Ipswich River are still based on an outdated hydrologic analysis (due to funding limitations, the Town was only able to address the Martins Brook Watershed through the CTP program). Based on recent experience, the Town has concluded that the flood mapping for the Ipswich River in North Reading is already underestimating the true 1% chance flood (i.e. the FEMA 100-year flood) based on floods that have occurred over the past two decades, let alone the floods that will occur in the future resulting from increased precipitation due to climate change.

When the Town became aware of the MVP Program, developing an MVP Plan was the next logical step in North Reading's hazard mitigation efforts, and as such, the Town applied for and received a grant from the Commonwealth to develop an MVP Plan. In developing the MVP Plan, the expectation is that it will fully compliment and build upon the Town's currently adopted 2016 Hazard Mitigation Plan.

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 different types of disasters, 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. Sadly, 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 seem to be an obvious cost-effective strategy, especially when considering the new B/C ratio of 7:1 from the NIBS 2017 study.

Based on the simple equation that Risk = Probability x Consequences, as North Reading considers its vulnerability (i.e. Risk), new 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. When taking into consideration the continued development that is occurring in flood-prone areas (i.e. increased consequences), the Town is most likely increasing its risk if it does not offset these two factors with more proactive mitigation efforts.

TOWN PROFILE AND HISTORY

(Excerpts taken from Town of North Reading's 2016 Hazard Mitigation Plan Update)

The Town of North Reading is a 13.53 square mile suburban Town in Middlesex County, set entirely within the watershed of the Ipswich River. It was created as an independent Town in 1853 and retains a number of simple and well-preserved mid-18th century homes. The Town of North Reading is located in Northeastern Massachusetts, bordered by Wilmington on the west, Andover and North Andover on the north, Middleton and Lynnfield on the east, and Reading on the south. North Reading is 10 miles south of Lawrence and 15 miles north of Boston. North Reading has a total population of 15,014 as of July 1, 2014.

North Reading was incorporated as a Town in 1853, having earlier (1713) been the North Parish and part of what is now Wakefield and Reading, the First and West Parishes, respectively. The earliest human residents were the Algonquin people of the Massachusetts language group, whose campgrounds adjacent to several waterways have been documented by archaeologists. Many artifacts are now at the Peabody Museum at Phillips Academy. Most of the European settlers later worked at clearing and farming land. "As the population grew, occupations diversified, a service sector developed, with schools, mills, taverns, shoe shops (a winter occupation for farmers), tannery, railroad station, fire engine company, and a militia-training field."

"Original grants of large farmsteads along the river during the mid-17th century brought six families to the settlement before 1680. The economy of the Town in the 17th and 18th century was based on subsistence farming with limited crop production. There was a sawmill on Lob's Pond by 1694 and grist and sawmills at the village center by 1794. Some small scale boot and shoe making was underway by 1820, and by 1850 small sheds or shops to make shoes were attached to almost every house in Town. These shops produced cheap footwear that was sold south to clothe slaves, and the Civil War destroyed the Town's industry. The principal products of the Town in the early 20th century were milk, apples and fruits. The Town center retains a Federal style meeting house and affluent Federal village with a well-preserved district of period houses, and Townspeople are very proud of the fact that their Town center retains its complete historic fabric."

Like many rural communities, the railroad brought immense change to North Reading. The introduction of the railroad provided a means to transport freight between the large mills in Lawrence and Lowell, and introduced a way for passengers to travel far beyond their Town borders. The railroad came to North Reading in 1850 and joined South Danvers (now Peabody) to Tewksbury where it connected to the Lowell mills via the Lowell and Lawrence Railroad. By 1887, the Boston and Maine Railroad took over the line. Passenger service along the route ended in 1932, and freight service between North Reading and Wilmington ended in 1935.

After World War II, North Reading began to transform into the community it remains today, an outlying suburb of the Boston Metro area. Much of the agricultural land has been developed as housing. Although there is some local industry concentrated within the southwestern portion of Town and commercial development along Main Street (Route 28), it is predominantly a residential community.

GEOGRAPHY

The Town is a suburban community, which retains some of the character of its early rural heritage. Gentle rises and flat meadows descend to the Ipswich River Basin, which traces a path through the southern portion of the Town just south of the historic Town Center. Smaller streams and brooks meander through the central and western portions of North Reading with four ponds and connected wetland systems scattered throughout the northern half of the Town. Much of the undeveloped land is forested and there are traces of stonewall from the Town's early agricultural heritage.

The landform of North Reading is generally from flat to gently rolling. The highest elevation is 230 feet above mean sea level on United States Geological Survey datum, with an average elevation of approximately 100 feet. The advance and retreat of the continental ice sheet from more than 10,000 years ago left North Reading's pre-glacial bedrock covered with a variety of glacial deposits. As a result, it has a direct bearing on the suitability of much of the Town's land for development and other purposes. The Town's glacial deposits that were left by departed ice sheets have two general types, a) compact basal till, and b) outwash deposits, which form the parent material for the majority of the Town's soils.

Compact basal till was formed beneath the actively moving ice sheet, and is an unsorted assemblage of all particle sizes including clay, silt, sands, gravel, and boulders. The composition of basal till is very dense, hence commonly referred to as "hardpan." Infiltration is extremely slow through the hardpan, and as a result water is often perched in the soil above the dense till layer. As a consequence, many soils formed in basal till have severe limitations for septic disposal. These soils are often wet during the spring, but become very dry during the summer months. In North Reading, many of the till deposits occur in conjunction with shallow-to-bedrock areas. Some till areas have sandier layers near the surface, and may be suitable for development. However, many of the wetlands, which are found on the tops and slopes of hills, are the result of an underlying basal till deposit. As the ice sheet melted, glacial outwash deposits were formed in front of the "stalled" ice sheet. Similarly, kame terraces were formed between stagnant ice and adjacent hillsides. Both formations contain stratified (layered) deposits of sand and gravel.

Meltwater leaving the glacier carried gravel, sand, silt, and clay particles with it, leaving the stones and boulders behind in the stagnant ice. Because gravel and sand is relatively heavy, these materials were deposited in well-sorted layers fairly close to the melting ice, while the water continued to carry the lighter silts and clays away from the glacier. Because of the well-sorted coarse textured deposits, which lack silts and clays, many soils formed in these areas yield rapid "perc" test rates, and are viewed as good building sites. However, the extremely rapid permeability of many of these soils may be a disadvantage in aquifer recharge areas, as contaminants can quickly enter the groundwater. While many of these deposits are very

well-drained, wetlands are found in outwash plains when they are located in a low position on the landscape. A good surface indicator of an outwash plain is the presence of "kettle hole" depressions in a relatively level area, which lacks surface stones and boulders. Kettle holes were formed as outwash buried remnant ice blocks, which later melted, leaving the circular "kettle hole" depressions that often hold a small pond or wetland.

The U.S. Department of Agriculture (USDA) has determined that about 39% of the soils in North Reading are favorable for residential development, in light of the fact that the Town is not served by municipal sewers, instead relies on sub-surface disposal of sanitary waste. The favorable soils are typically better drained. Sandier soils, which are found in outwash deposits, yield acceptable percolation rates pursuant to the requirements of Title V of the State Sanitary Code. Soils that drain faster than 2 minutes per inch are considered poor filters of sewage, and should be considered a constraint to development in aquifer recharge areas. Most of the remaining soils are from moist to wet because of its imperfect drainage property (including many areas underlain by dense basal till), shallowness to bedrock, or a high water table during a portion of the year. Other soils unfavorable to development are steeply sloped, or contain densely packed glacial till, which is too impermeable for septic systems. Like much of New England, glaciation has left significant obstacles to development in North Reading.

The native vegetation of North Reading is an integral part of the Town's regional character. The tall oaks and huge white pines, which were prized by the king's shipbuilders for masts, clearly show that this is not the shore, nor the inland bottomlands, nor the limestone areas of the Berkshires. They are indicators of the dry, sandy; acidic soils across the northerly half of Town. By contrast, the fern-covered forests elsewhere in Town indicate that water is nearby and the area is probably a floodplain.

North Reading, despite recent intensity of development, still contains a few large tracts of forestland. The University of Massachusetts carried out an analysis of land use and vegetative based on 1971 aerial photography, classified slightly more than 5,000 acres (57.7% of the Town) as forest. Of this, approximately 50.5% hardwoods, 9% softwoods, and about 40.5% mixed forest. These forests were predominately well-stocked with large 40-80 foot trees. Follow-up research in 1994 by the Town Planning Department estimated remaining forest cover of less than 2,938 acres or 34% of the Town. Some of this forested acreage is state or municipally owned, while the remainder is in private ownership. The most extensive tract of forested land extends from Haverhill Street to the eastern Town boundary on the north side of Elm Street.

RIVERS AND PONDS

As part of the Ipswich River Watershed area, North Reading is located in one of the most historically and ecologically significant river systems in the region. The Ipswich River is part of the Great Marsh ecosystem which extends to New Hampshire, and more than 330,000 people depend on the river and its aquifers for drinking water. The Ipswich River is considered a highly stressed river basin, due to the fact that segments of the river run dry on a regular basis. American Rivers, a national river organization, designated the Ipswich River as the third most endangered river in America in 2003. North Reading's water resources include rivers and streams, ponds, wetlands, flood areas.

The Skug River, which originates along the Andover-North Andover border, enters North Reading on its northern border and flows westerly into Martins Pond. Martins Brook flows out of Martins Pond, enters Wilmington, re-enters North Reading, and forms an important tributary to the Ipswich River. It also contributes to groundwater supply at the Town's Central Street wells, and during the dry season groundwater is replenished by stream flow.

The Ipswich River forms the southern boundary of the Town between the Wilmington Town line (at the southwest corner of North Reading) and Beaver Brook. The river continues to flow easterly from Beaver Brook through the south central region of Town, and then forms the southeastern border between North Reading and Lynnfield.

The largest of the Town's ponds include Martins Pond, Eisenhaures Pond, Bradford Pond, and Swan Pond. Three of the ponds are likely greater than ten acres in size in their natural state, which would classify them as Great Ponds of the Commonwealth. "The Massachusetts Public Waterfront Act (Chapter 91) protects pedestrian access and "public strolling rights" to these water bodies, while other ponds can be owned privately by surrounding landowners and public access can be prohibited." Only Martins Pond and Swan Pond were officially surveyed by the state Department of Environmental Protection (DEP) as being greater than ten acres in area.

Most of Martins Pond is surrounded by older private development – former vacation homes that are now year-round residences. A portion of the shoreline includes a park (Clarke Park) and a boat launch. For two decades now, The Martins Pond Association is a local organization that has been advocating and providing stewardship services that support the Pond. With funding help from DEP, North Reading and the Association have undertaken a shoreline restoration and sediment reduction project and a stormwater reduction project.

"Swan Pond is located in the least densely populated sector of Town. The Town of Danvers has rights to use Swan Pond as a public water supply. Access is permitted on Swan Pond for non-motorized boats. The shoreline of Eisenhaures Pond has conservation easements among new upscale private home subdivisions. In addition, Bradford Pond lies within the State Forest. The Town holdings here are surrounded by industrial and residential development."

North Reading has a wetlands by-law that extends state and federal wetland regulations and 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, a five-person Board of Selectmen, and Town Administrators run the Town of North Reading. Michael P. Gilleberto is currently the Town Administrator. Each member of the Board of Selectmen serves a three-year term. "The Board may enact rules and regulations in a variety of areas, as well as establish Town policies and procedures on many issues, unless such issues are delegated by law or vote of the Town Meeting to another officer or board." The Board appoints the Town Administrator who supervises the operation of Town departments.

HISTORICAL PROPERTIES

The Town of North Reading has a "Center Village" historic district that was established by a Town meeting held in 1993. Two other historic districts of significance are West Village (Park Street West near Nutter Road and Mill Street) and Saddler's Neck (specifically near the intersection of Haverhill and Chestnut Streets). The Town has three Town-owned cemeteries that range from less than an acre to 30 acres in size.

The Town owns six historical buildings/sites:

1. Town Common: In 1713, the Town Common was constructed as the Reading Town Common (North Reading split from Reading in 1853).
2. Meeting House: The Meeting House dates to 1829 and is still used by the Town's senior citizens and for general Town meetings.
3. Damon Tavern: The David Damon Tavern was built in 1817 and is located on Bow Street. It was a halfway stop for the Salem-Lowell and Boston-Haverhill routes coaching roads, and also served as the Town's first Post Office. The tavern was open to the public as soon as The North Reading Historical and Antiquarian Society restored it.
4. Putnam House: In 1717 the inhabitants of the North Reading Parish voted for Reverend Daniel Putnam to become their minister, in 1720 they built him a home that is still standing at 27 Bow Street. The North Reading Historical and Antiquarian Society restored the Putnam House and use it for its headquarters.
5. Flint House: The building that houses the Flint Memorial Library was first built in 1874 by Harriet Flint on the west end of the island formed by Park and Bow Street (known then as Flint Memorial Hall). In 1875, the library was installed in the southeast corner of the ground floor and remained there until 1958 when it was relocated across the street to the Weeks Memorial Building (formerly the Damon Tavern). During the 1970's, the Flint Building, which was being used as the Town Hall, but began to fall into disrepair. Town offices were moved in December of 1988 and the building was left vacant. In 1991, the building was renovated and became what is now the Town's Public Library.
6. West Village School House: "The North Reading Minit and Militia disassembled and reconstructed the West Village Schoolhouse, now nestled at the far northeast corner of the Putnam House property. Built circa 1845, this school originally served the residents of the western section of Town. Until the 1980's, the building was near the northwest corner of Park and Main Street (the present location of the Eastgate Liquors parking lot). It had been an automobile repair shop for many years and was slated to be demolished to make room for new construction. The Minit men dismantled the structure and stored parts of it in several places throughout the Town. Over a period of several years, they gradually reconstructed the school in its present location. The local treasure has been returned to the 19th century, complete with chalkboards, teacher's desk, student desks, "pot-bellied stove", and a working bell in its steeple. The building has a volunteer teacher, in appropriate dress, who often hosts classes for the local elementary schools."

PARKS AND RECREATION

The Town of North Reading includes Ipswich River Park, a "49-acre site at the junction of Haverhill, Central and Chestnut Streets. The property was taken by eminent domain and settled for a price of $1,450,000. In 1994 and 1995 the Town applied for and received a total of $1,000,000 in development grants from the Land and Water Conservation Fund and from the Urban Self-Help Program. Another $25,000 was received as a canoe launch grant from the Public Access Board. By accepting these grants, The Town matched $724,000. Half of the matching funds needed were supported through the Hillview Enterprise Fund and the balance through fundraising. The Land Utilization Committee spearheaded the fund-raising.

Planning and building Ipswich River Park has been truly a community project. Established for active and passive recreation, this park is dedicated to all North Reading citizens-past, present, and future-and promises to hold "something for everyone."

The Parks and Recreation Department also "maintains Benevento Memorial Park (baseball fields, restrooms and concession/storage facility), Chestnut Street Complex (softball field, soccer fields, basketball court and Kid Spot playground, concession/storage facility); Clarke Park at Martin's Pond (boat dock, sand volleyball court, basketball court, playground, sheltered picnic area, bathroom/storage facilities); Arthur J. Kenney Field (synthetic turf field and track, press box, concession/storage facilities); Ipswich River Park (soccer fields, baseball field, softball field, tennis courts, basketball courts, street hockey rink, skate park, horseshoe pits, gazebo picnic area, pavilion picnic area concession/storage facility, bathroom facilities, park maintenance building and Recreation center); Rita J. Mullin Softball Field; Town Hall Softball Field; North Parish Park; Park Street (basketball court) and we assist the school department with maintenance on fields that youth sports actively participate."

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 February 14, 2018. At the Kick-off meeting, the MVP Core Team decided to use 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 on March 21, 2018 and March 27, 2108, respectively.

The MVP Core Team also developed a list of potential workshop participants to be invited and determined what materials would be needed for the workshops. A public notice describing the workshops was posted on the Town's website and a newspaper article about the MVP process, including the workshop dates, was published in the North Reading Transcript on March 15, 2018. The first workshop focused on identifying the Town's top hazards and vulnerabilities, as well as the Town's strengths and weaknesses. Based on the results of the first workshop, the second workshop focused on developing action steps the Town can take to be more resilient to the projected climate change taking into consideration previous action steps the Town has already developed as part of the 2016 Hazard Mitigation Plan.

Following the workshops that were held in late March, a draft of this report was completed and presented at a public listening session at Town Hall held on May 17, 2018. Notice of the public listening session was also posted on the Town's website and described in a second newspaper article in the North Reading Transcript on May 10, 2018.

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 NORTH READING

At the first workshop on March 21, 2018, an opening presentation was made explaining the MVP Process and the Town's previous mitigation efforts. The group was also provided with climate change projections developed by Northeast Climate Science Center at the University of Massachusetts Amherst, which for North Reading primarily focus on increased average temperatures and increased precipitation (sea level rise is not a factor in North Reading). Using the TNC's CRB process and templates, GIS mapping, the UMass climate change projections, and previously identified hazards in North Reading from the Town's Hazard Mitigation Plan, the participants broke into two separate groups to review and discuss the information and come up with their list of the top four hazards for the Town.

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

The results from each group were compared and were found to be very similar. Bringing the two groups back together for open discussion, final consensus was arrived on the following top four natural hazards as follows:

1. Flooding: There was consensus among all participants that the number one natural hazard the Town has had to deal with for decades now has been flooding, especially in the Matins Pond area and at roadways with inadequate culvert capacity that are overtopped and must be closed during floods. It was determined that flooding issues will only be exacerbated by climate change.

2. Winter Storms/Blizzards/Nor'easters: Winter storms were determined to be the second most troublesome natural hazard. Given the problems that occurred from winter storms this past year with heavy wet snow taking down trees and utility wires, it was determined that warmer temperatures and increased precipitation would likely lead to even more similar type events.

3. Wind: While the participants acknowledged that wind is one of the factors with Winter Storms, which was already selected, they felt that wind-related events during other seasons besides winter had been a problem in Town previously and is anticipated to become more extreme in the future with climate change.

4. Extreme Cold/Heat (including drought): This winter, the Town experienced problems with extreme cold temperatures and has had 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 and power outages will exist.

VULNERABLE AREAS AND ATTRIBUTES

Once the full group of workshop participants agreed on the top four hazards, they went back to their separate groups and using GIS maps, the CRB matrix template and their local knowledge of the Town, each group developed a list of vulnerabilities. Again, following the CRB guidelines, the breakout groups considered the Town's vulnerabilities as they relate to three categories, namely Infrastructural, Societal, and Environmental. It should be noted 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 one consolidated list of vulnerabilities for each category as is summarized in Table 1 below:

Table 1: Vulnerable Areas and Attributes for North Reading based on Climate Change Projections

INFRASTRUCTURAL	SOCIETAL	ENVIRONMENTAL
• *School Buildings* • *DPW Building* • *Public Safety Building* • *Town Wells and Pumping Station and Water System* • *Roads/Culverts/Bridges* • *Drainage System* • *Electrical Grid* • *Septic Systems*	• *Health Facilities - (Group Homes)* • *State Housing* • *Senior Housing* • *Nursing Home* • *Trailer Park* • *Martins Pond Neighborhood*	• *Street Trees* • *Martins Pond* • *Ipswich River/Martins Brook/Skug River* • *Ponds/Wetlands* • *Ipswich River Park*

INFRASTRUCTURAL

Buildings (schools, public safety, DPW)

The major concern with the Public Safety Building and the DPW garage is that they are located in or right next to the FEMA floodplain of the Ipswich River, which is known to be based on outdated information. These are two critical facilities that need to be fully functional during floods.

For other school buildings, the major concern was flat roofs and snow loads. With higher average temperatures and increased precipitation, heavier, wet snowfalls could increase loads on flat roofs and potentially result in collapses.

Town Wells, Pumping Station and Water System

The Town's current well and pumping Station are located in the floodplain and is susceptible to flood damage and contamination. A new water supply will reduce this vulnerability and will be discussed further in Section V.

Roads/Culverts/Bridges

There are 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.

Drainage System

The Town has developed and 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.

Electrical Grid

Much of the electric grid is above ground on poles such that wires can be impacted by trees during severe storms that have heavy wind and/or wet snow.

Septic Systems

Many septic systems are old and were not installed high enough above the seasonal highwater table. Also, some are located in floodplains, such that during floods and/or wet weather, there is an increased risk of contaminated groundwater aquafers. This risk will be exacerbated with increased precipitation and flooding as projected on the future.

SOCIETAL

Health Facilities - (Group Homes)

There are several group homes in town with residents that could require special assistance during severe weather events with power outages.

State Housing/Senior Housing/Nursing Home

Elderly residents may require special care and assistance during extreme weather events, especially with any loss of basic utility services, such as electric service.

Trailer Park

Typically, mobile homes are less durable than conventional wood frame structures that are built on stone/concrete foundations and suffer more damage during sever weather events

Martins Pond Neighborhood

There are many residences that were originally built as summer camps that have been converted to full time residences. Many of these structures were built before the National Flood Insurance Program came into existence and provided Flood Insurance Rate Maps. As such, the homes were never built with the current or projected flood risk in mind.

ENVIRONMENTAL

Street Trees

Many large street trees present a risk of falling or losing limbs that can: take down electric, telephone and cable lines; block roadways; cause property damage; and in rare cases, even fall on someone.

Martins Pond

Martins Pond currently experiences periods of high water that cause flood damage and impact septic systems. Increased bacteria/algae and other water quality issues occur during dry weather or drought periods. These conditions are expected to worsen in the future based on climate change projections.

Ipswich River/Martins Brook/Skug River

The three main water courses in Town are experiencing the effects of urbanization. They are seeing increasingly higher flood elevations during heavy precipitation due to increased impervious area in the watersheds and lower base flows during summer months, in addition to higher water temperatures, which is harmful to fish and wildlife.

Ponds/Wetlands

Increased temperatures and precipitation projected for the future could result in increased mosquito populations and increased spread of disease transmitted by mosquitos. Ponds will experience the same extremes as described above for Martins Pond

Ipswich River Park

While passive recreation such as parks is an ideal use for floodplains, increased flooding and precipitation could result in bordering vegetated wetlands and invasive plants encroaching into park land. Filling the park to raise it above flood elevation would result in a loss of flood storage that would have to be compensated elsewhere somehow, such that raising or filling park areas located in floodplains is not a viable solution.

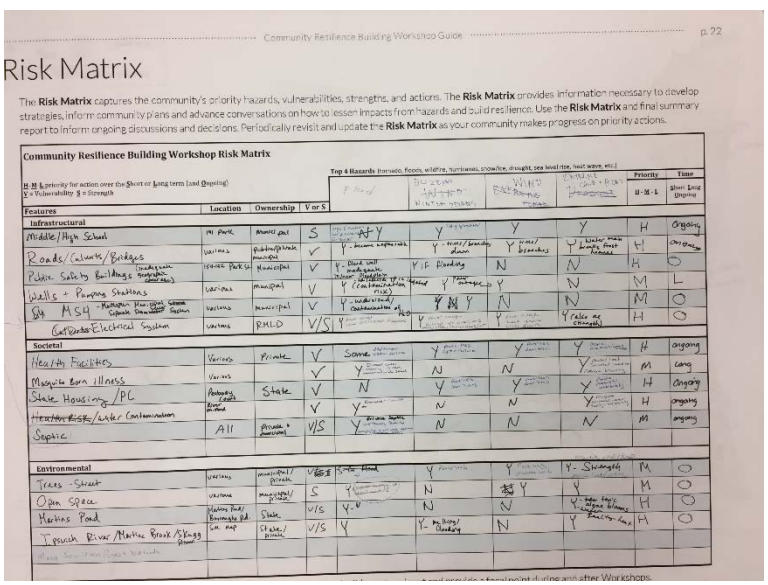
Participants determine the top four hazards and identify vulnerabilities using the CRB Workshop guidelines at the first workshop

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, followed only by winter storms. While the Town has been very proactive with its hazard mitigation and floodplain management activities, even to the point of revising its own FEMA Flood Insurance Study for the Martins Brook watershed through a FEMA grant program between 2000-2004, it became obvious that not having flood mapping that shows potential future floodplains that take into account climate change projections makes it very difficult to assess vulnerabilities and future risk accurately. The Town has a computer model for the Martins Brook watershed that could be rerun with new rainfall data. However, the FEMA study for the Ipswich River is very outdated and could be underestimating peak flood discharges by as much as 40% for the current 1% chance (100-year) flood, never mind what the 1% chance flood could be 30-70 years from now. Therefore, there was consensus that having flood maps that show potential floodplains in the future is critical for proper resiliency planning.

Another concern 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 floodplains do not match the natural floodplain 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. A case in point is the Route 62 culvert in Wilmington, which is undersized and controls flood elevations in Martins Pond. The culvert acts as a dam such that increasing the size of this culvert would allow larger discharges to flow downstream impacting homes in Wilmington that were built lower than they should have been in the floodplain.

Finally, in addition to flooding issues, not having structural evaluations of public buildings with flat roofs makes it difficult to understand the real risk of these buildings to increased (wetter) snow loads.


Community Resilience Building Workshop Guide p. 22

Risk Matrix

The **Risk Matrix** captures the community's priority hazards, vulnerabilities, strengths, and actions. The **Risk Matrix** provides information necessary to develop strategies, inform community plans and advance conversations on how to lessen impacts from hazards and build resilience. Use the **Risk Matrix** and final summary report to inform ongoing discussions and decisions. Periodically revisit and update the **Risk Matrix** as your community makes progress on priority actions.

Community Resilience Building Workshop Risk Matrix

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

Features	Location	Ownership	V or S	Top 4 Hazards (tornado, floods, wildfire, hurricanes, snowfire, drought, sea level rise, heat wave, etc.)				Priority H-M-L	Time Short Long Ongoing
Infrastructural									
Middle/High School	Int. Park	Municipal	S		Y	Y	Y	H	Ongoing
Roads/Culverts/Bridges	Various	Public/Private Municipal	V	Y - Some unpassable	Y - Some/Boundary shown	Y Some/Boundaries	Y Water main burst, Fuel tanks	H	Ongoing
Public Safety Buildings	Various Park St	Municipal	V	Y - Dam unit Y - Inadequate Water Supply	Y I.F. Flooding	N	N	H	O
Wells + Pumping Stations	Various	Municipal	V	Y (Contamination risk)	Y Power outages	Y	N	M	L
Sewer MSW - Multiple Municipal Sewer System	Various	Municipal	V	Y - Underground Contamination risk	N Y	N	N	M	O
Gas/Electric Electrical System	Various	RMLD	V/S	Y	Y	Y	Y Cable are strength	H	O
Societal									
Health Facilities	Various	Private	V	Some	Y	Y	Y	H	ongoing
Mosquito Born Illness	Various		V	Y	N	N	Y	M	Long
State Housing/PC	Various Cities	State	V	N	Y	Y	Y	H	Ongoing
~~Hentor Risk~~/Water Contamination	Various Sections		V	Y	N	N	Y	H	ongoing
Septic	All	Private + Municipal	V/S	Y	N	N	N	M	ongoing
Environmental									
Trees - Street	Various	Municipal/ Private	V	Some	Y	Y	Y - Strength	M	O
Open Space	Various	Municipal/ Private	S	Y	N	Y	Y	M	O
Martins Pond	Various Park/ Boundary Rd	State	V/S	Y	N	N	Y Water Fowl Habitat Fishing Area	H	O
Ipswich River/Martins Brook/Kings Brook	Cul. map	State/ Private	V/S	Y	Y - Multiple Shading	N	Y	H	O

Figure 1: Participants used the CRB template to record their decisions for hazards and vulnerabilities

IV. SPECIFIC CATEGORIES OF CONCERNS AND CHALLENGES

INFRASTRUCTURAL

Buildings (schools, public safety, DPW)

Snow Loads on Flat Roofs: The Town should have structural analyses performed for its buildings with flat roofs to truly understand the risk of increased snow loads. Current building codes are not considering climate change and potential for increased snow loads. Performing structural rehabilitation to meet a higher factor of safety may be impractical/cost prohibitive. With results of a study, the town could implement a plan to disallow occupancy in certain buildings when snow depths are too great.

Flooding near public buildings: Since the flood study for the Ipswich River is based on a hydrologic analysis performed in the 1970's, the actual flood risk to the DPW building and Public Safety Building are unknown, especially when considering climate change projections. A new hydrologic and hydraulic analysis for the Ipswich River that considers climate change projections is required for the Town to truly evaluate its risk at these two critical infrastructure locations. The Town has a computer model of Martins Brook that could be run with new rainfall data, but does not have a model for the Ipswich River.

Water System

As mentioned above, the real risk of flooding at the current well and pumping station is unknown until a model is run with climate change projections.

Roads/Culverts/Bridges

Like the previous two items, new hydrologic and hydraulic analyses that consider climate change data are required for the Town to truly understand its risk of the next 50-100 years. Also, many culverts and bridges were installed before the NFIP and the MA WPA were in place and did not consider the natural stream morphology or the function of the floodplain. 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 floodplains 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.

Drainage System

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 are 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. Future "Complete Streets" projects will be able to incorporate "Green Infrastructure" components that will help mitigate potential stormwater runoff impacts due to climate chance, namely peak flow, water quality, and heat island impacts.

Electrical Grid

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

Septic Systems

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.

SOCIETAL

Health Facilities - (Group Homes)/State Housing/Senior Housing/Nursing Home

Communicating with and getting access to private group homes and elderly care facilities in emergency situations is challenging and response time can sometimes mean the difference between life and death. There is no hospital in North Reading itself.

Trailer Park

Making improvements to mobile homes to make them more durable, such that they have equivalent resiliency compared to conventional wood frame structures built on stone/concrete foundations, is impractical and cost prohibitive. As such, mobile home parks will always be more vulnerable to damage during extreme weather events.

Martins Pond Neighborhood and Watershed Associations

Elevating homes or buying out the most flood-prone properties in the Martins Pond area are potential solutions to become more resilient to increased flooding in this area, but may be both cost prohibitive and unacceptable to residents. Both the Martins Pond Association and the Ipswich River Watershed Associations are knowledgeable and active. They both inform and educate residents about environmental issues related to the two main water courses in Town, Martins Brook and the Ipswich River.

ENVIRONMENTAL

Street Trees

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.

Martins Pond/Ipswich River/Martins Brook/Skug River

If climate change projections are realized in the future, there will be a constant demand from people living in the floodplains of these flooding sources 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, would be acceptable from an environmental permitting standpoint and would not impact floodplains either upstream or downstream. Unfortunately, many structures were built too low in floodplains before the NFIP existed and there were flood maps, never mind that floodplains could increase with climate change.

Ponds/Wetlands/Ipswich River Park

Increased hydrology in wetlands, ponds and park areas 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.

V. CURRENT STRENGTHS AND ASSETS IN NORTH READING

Certain Infrastructural, Societal, and Environmental items that 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 discussed below were already discussed previously relative to different attributes that the participants recognized as vulnerabilities.

Table 2: Current Strengths and Assets in North Reading related to Climate Change Resiliency

INFRASTRUCTURAL	SOCIETAL	ENVIRONMENTAL
• *Roadways* • *School Buildings* • *Public Safety Building* • *DPW Garage* • *Water System* • *Electrical Grid* • *Septic Systems*	• *Health/Elderly care Facilities* • *Watershed Associations* • *Churches* • *Relationships with Abutting Communities*	• *Rivers, Ponds and Wetlands* • *Open Space and Parks* • *Trees*

INFRASTRUCTURAL

Roadways

While certain roadways are susceptible to overtopping during floods, the roadway network in Town is generally in good to fair condition and the Town has several state highways running through it. Also the Town's proximity to Interstate 93 via several roadways is a strength during emergencies.

School Buildings

Aside from the concern about heavier snow loads on flat roofs, the Town's school buildings are generally in good condition and well maintained. These facilities could be used as emergency shelters if needed.

Public Safety Building

While the Public Safety Building, which houses both the Police and Fire Departments, is located in the floodplain of the Ipswich River, the facility has a floodwall that was constructed in 2000 and was modified in 2010 with additional freeboard. The flood wall has already protected the facility several times during floods that would have previously impacted the facility.

DPW Garage

While this critical facility is located within the floodplain of the Ipswich River, the issue the Town has is more with access to the facility when the access road is flooded as opposed to flooding of the facility itself. The garage is above the 100-year floodplain and has not yet been flooded during previous floods (some of which exceeded the effective FEMA flood elevation, although the effective FEMA study is out of date).

Water System

While the Town's wells are vulnerable to flooding, the Town has the ability to purchase water from the Town of Andover, such that it has two sources. It would also be possible in the future for the Town to purchase its

water from the Massachusetts Water Resources Authority, which currently supplies the Town of Reading, although there is not any agreement in place at the present time.

Electrical Grid

Like every other suburban town in New England, North Reading's electrical lines, which are mostly above ground on utility poles, are susceptible to storm damage. Also, the entire New England area could face a supply problem in the future during extreme hot weather if new sources of energy do not become available (especially local renewable energy). That said, electricity in North Reading is provided by Reading Municipal Light Department (RMLD). RMLD was established in 1894 and is a municipal electric utility serving over 68,000 residents in the towns of Reading, North Reading, Wilmington, and Lynnfield Center. RMLD has over 29,000 meter connections within its service territory. Residential customers account for approximately one-third of RMLD's electricity sales while commercial, industrial, and municipal customers account for about two-thirds of sales. There are over 2,400 commercial and/or industrial customers in the communities RMLD serves. RMLD is the second largest of the 41 municipal light departments in Massachusetts, is not-for-profit, and is locally owned and controlled. RMLD has been very supportive of North Readings mitigation efforts and has a good history of actively participating in the Town's hazard mitigation (and now their resiliency planning) efforts.

Septic Systems

While the workshop groups raised concerns about older septic systems, especially older systems that are located in floodplains, it was also determined that having septic systems rather than a municipal-owned sewer system and wastewater treatment plant, is a very sustainable and decentralized approach for the Town's sanitary sewage disposal. Septic systems, when constructed properly, which systems since the 1980's in general should be, recharge ground water and help maintain baseflows in streams. Often times, towns like North Reading will transport sewage to regional treatment plants and take water outside of the watershed, which can have a negative impact to the water balance of a particular watershed, especially if it is already stressed like the Ipswich River's watershed. Fortunately, this is not the case in North Reading.

SOCIETAL

Healthcare/Elderly Care Facilities

While North Reading does not have a hospital within the Town itself, 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.

Watershed Associations

There are two active watershed associations involved in North Reading, the Martins Pond Association (MPA), which is mostly made up of residents living in the Martins Pond area, and the Ipswich River Watershed Association (IRWA), which is a larger regional group. Both groups are strong advocates for environmental protection of these two important resources and the MPA, especially, has been actively involved with the Town's flood mitigation efforts and water quality improvements for Martins Pond.

Churches

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.

Relationships with abutting communities

North Reading has good working relations with its neighboring communities. It purchases water from Andover. It also has a common interest in the Route 62 culvert with Wilmington, since the culvert acts a hydraulic control for Martins Brook and passes through both communities. The Town also has mutual aid agreements with the surrounding fire departments.

ENVIRONMENTAL

Rivers, Ponds and Wetlands

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, brooks, and ponds in Town, provide wildlife and aquatic habitat, recreational opportunities, and scenic vistas that all add to the quality of life in North Reading. Wetlands provide wildlife habitat, flood storage and biological processes that improve water quality from stormwater runoff.

Open Space and Parks

Public open space and parks provide recreational opportunities for residents and in some cases, serve as passive uses in floodplains that can store flood waters without resulting in costly flood damage.

Trees

Trees were identified as a vulnerability in the sense that they can take down power lines, block roads and cause property damage. However, the strength that trees add to the Town's resiliency to climate change far outweigh any vulnerability they present. Trees add oxygen to the atmosphere, help reduce heat island effects, reduce rainfall runoff, provide wildlife habitat, provide beauty to landscapes, reduce wind and more. Of course tree growth does need to be managed at certain locations to reduce the safety risks associated with falling trees and/or tree limbs, but their benefit far exceeds the overall vulnerabilities they create.

Appendix B 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; Winter Storms; Wind; and Extreme Cold/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 from climate change. As part of the process, the participants reviewed the (All Hazard) Mitigation Actions that were developed for the Town's 2016 Hazard Mitigation Plan and evaluated which ones were applicable to the MVP Plan and how priorities for certain mitigation actions may change in light of the UMass climate change projections. Table 3 below 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 NORTH READING

As has already been alluded to above, by far the highest priority recommendation to come out of the workshops is the need for a town-wide hydrologic/hydraulic model that can be used to evaluate the flooding impacts from increased precipitation in the future. As discussed, the FEMA Flood Insurance Study for the Ipswich River is severely outdated (it is based on a 1970's hydrologic analysis), and doesn't even accurately depict current flood risks, let alone future risks based on climate change predictions. The hydrologic model for the Martins Brook watershed is more up to date than the model for the Ipswich River, but even the model for Martins Brook is over 15 years old now and does not factor in climate change.

The Martins Brook model could be updated with new hydrology relatively easy and then the new discharges could be run in the hydraulic model to develop projected floodplains. For the Ipswich River, a completely new hydrologic analysis (Log Pearson Type III gage analysis) and hydraulic computer model (USACE HEC-RAS) are required. The hydraulic model could come from FEMA if they update the study in the near future, or the Town could build their own computer model as they did for Martins Brook if funding is made available.

A lesser priority that the workshop groups came up with was structural evaluations of public buildings with flat roofs as related to snow loads.

Table 3 below shows all the action steps reviewed and developed as a result of the Community Building Resilience workshops for North Reading.

The action steps have been prioritized in Table 3 as follows:

Completed
Applicable to FEMA Hazard Mitigation Plan, but not MVP Plan
High MVP Priority
Medium MVP Priority
Low MVP Priority

Table 3: Recommended Action Steps to Improve Resiliency to Climate Change in North Reading

Project No.	Mitigation Action	Timeframe	Responsible Organization	Potential Funding Source	Estimated Cost
1	Establish a Floodplain and Stormwater Management Public Education Program.	2018	DPW	Town	$10,000
2	Develop a Town Community Emergency Response Team (CERT).	2018	Emergency Management	Town	$5,000
3	Adopt the Operation and Maintenance Plan for Martins Brook.	2018	Martin's Pond Association	Town	$5,000
4	Collect data to be used toward future benefit-cost-analysis.	2018-2019	DPW	Town	Minimal Town Funds
5	Updates to the Stormwater Bylaw so all projects exceeding the 1-acre threshold comply with the bylaw.	2018-2019	Community Planning Commission, Town Planner	Flood	Minimal Town Funds
6	Coordinate with USGS and Ipswich River Watershed to access flow monitoring information along Ipswich River. Install monitors at key locations on Martins Brook.	2016-2017	DPW & Martin's Pond Association	Grants	$40,000
7	Expand the Town's GIS with pre-designed maps and the updated base map for asset management during disaster events.	2018	DPW	Town	Minimal Town Funds
8	Support upgrade of the Benevento Culvert along Martins Brook.	2018-2020	Martin's Pond Association	Private	$500,000
9	Implement channel clearing and maintenance between Benevento and the pond.	2018-2019	Martin's Pond Association	Town	$20,000
10	Renovate DPW garage with facilities to accommodate Town employees during severe weather events and disasters. **Create Emergency Action Plan for access through flooded access roads**	2018-2020	DPW	Town/ FEMA	$150,000

Project No.	Mitigation Action	Timeframe	Responsible Organization	Potential Funding Source	Estimated Cost
11	Review current operation/maintenance procedures within the Town relative to cleaning storm drain systems. Consider creating a stormwater utility for funding for maintenance and capital improvements.	2018-2019	DPW	Town	$25,000
12	Rehabilitate Three salt storage shed for a season's supply of rock salt.	2018-2020	DPW	Town/ MassDOT	$200,000
13	Develop a public education campaign under the leadership of Reading Municipal Light Department regarding tree care on private property relative to electric wires.	2018	DPW	Town/ RMLD	$10,000
14	Develop a comprehensive debris management response plan for post extreme weather events.	2018	DPW	Town	$25,000
15	**Update the Ipswich River FEMA Flood Mapping Study. Develop H&H Models for both Ipswich River and Martins Brook Watersheds that consider Climate Change Projections**	**2018**	**Building Inspector & Town Engineer**	**FEMA**	**$100,000**
16	Replace the Chestnut Street Culvert over the Ipswich River and raise existing road grade to prevent overtopping	2018-2020	DPW	Town/ FEMA	$750,000
17	Replace the Haverhill Street Culvert and raise the Haverhill Street roadway.	2018-2020	DPW	Town/ FEMA	$500,000
18	Purchase a permanent generator for the senior center.	2018	Elder Services	Town/ FEMA	$20,000
19	Evaluate the structural capacity of flat roofs on critical and public facilities. Install strain gauges to monitor snow loads.	2018	DPW	Town/ FEMA	$35,000

Project No.	Mitigation Action	Timeframe	Responsible Organization	Potential Funding Source	Estimated Cost
20	Flood-proof the Town's water supply facilities up to the 500-year flood elevation, especially the Central Street well field pumping facility.	2018-2019	DPW & Utility Department	Town/ FEMA	$100,000
21	Move all critical equipment, debris, etc., out of the 100-year floodplain near the DPW garage.	2016-2017	DPW	Town	$50,000
22	Raise Profile of Burroughs Road to reduce overtopping and maintain access to west side of pond.	2018-2022	DPW	Town/ FEMA	$1,000,000
23	Detain stormwater upstream of Lindor Road by installing control weirs at three locations per Green International study.	2018-2019	DPW	Town	$25,000

APPENDIX A – COMPLETED RISK MATRIX/ WORKSHOP MATERIALS

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.org

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

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

Features	Location	Ownership	V or S	Flood	Winter Storms	Wind	Extreme Cold + Heat	Priority **H** - **M** - **L**	Time **S**hort **L**ong **O**ngoing
Infrastructural									
Major Roadways	Multiple Locations	Town	V & S	V: Roadway closures due to flooding S: Detours exist, Access to I-93 **[3, 11, 16, 17, 23]***	V: Roadway closures due to fallen trees/power lines S: Detours exist, Access to I-93 **[12]**	V: Roadway closures due to fallen trees/power lines S: Detours exist, Access to I-93	V: Road closures due to water main breaks (cold) S: Detours exist, Access to I-93 **[12]**	H	Ongoing
Major Culverts and Bridges (identified in 2016 Town's HMP)	Multiple Locations	Town	V	Roadway Closures due to roadway overtopping of flood waters **[3, 11, 16, 17, 23]**	Potential blockage from fallen trees/debris	Potential blockage from fallen trees/debris	N/A	H	Ongoing
Route 62 Culvert in Wilmington	Rt 62	Wilmington	V	The culvert is the hydraulic control for Martins Brook and is prone to clogging. Culvert is old and failure would create major transportation problem for North Reading	Potential blockage from fallen trees/debris	Potential blockage from fallen trees/debris	N/A	H	Long Term
DPW Garage	Chestnut Street	Town	V & S	V: Chestnut Street overtops during floods creating access issue to complex **[10, 11]**	V: Limited accomodations for workers who work continuously through storms. Salt sheds need rehabilitation S: Newer Snow removal Equipment **[10, 12, 19]**	V: Trees fallen in access road to building **[10]**	S: Fuel Station on site **[10, 12]**	M	Ongoing
School Buildings (Middle School and High School), Town Hall (former School building)	Park St, North Street and other locations	Town	V & S	S: Higher Elevation out of floodplain, Large Capacity for Shelter **[11]**	S: Generators on site V: Need staff for plowing/snow removal, Flat roofs concern with snow loads **[19]**	V: Fallen trees/wires	V: Pipes/meters breaking during extreme cold	M	Ongoing

Public Safety Building	Park St	Town	V & S	V: In floodplain, Single location limits geographic coverage. S: current flood wall has protected building to date **[11]**	V: Site does not have adequate room for snow storage **[19]**	N/A	S: Has generator V: Pipe breaks during extreme cold	H	Ongoing
Water System (including Wells and Pumping Stations)	Town-wide	Town	V & S	V: Access to pump stations impacted durign floods, potential for Contamination S: Town has a redundant supply from Andover **[20]**	V: Power outages and access to West Village site through adjacent town **[19]**	V: Power outages impact pumps	S: System has redundency **[7]**	M	Long Term
Municipal Separate Storm Sewer System (MS4)	Town-wide	Town	V	Much of street storm drain system is older and under cpacity. Liack of BMP's and outfall treatment	V: Blocakge of inlets during heavy snow	V: Blockage of Inlets by leaves and debris	N/A	H	Ongoing
Electrical Grid	Town-wide	RMLD	V & S	Power outage, water infiltration of systems	V: Power outage, buildings w/o generators **[13]**	V: Power outage from fallen treese and wires down can take time to repair **[13]**	V: System capacity during extreme heat	H	Ongoing
Septic System	Town-wide	Private/Town	V & S	V: older systems fail and may cause contamination, especially when groundwater is high S: sewage disposal is completely decntralized so no central plant concerns **[15]**	V: Systems with ejector pumps and no generators are not funtional when power is out.	V: Systems with ejector pumps and no generators are not funtional when power is out.	S: Power demand is much lowere than comparable sized Town with central WWTP	M	Ongoing
Flood Maps/GIS Data Layers	Town-wide	Town	V & S	V: FEMA Flood Mapping is out of date S: Town has GIS **[7, 15]**	V: Need more GIS layers **[7, 15]**	V: Need more GIS layers **[7]**	V: Need more GIS layers **[7]**	H	Ongoing

Societal

Healthcare Facilities (Group Homes)	Various	Private	V	Possible displacement, system failures **[1]**	Power loss, system failures **[13]**	Power loss, down trees **[13]**	Extreme heat-related health problems	H	Ongoing
Senior Housing	Peabody Court	State	S & V	S: located on higher ground **[1]**	V: Power outages, fallen trees. No snow storage available and removal difficult between buildings **[13]**	V: Power loss, down trees **[13]**	V: Elderly population, Aging water system, multiple breaks, no parts available	H	Ongoing
Nursing Home	North Street	Private	S	On high ground **[1]**	Have own snow removal **[13]**	Have own wastewater treatment (may not work during power outage)	Have own wastewater treatment (may not work during power outage)	M	Ongoing
Trailer Home Park	Rt 28	Private	V	Flooding possible from heavier rain in future	Power loss **[13]**	N/A	N/A	L	Ongoing
Martins Pond Neighborhood, Martins Pond Association and Ipswich River Watershed Association	Town-wide	Private/Town	S & V	V: Residents impacted by floods S: Residents are organized, communicate well, and monitor stream levels from gages along Martins Brook **[1, 4, 6]**	V: Martins Pond area access by Police/Fire, 1 way in/out, community communication **[4, 13]**	N/A	N/A	M	Ongoing
Churches	Various locations	Private	S & V	S: Potential shelter and source of food, donations [1]	V: Plowed by NRDPW, Communication [13]	N/A	N/A	L	Ongoing
O' Leary Senior Center	Park Street	Town	S	S: located on high ground. Establisehd meeting location	Power loss, system failures **[13, 18]**	Power loss, down trees **[13, 18]**	Power loss, system failures **[18]**	M	Ongoing

Environmental									
Street Trees	Town-wide	Town/Private	S & V	V: Fallen trees can block streams and culverts thereby exacerbating flooding S: Trees help reduce runoff	V: Fallen trees/braches can block roads and take down power lines. **[13]**	V: Fallen trees/braches can block roads and take down power lines. S: Wooded areas can help block and reduce wind **[13]**	S: Trees provide shade and cooling during extreme heat. Help reduce heat islands	H	Ongoing
Open Space/ Ipswich River Park	Various locations (see map)	Town/ Private/State	S	S: Best use of land in floodprone areas **[1]**	S: Snow removal not urgent	N/A	N/A	M	Ongoing
Ponds and Wetlands	Various locations (see map)	Town/ Private/State	S & V	V: Waterborn illness, Mosquitos, potentential for contamination S: Provides flood storage, water quality enhancement **[15, 17]**	N/A	N/A	V: Waterborn illness, Mosquitos, potentential for contamination. Increased algae, bacteria and degraded water quality, negative impact to fish habitat.	H	Ongoing
Ipswich River/ Martins Brook/ Skugg River	Town-wide (see map)	Town/ Private/State	S & V	V: Development has already occurred in the floodplain. Culverts are inadequate due to increased runoff from development. S: Important natural resources in Town for wildlife and recreation **[15, 16]**	V: Potential blockage from fallen trees/debris **[15]**	V: Potential blockage from fallen trees/debris	V: Waterborn illness, Mosquitos, potentential for contamination. Increased algae, bacteria and degraded water quality, negative impact to fish habitat. Periods in hot weather with little to no base flow	H	Ongoing
Beaver Dams	Town-wide	Town	S & V	V: Beaver Dams execerbate flooding conditions S: DPW has program in place to remove dams	N/A	N/A	N/A	L	Ongoing
*** [#] - Corresponding Action Item**									

MVP CORE TEAM KICK OFF MEETING

North Reading Municipal Vulnerability Preparedness (MVP) Plan

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

February 14, 2018

North Reading
MASSACHUSETTS

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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MVP Core Team

- Emergency Management: Theo Kuliopulos
- Martins Pond Association: Janet Niccosia/Larry Soucie
- Building Inspector: Jim DeCola
- Planning Department: Danielle McKnight
- Conservation Commission: Leah Basbanes
- Water Department: Mark Clark
- Town Engineer: Mike Soraghan
- Fire Department: Barry Galvin
- Health Department: Bob Bracey
- Police Department: Mike Murphy
- School Department: Wayne Hardacker
- GIS: Bill Ross
- Facilities Department: Julie Spurr-Knight

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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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Previous Related Mitigation Planning Efforts

January 2016 Hazard Mitigation Plan Update

- 2016 Update to the 2006 Plan approved by FEMA/MEMA
- Adopted by Town on May 23, 2016
- Plan evaluates impacts from natural hazards: Floods, Winter Storms, Wind, Fire, Geologic, Heat, Cold, Drought
- Provides Mitigation Strategies
- Makes Town eligible for FEMA Hazard Mitigation Grants

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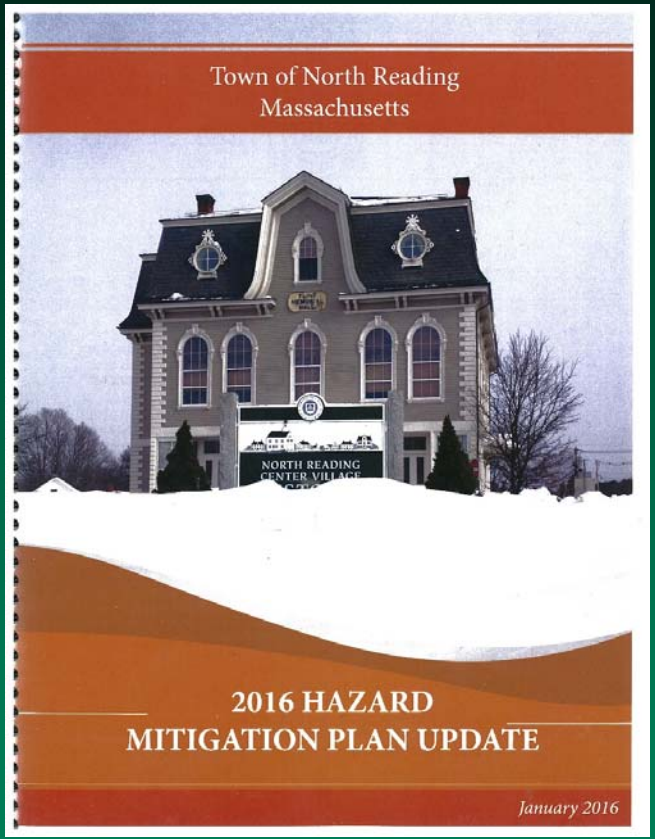
Previous Related Mitigation Planning Efforts



Ranking	Hazard
High Hazards	Nor'easter
	Flood
	Blizzard
	Hurricane
	Ice Storm
	Snow
Moderate Hazards	Heavy Rain
	Earthquake
	Tornado
	Drought
	HAZMAT
	Hail
	Lightning
	Microburst
	Beaver Dams
	Extreme Cold
Low Hazards	Ice Jams
	Extreme Heat
	Erosion
	Brush fire
	Dam Failure
	Landslide

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Previous Related Mitigation Planning Efforts

2016 Priority Level	Mitigation Action	Timeframe	Responsible Organization	Potential Funding Source	Estimated Cost
1	Establish a Floodplain and Stormwater Management Public Education Program.	2016	DPW	Town	$10,000
2	Develop a Town Community Emergency Response Team (CERT).	2016	Emergency Management	Town	$5,000
3	Adopt the Operation and Maintenance Plan for Martins Brook.	2016	Martin's Pond Association	Town	$5,000
4	Collect data to be used toward future benefit-cost-analysis.	2016-2017	DPW	Town	Low
5	Updates to the Stormwater Bylaw so all projects exceeding the 1-acre threshold comply with the bylaw.	2016-2017	Community Planning Commission, Town Planner	Town	Low
6	Coordinate with USGS and Ipswich River Watershed to access flow monitoring information along Ipswich River. Install monitors at key locations on Martins Brook.	2016-2017	DPW & Martin's Pond Association	Town/MA Riverways Program	$40,000
7	Expand the Town's GIS with pre-designed maps and the updated base map for asset management during disaster events.	2016	DPW	Town/ FEMA	$25,000
8	Support upgrade of the Benevento Culvert along Martins Brook.	2016-2018	Martin's Pond Association	Private	$500,000
9	Implement channel clearing and maintenance between Benevento and the pond.	2016-2017	Martin's Pond Association	Town	$20,000
10	Renovate DPW garage with facilities to accommodate Town employees during severe weather events and disasters.	2016-2020	DPW	Town/ FEMA	$150,000
11	Review current operation/maintenance procedures within the Town relative to cleaning storm drain systems. Consider creating a stormwater utility for funding for maintenance and capital improvements.	2016-2017	DPW	Town	$25,000

2016 Priority Level	Mitigation Action	Timeframe	Responsible Organization	Potential Funding Source	Estimated Cost
12	Build a storage shed for a season's supply of rock salt.	2016-2019	DPW	Town/ MassDOT	$200,000
13	Develop a public education campaign under the leadership of Reading Municipal Light District regarding tree care on private property relative to electric wires.	2016	DPW	Town/ RMLD	$10,000
14	Develop a comprehensive debris management response plan for post extreme weather events.	2016	DPW	Town	$25,000
15	Update the Ipswich River FEMA Flood Mapping Study.	2016-2020	Building Inspector & Town Engineer	FEMA	High
16	Replace the Chestnut Street Culvert over the Ipswich River and raise existing road grade to prevent overtopping.	2016-2019	DPW	Town/ FEMA	$750,000
17	Replace the Haverhill Street Culvert and raise the Haverhill Street roadway.	2016-2018	DPW	Town/ FEMA	$500,000
18	Purchase a generator for the senior center.	2016	Elder Services	Town/ FEMA	$20,000
19	Evaluate the structural capacity of flat roofs on critical and public facilities. Install strain gauges to monitor snow loads.	2016	DPW	Town/ FEMA	$35,000
20	Flood-proof the Town's water supply facilities up to the 500-year flood elevation, especially the Central Street well field pumping facility.	2016-2017	DPW & Utility Department	Town/ FEMA	$100,000
21	Move all critical equipment, debris, etc., out of the 100-year floodplain near the DPW garage.	2016-2017	DPW	Town	$50,000
22	Raise Profile of Burroughs Road to reduce overtopping and maintain access to west side of pond.	2016-2020	DPW	Town/ FEMA	$1,000,000
23	Detain stormwater upstream of Lindor Road by installing control weirs at three locations per Green International study.	2016-2017	DPW	Town	$25,000

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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.

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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

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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 (^{o}F).
	Maximum temperature	Maximum annual or seasonal temperature expressed in degrees Fahrenheit (^{o}F).
	Minimum temperature	Minimum annual or seasonal temperature expressed in degrees Fahrenheit (^{o}F).
	Days with Tmax > 90 ^{o}F	Number of days when daily maximum temperature exceeds 90°F.
	Days with Tmax > 95 ^{o}F	Number of days when daily maximum temperature exceeds 95°F.
	Days with Tmax > 100 ^{o}F	Number of days when daily maximum temperature exceeds 100°F.
	Days with Tmin < 32 ^{o}F	Number of days when daily minimum temperature is below 32 ^{o}F.
	Days with Tmin < 0 ^{o}F	Number of days when daily minimum temperature is below 0 ^{o}F.
	Heating degree-days (base 65 ^{o}F)	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 ^{o}F)	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 ^{o}F)	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

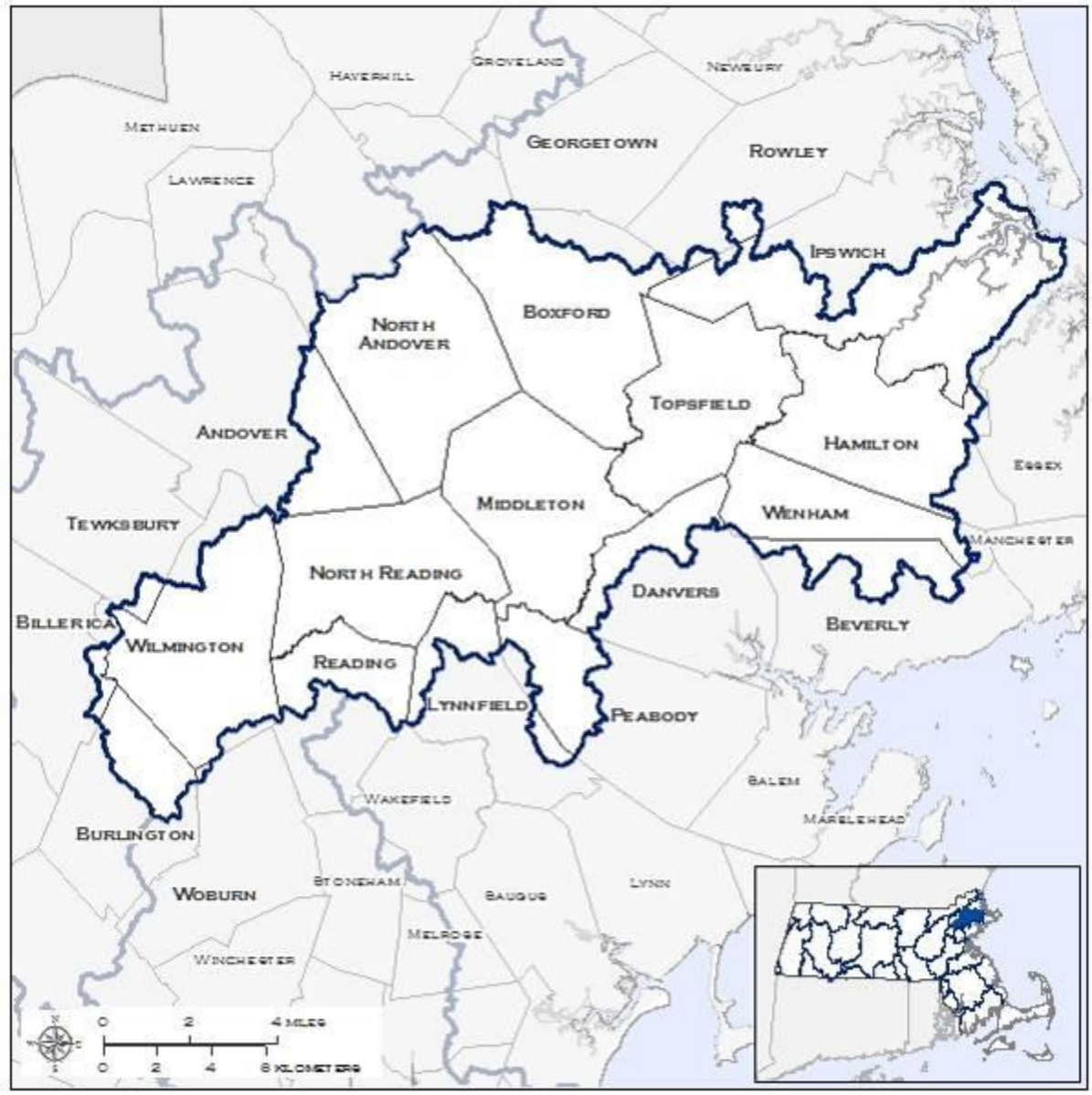
Climate Indicator		Observed Value 1971-2000 Average	Mid-Century Projected and Percent Change in 2050s (2040-2069)	End of Century Projected and Percent Change in 2090s (2080-2099)
Days with Precipitation Over 1”	Annual	7 days	Increase by 1 to 3 days	Increase by 1 to 4 days
	Winter	2 days	Increase by 0 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.

IPSWICH BASIN

MUNICIPALITIES WITHIN IPSWICH BASIN:

Andover, Beverly, Billerica, Boxford, Burlington, Danvers, Hamilton, Ipswich, Lynnfield, Middleton, North Andover, North Reading, Peabody, Reading, Rowley, Tewksbury, Topsfield, Wenham, Wilmington, and Woburn



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.

IPSWICH BASIN

Ipswich 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	49.48	+2.09 to +4.25	+2.74 to +6.21	+3.30 to +8.92	+3.59 to +10.76
	Winter	29.02	+2.14 to +4.76	+2.84 to +7.16	+3.56 to +8.99	+3.86 to +10.45
	Spring	46.97	+1.93 to +3.67	+2.61 to +5.51	+2.74 to +7.88	+3.35 to +9.61
	Summer	69.56	+2.07 to +4.22	+2.69 to +6.56	+3.12 to +9.50	+3.71 to +12.03
	Fall	51.99	+1.86 to +4.61	+3.25 to +6.49	+3.04 to +9.42	+3.51 to +11.76
Maximum Temperature	Annual	59.64	+1.99 to +3.98	+2.53 to +5.98	+3.02 to +8.87	+3.27 to +10.65
	Winter	38.33	+1.84 to +4.34	+2.42 to +6.66	+3.06 to +8.29	+3.42 to +9.59
	Spring	57.4	+1.81 to +3.51	+2.32 to +5.52	+2.68 to +8.06	+3.22 to +9.54
	Summer	80.22	+1.84 to +4.29	+2.55 to +6.48	+3.01 to +9.67	+3.51 to +12.17
	Fall	62.19	+1.95 to +4.44	+2.94 to +6.65	+2.94 to +9.62	+3.37 to +12.06
Minimum Temperature	Annual	39.32	+2.18 to +4.56	+2.97 to +6.34	+3.59 to +8.93	+3.92 to +10.86
	Winter	19.7	+2.42 to +5.22	+3.16 to +7.66	+4.12 to +9.68	+4.31 to +11.13
	Spring	36.54	+2.02 to +3.93	+2.87 to +5.83	+2.93 to +7.69	+3.49 to +9.52
	Summer	58.9	+2.18 to +4.28	+2.84 to +6.88	+3.23 to +9.34	+3.88 to +11.90
	Fall	41.79	+1.81 to +4.81	+3.23 to +6.34	+3.14 to +9.33	+3.65 to +11.61

- The Ipswich 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 2.6 °F to 6.5 °F (3-8% increase); end of century increase of 3.5 °F to 12.2 °F (4-15% increase).
    - Fall mid-century increase of 2.9 °F to 6.7°F (5-11% increase); end of century increase by and 3.4 °F to 12.1 °F (5-19% 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 7.7 °F (16-39% increase); end of century increase by 4.3 °F to 11.1 °F (22-56% increase).
    - Fall mid-century of 3.2 °F to 6.3 °F (8-15% increase); end of century increase of 3.7°F to 11.6 °F (9-28% increase).

IPSWICH BASIN

Ipswich 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	6.88	+5.55 to +17.30	+8.48 to +30.62	+10.21 to +50.12	+11.88 to +68.93
	Winter	0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00
	Spring	0.34	+0.23 to +0.75	+0.35 to +1.37	+0.40 to +2.25	+0.24 to +3.83
	Summer	6.23	+4.81 to +15.24	+6.99 to +24.93	+8.69 to +40.55	+10.55 to +54.68
	Fall	0.31	+0.34 to +1.88	+0.70 to +4.75	+0.67 to +8.59	+1.14 to +11.81
Days with Maximum Temperature Over 95°F	Annual	0.62	+1.61 to +6.48	+2.29 to +12.74	+3.01 to +26.29	+4.58 to +40.81
	Winter	0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00
	Spring	0.00	+0.02 to +0.19	+0.03 to +0.38	+0.06 to +0.67	+0.06 to +1.37
	Summer	0.62	+1.51 to +5.95	+2.02 to +11.16	+2.85 to +22.65	+4.24 to +35.46
	Fall	0.00	+0.03 to +0.50	+0.05 to +1.41	+0.08 to +3.44	+0.15 to +4.77
Days with Maximum Temperature Over 100°F	Annual	0.05	+0.10 to +1.30	+0.22 to +3.34	+0.31 to +7.52	+0.24 to +14.18
	Winter	0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00
	Spring	0.00	+0.00 to +0.01	+0.00 to +0.03	+0.00 to +0.10	+0.00 to +0.36
	Summer	0.05	+0.10 to +1.25	+0.20 to +3.21	+0.28 to +7.16	+0.24 to +13.11
	Fall	0.00	+0.00 to +0.06	+0.00 to +0.18	+0.00 to +0.51	+0.00 to +1.00

- Due to projected increases in average and maximum temperatures throughout the end of the century, the Ipswich basin is also expected to experience an increase in days with daily maximum temperatures over 90 °F, 95 °F, and 100 °F.
    - Annually, the Ipswich basin is expected to see days with daily maximum temperatures over 90 °F increase by 8 to 31 more days by mid-century, and 12 to 69 more days by the end of the century.
    - Seasonally, summer is expected to see an increase of 7 to 25 more days with daily maximums over 90 °F by mid-century.
    - By end of century, the Ipswich basin is expected to have 11 to 55 more days.

IPSWICH BASIN

Ipswich 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	4.12	-1.03 to -2.71	-1.29 to -3.13	-1.43 to -3.36	-1.42 to -3.46
	Winter	4.06	-1.02 to -2.59	-1.24 to -2.92	-1.38 to -3.27	-1.39 to -3.38
	Spring	0.04	-0.20 to +0.03	-0.00 to -0.23	-0.01 to -0.29	-0.01 to -0.25
	Summer	0.00	-0.00 to -0.00	-0.00 to -0.00	-0.00 to -0.00	-0.00 to -0.00
	Fall	0.02	-0.00 to -0.00	-0.00 to -0.00	-0.00 to -0.00	-0.00 to -0.00
Days with Minimum Temperature Below 32°F	Annual	129.69	-11.50 to -28.24	-17.60 to -41.81	-21.23 to -55.33	-23.38 to -65.25
	Winter	78.98	-3.33 to -8.87	-4.15 to -15.58	-6.11 to -24.32	-7.88 to -30.84
	Spring	30.97	-4.54 to -10.85	-7.06 to -14.80	-7.84 to -18.42	-8.73 to -20.14
	Summer	0.00	-0.04 to -0.00	-0.04 to -0.00	-0.04 to -0.00	-0.03 to -0.00
	Fall	19.71	-3.66 to -8.72	-6.20 to -11.46	-6.68 to -14.55	-5.80 to -16.33

- Due to projected increases in average and minimum temperatures throughout the end of the century, the Ipswich 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 4 to 16 fewer days by mid-century, and 8 to 31 fewer days by end of century.
    - Spring is expected to have 7 to 15 fewer days by mid-century, and 9 to 20 fewer days by end of century.
    - Fall is expected to have 6 to 11 fewer days by mid-century, and 6 to 16 fewer days by end of century.

IPSWICH BASIN

Ipswich 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	6269.22	-514.70 to -1104.48	-689.55 to -1507.20	-829.20 to -2019.14	-925.38 to -2407.09
	Winter	3256.74	-189.28 to -442.05	-248.14 to -659.82	-315.52 to -815.64	-358.00 to -959.71
	Spring	1681.62	-158.49 to -304.79	-215.06 to -457.84	-230.23 to -625.36	-294.57 to -735.28
	Summer	87.73	-31.97 to -55.7	-39.64 to -71.22	-48.25 to -79.85	-51.73 to -82.69
	Fall	1239.97	-124.14 to -332.50	-231.67 to -426.84	-220.85 to -611.72	-241.44 to -700.90
Cooling Degree-Days (Base 65°F)	Annual	590.1	+212.91 to +447.96	+291.57 to +754.03	+342.03 to +1151.97	+398.58 to +1521.14
	Winter	nan	-0.66 to +2.44	-0.43 to +5.63	+0.17 to +3.39	+0.35 to +6.21
	Spring	23.07	+14.42 to +33.62	+22.44 to +57.45	+26.10 to +98.15	+20.27 to +146.59
	Summer	507.15	+154.20 to +335.29	+196.37 to +538.65	+232.59 to +797.31	+280.33 to +1025.47
	Fall	54.37	+31.12 to +93.25	+45.05 to +178.18	+54.35 to +275.58	+78.85 to +357.99
Growing Degree-Days (Base 50°F)	Annual	2628.19	+397.84 to +810.94	+555.57 to +1237.46	+632.10 to +1937.88	+716.22 to +2437.70
	Winter	5.96	+0.08 to +15.21	+2.20 to +18.07	+5.89 to +30.73	+4.55 to +40.02
	Spring	299.31	+82.40 to +158.16	+105.22 to +258.47	+120.04 to +387.06	+129.58 to +502.31
	Summer	1799.53	+190.20 to +388.02	+247.15 to +603.09	+286.26 to +874.19	+340.70 to +1106.56
	Fall	516.06	+96.21 to +288.72	+167.20 to +423.63	+154.45 to +644.57	+209.73 to +814.99

- Due to projected increases in average, maximum, and minimum temperatures throughout the end of the century, the Ipswich 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 8-20% (248 -660 degree-days) by mid-century, and a decrease of 11-29% (358-960 degree-days) by the end of century.
    - The spring season is expected to decrease in heating degree-days by 13-27% (215-458 degree-days) by mid-century, and by 18-44% (295 -735 degree-days) by the end of century.
    - The fall season is expected to decreases in heating degree-days by 19-34% (232-427 degree-days) by mid-century, and by 19-57% (241 -701 degree-days) by the end of century.
- Conversely, due to projected increasing temperatures, summer cooling degree-days are expected to increase by 39-106% (196 -539 degree-days) by mid-century, and by 55-202% (280-1025 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 14-34% (247 -603 degree-days) by mid-century, and by 19-61% (341 -1107 degree-days) by end of century.
- Spring is expected to see an increase by 35-86% (105 -258 degree-days) by mid-century and 43-168% (130 -502 degree-days) by end of century.
- Fall is expected to see an increase by 32-82% (167 -424 degree-days) by mid-century and 41-158% (210 -815 degree-days) by end of century.

IPSWICH BASIN

Ipswich 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 Precipitation Over 1"	Annual	7.87	+0.10 to +1.81	+0.43 to +2.57	+0.94 to +2.45	+1.06 to +3.20
	Winter	1.96	+0.02 to +0.63	+0.15 to +1.09	+0.20 to +1.45	+0.29 to +1.60
	Spring	1.78	-0.19 to +0.73	-0.03 to +0.89	+0.10 to +1.16	+0.06 to +1.13
	Summer	1.69	-0.16 to +0.45	-0.11 to +0.51	-0.11 to +0.55	-0.13 to +0.51
	Fall	2.45	-0.27 to +0.58	-0.18 to +0.76	-0.42 to +0.60	-0.42 to +0.75
Days with Precipitation Over 2"	Annual	1.05	+0.02 to +0.45	-0.01 to +0.60	+0.09 to +0.69	+0.14 to +0.82
	Winter	0.19	-0.04 to +0.13	+0.00 to +0.15	+0.00 to +0.22	+0.04 to +0.29
	Spring	0.22	-0.06 to +0.18	-0.05 to +0.21	-0.06 to +0.27	+0.00 to +0.33
	Summer	0.27	-0.09 to +0.12	-0.06 to +0.14	-0.04 to +0.14	-0.05 to +0.16
	Fall	0.38	-0.04 to +0.23	-0.02 to +0.22	+0.02 to +0.20	-0.06 to +0.28
Days with Precipitation Over 4"	Annual	0.05	-0.01 to +0.14	+0.00 to +0.15	-0.01 to +0.12	-0.01 to +0.20
	Winter	0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.01	+0.00 to +0.02
	Spring	0.00	-0.02 to +0.04	+0.00 to +0.04	-0.01 to +0.05	-0.01 to +0.08
	Summer	0.00	-0.01 to +0.04	-0.01 to +0.04	-0.02 to +0.04	-0.02 to +0.05
	Fall	0.00	-0.02 to +0.08	-0.02 to +0.08	-0.02 to +0.09	-0.04 to +0.12

- The projections for expected number of days receiving precipitation over one inch are variable for the Ipswich 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 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.

Table 12: Sea level rise projections at the Seavey Island, ME tide gauge. Projections are given for the medium (RCP 4.5) and high (RCP 8.5) emissions scenarios, at multiple levels of likelihood, in feet relative to mean sea level in 2000.

SEAVEY ISLAND		Median (50th percentile) 50% probability SLR exceeds	Likely Range (17th-83rd percentiles) 66% probability that SLR is between…	99.9th Percentile Value Exceptionally unlikely that SLR will exceed
Emissions Scenarios: Medium (RCP 4.5); High (RCP 8.5)		Feet (relative to Mean Sea Level in 2000)		
2030	Med	0.5	0.3-0.7	1.1
	High	0.6	0.3-0.8	1.3
2050	Med	0.9	0.6-1.2	2.3
	High	1.0	0.7-1.4	2.5
2070	Med	1.4	0.9-1.9	4.3
	High	1.6	1.1-2.2	4.8
2100	Med	1.9	1.2-2.8	7.9
	High	2.6	1.7-3.7	9.3

Table 13: Sea level rise projections at the Newport, RI tide gauge. Projections are given for the medium (RCP 4.5) and high (RCP 8.5) emissions scenarios, at multiple levels of likelihood, in feet relative to mean sea level in 2000.

NEWPORT		Median (50th percentile) 50% probability SLR exceeds	Likely Range (17th-83rd percentiles) 66% probability that SLR is between…	99.9th Percentile Value Exceptionally unlikely that SLR will exceed
Emissions Scenarios: Medium (RCP 4.5); High (RCP 8.5)		Feet (relative to Mean Sea Level in 2000)		
2030	Med	0.6	0.5-0.8	1.2
	High	0.7	0.4-0.9	1.5
2050	Med	1.1	0.8-1.4	2.4
	High	1.2	0.9-1.6	2.6
2070	Med	1.7	1.2-2.2	4.6
	High	1.9	1.3-2.5	5.1
2100	Med	2.4	1.6-3.2	8.3
	High	3.1	2.1-4.1	9.8

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

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*

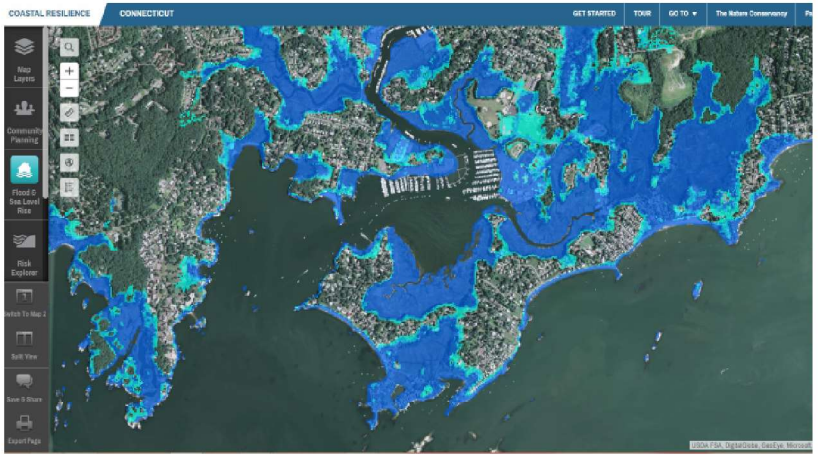
3

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

B Characterize Hazards

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

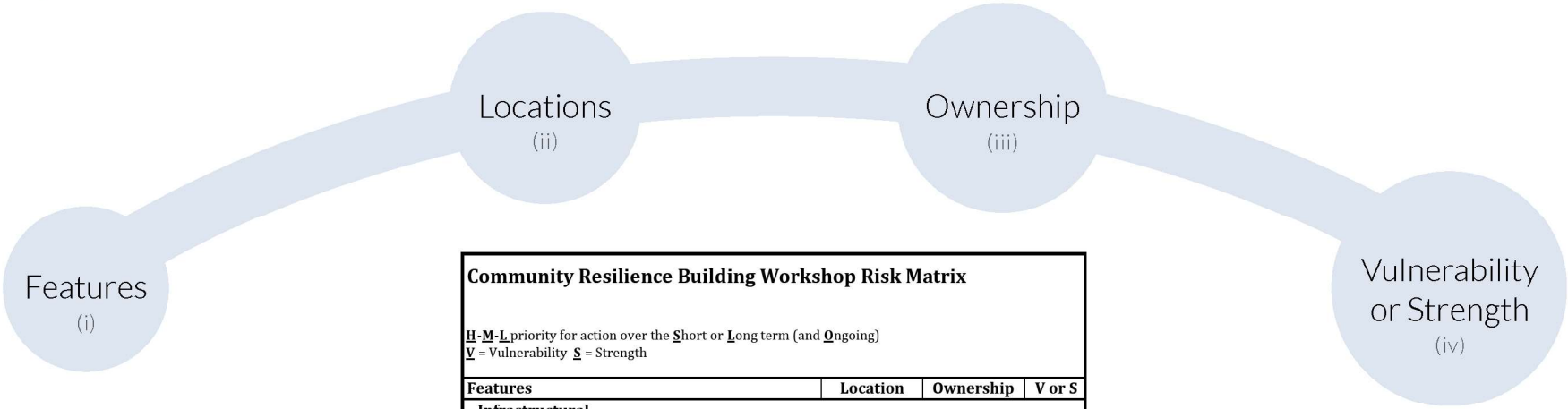
H-**M**-**L** priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

				Top 4 Hazards (tornado, floods, wildfire, hurricanes, snow/ice, drought, sea level rise, heat wave, etc.)					
				Coastal Flooding	Extreme Precipitation Events	Heat Waves	Wind	**Priority**	**Time**
Features	**Location**	**Ownership**	**V or S**					**H - M - L**	**S**hort **L**ong **O**ngoing
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 Short or Long term (and Ongoing)
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.

1

Identify infrastructural vulnerabilities and strengths (small teams).

Infrastructure such as residential housing, schools, commercial building, churches, office parks/campuses, laboratories, roads, bridges, and utilities among others can be vulnerable to hazards as well as serve to strengthen the community. The objective of this step is to identify infrastructural vulnerabilities and strengthens across the entirety of the community.

(i) List infrastructural features. On the **Risk Matrix**, list infrastructural features—such as housing, commercial buildings, roads, and utilities—that have been or could be affected by the **Top 4 Hazards**. Identify those that have withstood, could withstand, and/or are critical to maintain and improve. *Examples:* Communications systems, evacuation signage, and emergency operating centers. Refer to "Triggering Questions" to accelerate dialogue.

(ii) Describe locations via participatory mapping. For each feature, describe the specific location. Mark the location on the community basemap provided. Be sure to label in such a way as to be legible after the Workshop.

(iii) Identify ownership. Add information about who owns or has responsibility for each feature listed. *Examples:* City, county, state, private, association, department, agency, and corporate.

(iv) Identify each feature as vulnerability or strength. Assign each listed feature with "V" or "S," or both. In some cases, a community feature is both a vulnerability and strength. *Example:* One municipality identified a pond as a strength and vulnerability because it served as a water source for the comm unity, yet posed a flooding risk to adjacent homes and a church if not drawn down prior to major rainstorms.

Triggering Questions:

- What infrastructure/facilities are exposed to current and future hazards? Transportation, waste water treatment, nursing homes, schools, office park, hazardous materials facility, dams, laboratories, churches, pharmacies, groceries, gas stations?
- What makes this infrastructure vulnerable? Location, age, building codes, type of housing?
- What are the consequences of this infrastructure being vulnerable? Lack of access to critical facilities – urgency care/pharmacies?

Examples of Vulnerabilities:

- Main road floods during storms, blocking emergency response.
- Power outages during heat waves lead to health concerns.
- Wildfire and high winds resulting in supply chain interruptions.
- Sewer pump stations become submerged and inoperable.
- Compromised rail system due to heat-related warping of tracks.

Examples of Strengths:

- Critical road elevated and passable by emergency management.
- Hurricane roof installed at school with improved sheltering capacity.
- Hardened utility lines reduce outages due to ice storms.
- Undersized culvert replaced to reduce flooding in key intersection.
- Improvement to communication systems during extreme weather.

2

Identify societal vulnerabilities and strengths (small teams).

Social vulnerability is a combination of the factors and forces that affect the susceptibility of various groups within a community to harm as well as their collective ability to respond positively after extreme event and/or more routine, ongoing hazards. Social vulnerability involves such factors as the availability of health care services and access to lifelines (food/water, emergency response personnel, etc.). Social strengths are often represented by those support networks that connect and maintain the supply of goods and services to impacted groups within the community. The objective of this step is to identify the people, places, and services that are at risk from the **Top 4 Hazards** as well as those that currently add strength to the communities' overall resilience.

(i) List societal features. On the **Risk Matrix**, list societal features. Consider factors that affect the ability of groups to deal with adverse impacts from hazards. Conversely, consider factors or characteristics that increase the capability of groups to negate, withstand, and quickly recover from hazards. Refer to "Triggering Questions" to accelerate dialogue.

(ii) Describe locations via participatory mapping. For each feature, describe the location. Be as specific as possible. Legibly mark the location on the community basemap provided. *Examples:* Is a population of elderly residents located in a particularly high-hazard area? Are other services such as gas stations, supermarkets, data server facilitates, critical hospital care units, pharmacies, churches, emergency command centers, shelters, public works facilities, and fire stations located in vulnerable locations?

(iii) Identify ownership. Add information about who owns or has responsibility for each feature listed. *Example:* Senior population may live in retirement communities (private) or senior housing (public).

(iv) Identify each feature as vulnerability or strength. Assign each listed feature with "V" or "S," or both.

Triggering Questions:

- What are the population characteristics of the people living in high-risk areas? Elderly, low/moderate income, special needs, languages spoken?
- What are the strengths and vulnerabilities of people in your community? Active civic groups, organizations, associations; full-time police, fire, and emergency medical services; strong lines of communication for emergency information?
- How can hazards intensify these characteristics? Where are areas for improvement in the community?

Examples of Vulnerabilities:

- Senior housing without back-up generators during heat waves.
- Residents without access transportation during hurricane evacuation.
- Household contaminate and sewage mobilization during flooding.
- Limited areas of refuge in elementary schools during tornados.

Examples of Strengths:

- Reliable communications protocols across departments for all employees.
- "Neighbor-helping-neighbor" program aligned with emergency operations.
- Well-supported volunteer organizations (fire, ambulance, CERTs).
- Faith-based and civic groups with hazard preparedness plans.

3

Identify environmental vulnerabilities and strengths (small teams).

Cataloguing the vulnerabilities and strengths of natural systems can be complex. Existing factors such as pollution, haphazard development/redevelopment, and invasive species can reduce the ability of natural systems to respond and assist with hazard impact reduction. Previous and ongoing open-space protection in high-risk areas (i.e., unstable slopes, low-lying floodplains) is viewed as a strength that often directly increases community resilience. Other benefits of natural systems to communities include flood storage, recreation, tourism, elevated property values, cooling during heat waves, and water filtration, among others. Understanding these factors can help facilitate collaborative approaches between development and conservation that fosters community resilience building.

(i) List environmental features. On the **Risk Matrix**, list environmental features. Consider natural resources that are vulnerable to hazards or that can provide protection for people, property, and amenities from top hazards. Refer to "Triggering Questions" to accelerate dialogue.

(ii) Describe locations via participatory mapping. For each feature, describe the location. Be as specific as possible. Legibly mark the location on the community basemap provided. *Example:* Identify where wetlands are in relation to current development (e.g., marinas, road crossings, fire stations, historic building, cemeteries, neighborhoods, nursing homes, etc.).

(iii) Identify ownership. Add information about who owns or has responsibility for each feature listed. *Examples:*

- Local beach with boat ramp owned by city.
- Nature preserve owned by local land trust.
- Grassland and forest owned by federal agency.
- Floodplain privately owned by farm.

(iv) Identify feature as vulnerability or strength. Assign each listed feature with "V" or "S," or both.

Triggering Questions:

- What natural resources are important to your community?
- What benefits do these natural resources provide (storm buffering, fire breaks, erosion control, water quality improvement, slope stabilization, recreation)?
- Which natural resources are exposed to current and future hazards?
- What have been the effects of these hazards on these natural resources?
- Where are the high-risk areas and what vulnerabilities exist for the environment?

Examples of Vulnerabilities:

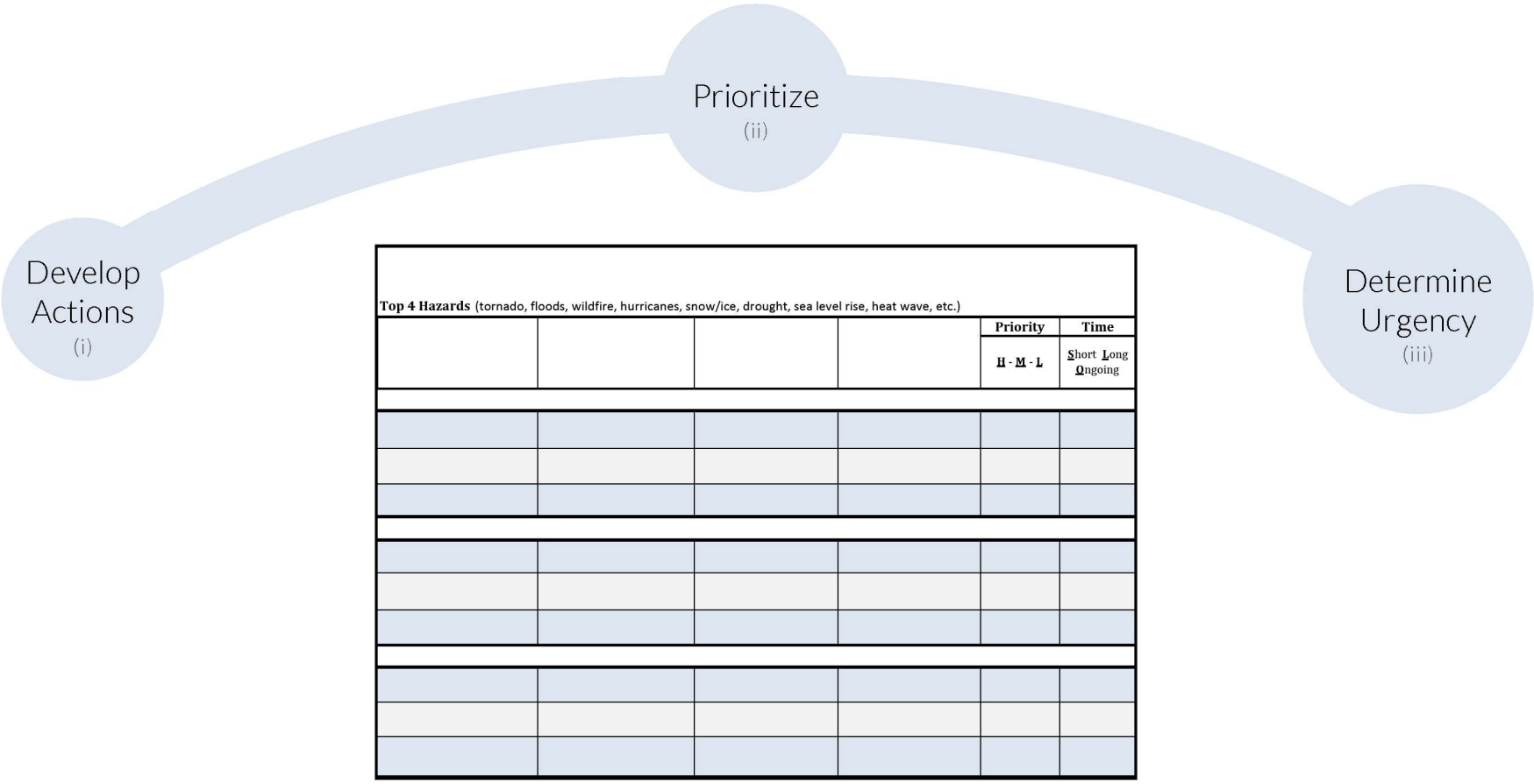
- Beachfront development reducing protection provided by dunes.
- Proliferation of subdivisions in wildfire and flood prone areas.
- Lack of urban tree canopy increasing heat island effects.

Examples of Strengths:

- Oyster reefs and tidal wetlands help reduce wave damage to property.
- Forested watersheds maintain drinking water supply during droughts.
- Native, vegetated slopes remain stable after intense 24-hour rain events.
- Floodplains provide stormwater storage and downstream flood reduction.

D Identify and Prioritize Community Actions

Section D Objective: For each profile – Infrastructural, Societal, Environmental – carefully identify and then prioritize actions to help reduce vulnerability or reinforce strengths for each or all of the **Top 4 Hazards**. Continue to work as small teams through the following three steps for each profile and capture dialogue, in detail, on the respective 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.



Steps D1, D2 and D3 below focus on identifying and prioritizing intrastructural, societal and environmental actions. Each step requires three tasks to complete the Risk Matrix: **(i)** develop actions, **(ii)** prioritize actions (**H**igh, **M**edium, **L**ow), and **(iii)** determine urgency (**O**ngoing, **S**hort-term, **L**ong-term).

1

Identify and prioritize infrastructural actions.

Example of a **Risk Matrix** filled in with infrastructural actions, priorities, and level of urgency.

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

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

Features	Location	Ownership	V or S	Coastal Flooding SLR/Storm Surge	Inland Flooding and Rain Events	Ice and Snow	Wind	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Town Campus	Specific	Town	V	Verify risk from flooding events; Identify alternative locations during peak flooding; Verify maintenance plan annually				H	S
Evacuation Routes - Roads	Town-wide	Town/State	V	Install highly visible signage for evacuation routes; Develop and implement communication program				H	S
Electrical Distribution System	Multiple	CL&P/Town	V	Within floodplain area, establish plan to address protection and long-term relocation of equipment		Upgrade transformers; Maintain power line protection zone (tree trimming)		H	O-L
Dams (inland and coastal)	Multiple	Private	V	Prevent possibility of catastrophic dam failure; Identify and remove dams to minimize downstream flooding due to failure				H	L
Railway and State Bridges	Multiple	Amtrak/State	V	Improve communications between parties; Expand green/gray infrastructure and improve bridge structures; Assess vulnerability and prioritize infrastructure improvement list				M	S
State Roads/Intersections	Town-wide	State/Town	V	Coordinate with DOT, volunteers, public works to improve response; Need signage to warn of flooding risk in critical intersections				M	L
Wharves and Shore Infrastructure	Shore	Town-State-Private	V	Pursue comprehensive shoreline management plan; Establish community dialogue on retaining/relocating infrastructure				L	S
Waste Water Treatment Facility	Specific	Town	V	Conduct alternative siting feasibility study; Relocate to low risk area within next 25 years.				L	L
New Ambulance Center	Specific	Town	S	Continue to support services in budget; Add additional staff and vehicle in next annual cycle					Ongoing
Zoning Regulations (maintain large lot size)	Multiple	Town	S	Current building codes control development in risky areas; Consider additional zoning incentives (TDRs) to reduce risk to residential units					Ongoing

More examples of actions:

- Improved access in high-risk locations
- Reduce housing stock in vulnerable areas
- Prioritize development in low-risk areas
- Integrate future risks in capital improvement plans
- Flood-proof manhole covers
- Secure new generators for critical facilities

When prioritizing, consider factors such as:

- Funding availability and terms
- Agreement on outstanding impacts from recent hazard events
- Necessity for advancing longer-term outcomes
- Contribution towards meeting existing local and regional planning objectives

Examples of urgency:

- Current project to install hurricane-proof roof on school is an ongoing **(O)** action.
- Ensuring evacuation procedures are updated annually is considered a short-term **(S)** action.
- Reducing housing stock in high-risk areas, elevating a road, or replacing a bridge are long-term **(L)** actions.

2

Identify and prioritize societal actions.

Example of a **Risk Matrix** filled in with societal actions, priorities, and level of urgency.

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

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

Features	Location	Ownership	V or S	Coastal Flooding SLR/Storm Surge	Inland Flooding and Rain Events	Ice and Snow	Wind	Priority	Time
								H - **M** - **L**	**S**hort **L**ong **O**ngoing
Societal									
Elderly Citizens (facilities)	Multiple	Private	**V**	Assess and identify vulnerabilities to determine residents needs during emergencies; Coordinate emergency planning efforts; Conduct routine evacuation drills				**H**	**S**
Neighborhood Cooperation	Town-wide	Private	**V**	Assist associations in identifying and conducting best practices to reduce risk; Advance a "Neighbor helping Neighbor" Program through Community Center training				**H**	**S**
Faith-based Organizations	Multiple	Private	**V**	Coordinate organizations in identifying and conducting best practices amongst members to reduce risk				**H**	**S**
Homeless Population	Town-wide	Town	**V**	Extreme weather flyers and communications about available services				**M**	**S**
Vulnerable Neighborhoods	South side	Town/Private	**V**	Identify level and location of vulnerable units; Develop longer term plan to reduce vulnerability				**M**	**L**
Coordinated Evacuation Plan	Town-wide	Town/State	**V**	Reconfigure evacuation routes; Update signage along critical routes				**L**	**S**
Sheltering Facility (upgrades)	Town/Region	Town/State	**V**	Conduct feasibility analysis for regional sheltering facility; Seek to construct over next 15 years.				**L**	**L**
Shelter Management Plan	Town-wide	Town	**S**	Review and update as needed on annual basis; More resources required (cots, shampoo, etc.)					**Ongoing**
Lower Household Expenses (flood insurance)	Town-wide	Town	**S**	Continue enrollment in FEMA Community Rating System (CRS);Reduced number flood insurance rate payers through volunteer buyouts/relocation					**Ongoing**
Volunteer Fire Department	Town-wide	Town	**S**	Continue support (well equipped and experienced) to further strengthen services - volunteer outreach					**Ongoing**

More examples of actions:

- Strengthen volunteer opportunities for residents
- Increase hazard awareness in high risk areas through education and outreach
- Foster a neighbor-helping-neighbor program across community

When prioritizing, consider factors such as:

- Funding availability and terms
- Agreement on outstanding impacts from recent hazard events
- Necessity for advancing longer-term outcomes
- Contribution towards meeting existing local and/or regional planning objectives

Examples of urgency:

- A current regional sheltering and shared services agreement is an ongoing **(O)** action.
- A communication campaign on hazard impacts implemented in next six months is a short-term **(S)** action.
- Relocating affordable housing from high-hazard areas is a long-term **(L)** action.

3

Identify and prioritize environmental actions.

Example of a **Risk Matrix** filled in with environmental actions, priorities, and level of urgency.

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

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

Features	Location	Ownership	V or S	Coastal Flooding SLR/Storm Surge	Inland Flooding and Rain Events	Ice and Snow	Wind	Priority H - M - L	Time Short Long Ongoing
Environmental									
Beaches & Dunes	Multiple	State-Town-Private	V/S	Maintain existing beaches & dunes; Assess values and key locations relative to people and property				H	S
Forest (uniform age structure)	Town-wide	Town/State	V	Seeks management that diversifies the age structure of forests in Town; Assess and identify key vulnerabilities from tree fall				H	S
Salt Marsh	Multiple	State/Private	V/S	Maintain existing marsh; Consider additional regulatory protection (increased setbacks) to prevent impacts to resource; Assess risk reduction potential from existing and future wetlands				H	S
Open Space Acquisition (for flood impact reduction)	Town-wide	Town-State-Private	V	Secure state funding; Salt marsh advancement zones	Secure state/federal funding	Include land protection needs Master Plan		H	S-L
State Parks	Specific	State	V	Encourage the State to work more closely with Town to comprehensively maintain town-wide natural resources, amenities, and water quality; Coordinate with state regarding evacuation procedures				M	S
Rippowam River	Specific	State/Town	V		Improve risk reduction characteristics of waterway through natural infrastructure & riparian buffer enhancements			M	S-L
Drinking Water Reservoir	Multiple	State-Private	V	Conduct assessment to comprehensively identify vulnerabilities and develop action plans to increase resilience of natural resources and long term water quality/quantity; Implement improvements				L	L
Protected Open Space	Multiple	State-Town-Private	S	Maintain existing open space to help reduce risk to Town; Seek to increase open space with the highest risk reduction characteristics					Ongoing
Tree Inventory	Town-wide	Town	S	Continue to utilize tree inventory to develop comprehensive, priority-based tree maintenance plan along transportation/utility corridors					Ongoing
River Restoration Projects	Specific	Town/Private	S	Continue implementation of projects to restore river buffer and remove dam to reduce risk to adjoining homes and businesses					Ongoing

More examples of actions:

- Conserve high value salt marsh advancement zones
- Protect and manage parks and lands located in flood zones
- Establish community-based green infrastructure proximate to high-risk locations
- Stabilize vulnerable slopes with native vegetation
- Increase urban tree canopy in low to moderate income neighborhoods

When prioritizing, consider factors such as:

- Funding availability and terms
- Agreement on outstanding impacts from recent hazard events
- Necessity for advancing longer-term outcomes
- Contribution towards meeting existing local and/or regional planning objectives

Examples of urgency:

- Protecting existing dunes by not permitting future development on the dunes is an ongoing **(O)** action.
- A dune restoration project implemented shortly after a hurricane is a short-term **(S)** action.
- Relocating homes to reduce risk and help expand the dune system to improve localized resilience is a long-term **(L)** action.

E Determine the Overall Priority Actions

Section E Objective: Develop agreement among workshop participants on the highest-priority actions across profiles—Infrastructural, Societal, Environmental—that will help reduce vulnerability or reinforce strengths resulting in greater community resilience. Once the large team has reconvened at the opening of this Section, directed report-outs by each small team (5-7 minutes per team using their Risk Matrix) in immediate succession is highly recommended.

1. Identify highest-priority actions (large team).

In Section D, participants in small teams created lists of actions for each feature across the infrastructural, societal, and environmental profiles. To ensure meaningful and more immediate community resilience building actions, the large team must reach agreement on a shorter (3 to 5) "highest-priority" action list. This Workshop step provides a vehicle to vet individual voices and for the large team, with all participants as a whole, to reach agreement on priorities for community resilience building.

2. Further define urgency and timing (large team).

To help move to a "highest-priority" action list, the large team should reconsider existing needs and urgency as expressed during the small team report-outs using their respective **Risk Matrixes**. The large team should also consider existing programs into which priority actions can be integrated easily or used to strengthen related actions with existing funding. In some cases, it may be advantageous to select a lower priority action if an opportunity for immediate integration and funding presents. Community resilience building is about creating irresistible and sustainable momentum through collaborative and routine action over time.

Facilitation Guidance: Several techniques are available to facilitate agreement by the large team on highest-priority actions. Directed report-outs by small teams (using **Risk Matrix**) with sequential capture and reinforcement of commonalities via flip charts is a very effective way to reach agreement on 3-5 highest-priority actions. This requires a facilitated dialogue and verbal agreement on highest-priority actions immediately following the small group reports. Providing an emphasis on "commonalities", as well as "differences", across small teams is an effective technique to accelerate agreement.

Alternatively, "sticky-dot voting" is a frequently used technique for determining which proposed actions are more important. With sticky-dot voting, a clear process is paramount, often including the following:

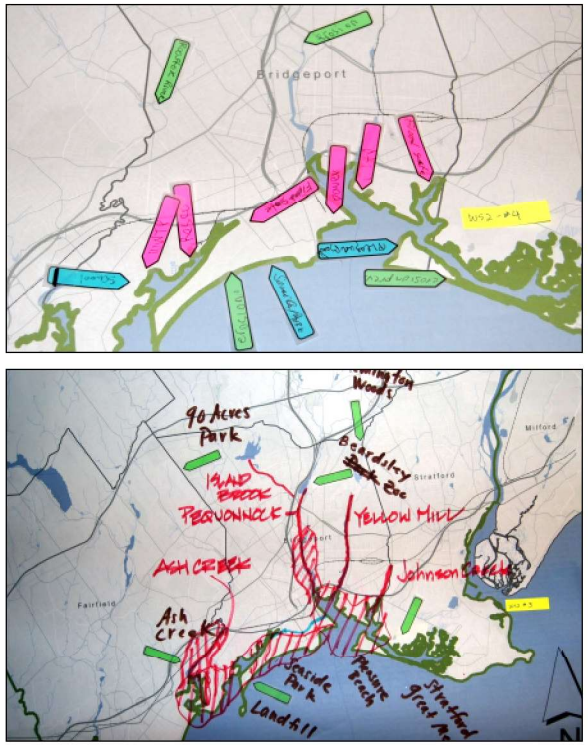
- Participants are given small dots (3-5) with an adhesive backing and told to place dots next to the actions on the Risk Matrixes they feel are of highest priority for the community.
- Specific criteria and instructions can be used to guide voting. For examples, participants may be given the option of placing all their dots next to one action, or directed to distribute among actions.
- Finally, the facilitator(s) tallies up dots to determine the 3-5 highest-priority actions. Final acknowledgement from participants on the 3-5 actions selected is paramount here.

F Put It All Together

Section F Objective: Develop comprehensive summary products from Community Resilience Building Workshop that will help reduce vulnerability or reinforce strengths resulting in greater community resilience.

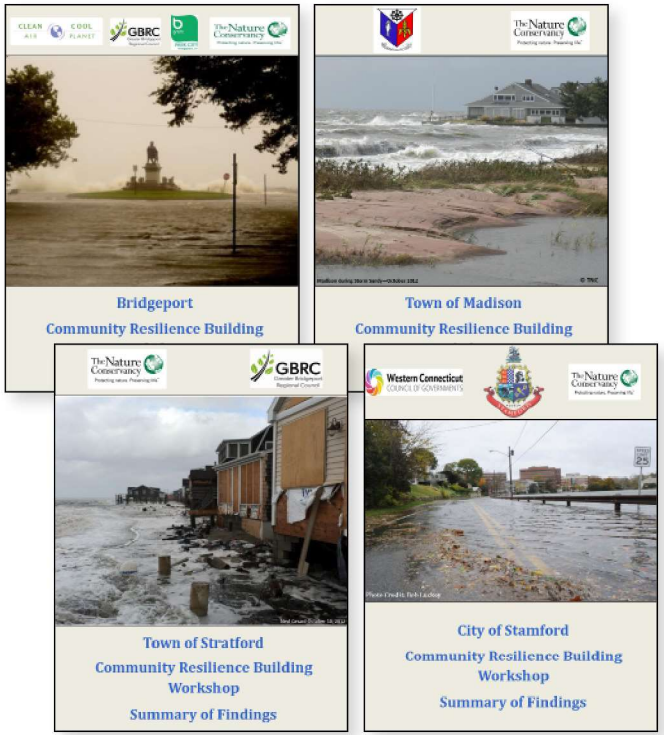
Generate final workshop products (core team).

In the aftermath of a **Community Resilience Building Workshop**, the core team must reconvene to generate a summary of findings report to be returned upon completion to participants and broader stakeholders. To achieve this outcome, the core team will need to 1) integrate and generate one master **Risk Matrix** for the community, 2) summarize top hazards and associated impacts (past, current, future), 3) distill the principal vulnerabilities and strengths, ownership, and locations, and 4) and organize a list of actions based on relative priority and urgency with emphasis on the 3-5 "highest-priority" actions. The final report should also list the affiliation of all invited and attending participants. Examples of completed summary of findings reports are available for review at **www.CommunityResilienceBuilding.org**. Public presentations of final findings from the Community Resilience Building Workshop are highly recommended to help increase awareness and receptivity amongst residents, citizens, and/or employees.



Participatory mapping on Base Maps (Sections B & C)

Priority actions with agreement (Sections D & E)



CRB Workshop summary of findings (Section F)

G Moving Forward

Section G Objective: Advance the Community Resilience Building Workshop outcomes ultimately resulting in greater community resilience. Successful approaches and techniques that can help with community resilience building after the Workshop include:

1. Continue community outreach and engagement.

- Develop a strategy to secure formal approval by leadership (council, boards, commissions, etc.) to advance priority actions.
- Establish working groups and leads to enhance momentum for identified priority actions.
- Start conversations with those not involved in developing the **Risk Matrix** and the Community Resilience Building Workshop – focus on impacts where people live and work.
- Share stories of successfully completed actions with others across the community and beyond.
- Pursue and secure funding for priorities and projects.

2. Secure additional data and information.

- Define and establish partnerships to assist with data and information needs.
- Implement data collection to help fill gaps and inform additional assessments.
- Prioritize where to focus more in-depth, data/information gathering efforts.
- Integrate monitoring protocols and procedures into projects and policies to ensure future resilience efforts are continuously re-informed and improving.
- Pursue funding to help with additional analysis and/or projects.

3. Inform existing planning and project activities.

- Identify existing efforts to reduce risks and provide protection to people, property, and the environment. This can provide a foundation on which to build a stronger, more comprehensive, community resilience strategy.
- Inform existing hazard mitigation, comprehensive, capital investment, stormwater, natural resources, housing, and sustainability planning with **Risk Matrix**.
- Examine current policies such as building codes and land use policies and update as needed to accommodate climate-related concerns and/or hazards prioritized in **Risk Matrix**.
- Set priorities and targets for community resilience building over time via clearly defined and agreed upon partnerships.

Risk Matrix Guide

Page numbers for the Workshop Steps & Tasks to complete each section of the **Risk Matrix**

B 2 Page 9

Community Resilience Building Workshop Risk Matrix

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

Features	Location	Ownership	V or S	Top 4 Hazards (tornado, floods, wildfire, hurricanes, snow/ice, drought, sea level rise, heat wave, etc.)				Priority	Time
								H - M - L	Short Long Ongoing
Infrastructural									
Societal									
Environmental									

C 1 Page 11

C 2 Page 12

C 3 Page 13

D 1 Page 15

D 2 Page 16

D 3 Page 17

Risk Matrix

The **Risk Matrix** captures the community's priority hazards, vulnerabilities, strengths, and actions. The **Risk Matrix** provides information necessary to develop strategies, inform community plans and advance conversations on how to lessen impacts from hazards and build resilience. Use the **Risk Matrix** and final summary report to inform ongoing discussions and decisions. Periodically revisit and update the **Risk Matrix** as your community makes progress on priority actions.

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

				Top 4 Hazards (tornado, floods, wildfire, hurricanes, snow/ice, drought, sea level rise, heat wave, etc.)					
								Priority	**Time**
Features	**Location**	**Ownership**	**V or S**					**H - M - L**	**Short Long Ongoing**
Infrastructural									
Societal									
Environmental									

Recommended Risk Matrix size for Workshops is 3' x 5' - large enough to legibly capture input and provide a focal point during and after Workshops.

Example of Completed Risk Matrix: Infrastructural

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

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

Features	Location	Ownership	V or S	Coastal Flooding SLR/Storm Surge	Inland Flooding and Rain Events	Ice and Snow	Wind	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Town Campus	Specific	Town	**V**	Verify risk from flooding events; Identify alternative locations during peak flooding; Verify maintenance plan annually				**H**	**S**
Evacuation Routes - Roads	Town-wide	Town/State	**V**	Install highly visible signage for evacuation routes; Develop and implement communication program				**H**	**S**
Nursing Homes/Elderly Care Facilities	Multiple	Private	**V**	Improve power generation; Review building codes and zoning for existing and future facilities				**H**	**S**
Homeowners Associations/Neighborhoods	Town-wide	Town/Private	**V**	Engage Neighborhood Associations and develop cooperative response plan with Town: Advance "Neighbor helping Neighbor" Program; Develop comprehensive neighborhood-based emergency plans				**H**	**S**
Electrical Distribution System	Multiple	CL&P/Town	**V**	Within floodplain area, establish plan to address protection and long-term relocation of equipment		Upgrade transformers; Maintain power line protection zone (tree trimming)		**H**	**O-L**
Dams (inland and coastal)	Multiple	Private	**V**	Prevent possibility of catastrophic dam failure; Identify and remove dams to minimize downstream flooding due to failure				**H**	**L**
Railway and State Bridges	Multiple	Amtrak/State	**V**	Improve communications between parties; Expand green/gray infrastructure and improve bridge structures; Assess vulnerability and prioritize infrastructure improvement list				**M**	**S**
Septic Systems	Town-wide	Private	**V**	Assess opportunities for community systems or alternative treatment technology; Upgrade regulations to reduce contamination in water ways				**M**	**L**
State Roads/Intersections	Town-wide	State/Town	**V**	Coordinate with DOT, volunteers, public works to improve response; Need signage to warn of flooding risk in critical intersections				**M**	**L**
Wharves and Shore Infrastructure	Shore	Town-State-Private	**V**	Establish community dialogue regarding retaining/relocating infrastructure; Advance comprehensive shoreline management plan				**L**	**S**
Waste Water Treatment Facility	Specific	Town	**V**	Conduct alternative siting feasibility study; Relocate to low risk area within next 25 years.				**L**	**L**
New Ambulance Center	Specific	Town	**S**	Continue to support services in budget; Add additional staff and vehicle in next annual cycle					**Ongoing**
Zoning Regulations (maintain large lot size)	Multiple	Town	**S**	Current building codes control development in risky areas; Consider additional zoning incentives (TDRs) to reduce risk to residential units					**Ongoing**
Business District (power generators)	Specific	Town/Private	**S**	Downtown business district with power generators in place; Prioritize pharmacy and gas stations					**Ongoing**

Example of Completed Risk Matrix: Societal

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

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

Features	Location	Ownership	V or S	Coastal Flooding SLR/Storm Surge	Inland Flooding and Rain Events	Ice and Snow	Wind	Priority H - M - L	Time Short Long Ongoing
Societal									
Elderly Citizens (facilities)	Multiple	Private	V	Assess and identify vulnerabilities to determine residents needs during emergencies; Coordinate emergency planning efforts; Conduct routine evacuation drills				H	S
Neighborhood Cooperation	Town-wide	Private	V	Assist associations in identifying and conducting best practices to reduce risk; Advance a "Neighbor helping Neighbor" Program through Community Center training				H	S
Faith-based Organizations	Multiple	Private	V	Coordinate organizations in identifying and conducting best practices amongst members to reduce risk				H	S
Municipal & Regional Tabletop Exercise	Town/Region	Town	V	Need to conduct exercises to maximize readiness; Better regional planning/communication plan to discuss vulnerabilities, share ideas, and resources				H	S
Homeless Population	Town-wide	Town	V	Extreme weather flyers and communications about available services				M	S
Database (locations of vulnerable population)	Town/Region	Town/State	V	Need to improve database to ensure high level responses and safety				M	S
Vulnerable Neighborhoods	South side	Town/Private	V	Identify level and location of vulnerable units; Develop longer term plan to reduce vulnerability				M	L
Coordinated Evacuation Plan	Town-wide	Town/State	V	Reconfigure evacuation routes; Update signage along critical routes				L	S
Coastal Homeowners	Coastline	Private	V	Review building codes and zoning regulations; Continue e communication about risks and evacuation procedures				L	S
Sheltering Facility (upgrades)	Town/Region	Town/State	V	Conduct feasibility analysis for regional sheltering facility; Seek to construct over next 15 years.				L	L
Code Red (Reverse 911)	Town-wide	Town	S	Maintain and upgrade as needed					Ongoing
Shelter Management Plan	Town-wide	Town	S	Review and update as needed on annual basis; More resources required (cots, shampoo, etc.)					Ongoing
Lower Household Expenses (flood insurance)	Town-wide	Town	S	Continue enrollment in FEMA Community Rating System (CRS);Reduced number flood insurance rate payers through volunteer buyouts/relocation					Ongoing
Volunteer Fire Department	Town-wide	Town	S	Continue support (well equipped and experienced) to further strengthen services - volunteer outreach					Ongoing

Example of Completed Risk Matrix: Environmental

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

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

Features	Location	Ownership	V or S	Coastal Flooding SLR/Storm Surge	Inland Flooding and Rain Events	Ice and Snow	Wind	Priority H - M - L	Time Short Long Ongoing
Environmental									
Beaches & Dunes	Multiple	State-Town-Private	**V/S**	Maintain existing beaches & dunes; Assess values and key locations relative to people and property				**H**	**S**
Forest (uniform age structure)	Town-wide	Town/State	**V**	Seeks management that diversifies the age structure of forests in Town; Assess and identify key vulnerabilities from tree fall				**H**	**S**
Salt Marsh	Multiple	State/Private	**V/S**	Maintain existing marsh; Consider additional regulatory protection (increased setbacks) to prevent impacts to resource; Assess risk reduction potential from existing and future wetlands				**H**	**S**
Shoreline Erosion	Coastal/Rivers	Town/Private	**V**	Assess impacts to various scenarios; Identify green infrastructure/living shoreline projects				**H**	**S**
Open Space Acquisition (for flood impact reduction)	Town-wide	Town-State-Private	**V**	Secure state funding; Salt marsh advancement zones	Secure state/federal funding	Include land protection needs Master Plan		**H**	**S-L**
Riparian Buffers	Town-wide	Town	**V**	Identify areas with greatest restoration potential; Areas for future acquisition that can prevent flooding to adjoining infrastructure				**M**	**S**
State Parks	Specific	State	**V**	Encourage the State to work more closely with Town to comprehensively maintain town-wide natural resources, amenities, and water quality; Coordinate with state regarding evacuation procedures				**M**	**S**
Rippowam River	Specific	State/Town	**V**		Improve risk reduction characteristics of waterway through natural infrastructure & riparian buffer enhancements			**M**	**S-L**
Drinking Water Reservoir	Multiple	State-Private	**V**	Conduct assessment to comprehensively identify vulnerabilities and develop action plans to increase resilience of natural resources and long term water quality/quantity; Implement improvements				**L**	**L**
Harbor Sedimentation	Coastal	Town	**V**	Reuse dredged sediment to augment natural infrastructure (beneficial reuse)				**L**	**L**
Protected Open Space	Multiple	State-Town-Private	**S**	Maintain existing open space to help reduce risk to Town; Seek to increase open space with the highest risk reduction characteristics					**Ongoing**
Beach/Dune Resiliency Plan	Coastal	Town/State	**S**	Continue to implement/update the Plan					**Ongoing**
Tree Inventory	Town-wide	Town	**S**	Continue to utilize tree inventory to develop comprehensive, priority-based tree maintenance plan along transportation/utility corridors					**Ongoing**
River Restoration Projects	Specific	Town/Private	**S**	Continue implementation of projects to restore river buffer and remove dam to reduce risk to adjoining homes and businesses					**Ongoing**

Quick Reference

Ⓐ Prepare for the Workshop

Ⓑ Characterize Hazards

1. Identify past, current & future impacts.
2. Determine the highest-priority hazards.

Ⓒ Identify Community Vulnerabilities and Strengths

1. Infrastructural
2. Societal
3. Environmental

Ⓓ Identify and Prioritize Community Actions

1. Infrastructural
2. Societal
3. Environmental

Ⓔ Determine the Overall Priority Actions

1. Identify highest-priority actions.
2. Further define urgency and timing.

Ⓕ Put It All Together

1. Finalize report.

Ⓖ Move Forward

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

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Features	Location	Ownership	V or S	Priority H-M-L	Time Short Long Ongoing
Infrastructural					
C 1 Page 11				D 1 Page 15	
Societal					
C 2 Page 12				D 2 Page 16	
Environmental					
C 3 Page 13				D 3 Page 17	

Triggering Questions:

Hazards B 2

- 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 yrs.)
- What's 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?

Infrastructural Profile C 1 D 1

- Transportation, waste water treatment, nursing homes, schools, office park, hazardous materials facility, dams, laboratories, churches, pharmacies, groceries, gas stations?
- What makes this infrastructure vulnerable? Location, age, building codes, type of housing?
- What are consequences of this infrastructure being vulnerable? Lack of access to critical facilities – urgency care/pharmacies?

Possible Actions: Improve access, reduce housing stock in vulnerable areas, prioritize future development in lower-risk areas, integrate future risks in capital improvement plans?

Societal Profile C 2 D 2

- Elderly, low/moderate income, special needs, languages spoken, citizens/employees?
- What are the strengths and vulnerabilities of people in your community? Active civic groups, organizations, associations; Full time police, fire, and emergency medical services; Strong lines of communication for emergency info?
- How can hazards intensify these characteristics? Where are areas for improvement in the community?

Possible Actions: Improve existing programs (which ones)? Increase awareness via education/outreach on hazards? Increase involvement by citizens/employees (on what and with whom)?

Environmental Profile C 3 D 3

- What natural resources are important to your community?
- What benefits do these natural resources provide (storm buffering, fire breaks, erosion control, water quality improvement, slope stabilization, recreation)?
- Which natural resources are exposed to current and future hazards?
- What have been the effects of these hazards on these natural resources?
- Where are the high risk areas and what vulnerabilities exist for the environment?

Possible Actions: Conserve high value resource areas? Protect land in flood zone from future development via codes, zoning, and/or land use policy?

Notes

Highest Priority Actions:

1. _____
2. _____
3. _____
4. _____
5. _____

The Nature Conservancy

www.CommunityResilienceBuilding.org

WORKSHOP NO. 1

North Reading Municipal Vulnerability Preparedness (MVP) Plan Workshop No. 1

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

March 21, 2018

North Reading
MASSACHUSETTS

GREEN INTERNATIONAL AFFILIATES, INC.

Building Strong Client Relationships Through Engineering Excellence

Agenda

1. Introductions
2. Overview of MVP Program (7 Steps)
3. 2016 Hazard Mitigation Plan Update
4. MVP Core Team/Goals for the Town's MVP Plan
5. Characterize Hazards
6. Identify Community Vulnerabilities & Strengths
7. Questions/Discussion
8. Adjourn

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2. 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

2. Overview of MVP Program

- Community Resilience Building Workshop Guide
  www.CommunityResilienceBuilding.com
- UMASS Climate Change Projections

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3. 2016 Hazard Mitigation Plan Update

January 2016 Hazard Mitigation Plan Update

- 2016 Update to the 2006 Plan approved by FEMA/MEMA
- Adopted by Town on May 23, 2016
- Plan evaluates impacts from natural hazards: Floods, Winter Storms, Wind, Fire, Geologic, Heat, Cold, Drought
- Provides Mitigation Strategies
- Makes Town eligible for FEMA Hazard Mitigation Grants

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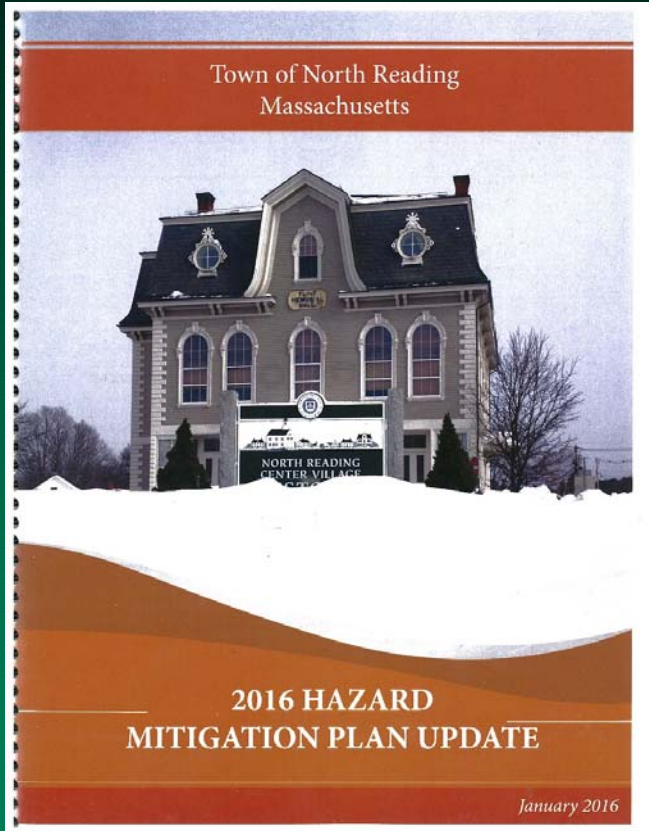
3. 2016 Hazard Mitigation Plan Update



Ranking	Hazard
High Hazards	Nor'easter
	Flood
	Blizzard
	Hurricane
	Ice Storm
	Snow
Moderate Hazards	Heavy Rain
	Earthquake
	Tornado
	Drought
	HAZMAT
	Hail
	Lightning
	Microburst
	Beaver Dams
	Extreme Cold
Low Hazards	Ice Jams
	Extreme Heat
	Erosion
	Brush fire
	Dam Failure
	Landslide

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3. 2016 Hazard Mitigation Plan Update

2016 Priority Level	Mitigation Action	Timeframe	Responsible Organization	Potential Funding Source	Estimated Cost
1	Establish a Floodplain and Stormwater Management Public Education Program.	2016	DPW	Town	$10,000
2	Develop a Town Community Emergency Response Team (CERT).	2016	Emergency Management	Town	$5,000
3	Adopt the Operation and Maintenance Plan for Martins Brook.	2016	Martin's Pond Association	Town	$5,000
4	Collect data to be used toward future benefit-cost-analysis.	2016-2017	DPW	Town	Low
5	Updates to the Stormwater Bylaw so all projects exceeding the 1-acre threshold comply with the bylaw.	2016-2017	Community Planning Commission, Town Planner	Town	Low
6	Coordinate with USGS and Ipswich River Watershed to access flow monitoring information along Ipswich River. Install monitors at key locations on Martins Brook.	2016-2017	DPW & Martin's Pond Association	Town/MA Riverways Program	$40,000
7	Expand the Town's GIS with pre-designed maps and the updated base map for asset management during disaster events.	2016	DPW	Town/ FEMA	$25,000
8	Support upgrade of the Benevento Culvert along Martins Brook.	2016-2018	Martin's Pond Association	Private	$500,000
9	Implement channel clearing and maintenance between Benevento and the pond.	2016-2017	Martin's Pond Association	Town	$20,000
10	Renovate DPW garage with facilities to accommodate Town employees during severe weather events and disasters.	2016-2020	DPW	Town/ FEMA	$150,000
11	Review current operation/maintenance procedures within the Town relative to cleaning storm drain systems. Consider creating a stormwater utility for funding for maintenance and capital improvements.	2016-2017	DPW	Town	$25,000

2016 Priority Level	Mitigation Action	Timeframe	Responsible Organization	Potential Funding Source	Estimated Cost
12	Build a storage shed for a season's supply of rock salt.	2016-2019	DPW	Town/ MassDOT	$200,000
13	Develop a public education campaign under the leadership of Reading Municipal Light District regarding tree care on private property relative to electric wires.	2016	DPW	Town/ RMLD	$10,000
14	Develop a comprehensive debris management response plan for post extreme weather events.	2016	DPW	Town	$25,000
15	Update the Ipswich River FEMA Flood Mapping Study.	2016-2020	Building Inspector & Town Engineer	FEMA	High
16	Replace the Chestnut Street Culvert over the Ipswich River and raise existing road grade to prevent overtopping.	2016-2019	DPW	Town/ FEMA	$750,000
17	Replace the Haverhill Street Culvert and raise the Haverhill Street roadway.	2016-2018	DPW	Town/ FEMA	$500,000
18	Purchase a generator for the senior center.	2016	Elder Services	Town/ FEMA	$20,000
19	Evaluate the structural capacity of flat roofs on critical and public facilities. Install strain gauges to monitor snow loads.	2016	DPW	Town/ FEMA	$35,000
20	Flood-proof the Town's water supply facilities up to the 500-year flood elevation, especially the Central Street well field pumping facility.	2016-2017	DPW & Utility Department	Town/ FEMA	$100,000
21	Move all critical equipment, debris, etc., out of the 100-year floodplain near the DPW garage.	2016-2017	DPW	Town	$50,000
22	Raise Profile of Burroughs Road to reduce overtopping and maintain access to west side of pond.	2016-2020	DPW	Town/ FEMA	$1,000,000
23	Detain stormwater upstream of Lindor Road by installing control weirs at three locations per Green International study.	2016-2017	DPW	Town	$25,000

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4. MVP Core Team/Goals for the Town's MVP Plan

- Emergency Management: Theo Kuliopulos
- Martins Pond Association: Janet Niccosia/Larry Soucie
- Building Inspector: Jim DeCola
- Planning Department: Danielle McKnight
- Conservation Commission: Leah Basbanes
- Water Department: Mark Clark
- Town Engineer: Mike Soraghan
- Fire Department: Barry Galvin
- Health Department: Bob Bracey
- Police Department: Mike Murphy
- School Department: Wayne Hardacker
- GIS: Bill Ross
- Facilities Department: Julie Spurr-Knight

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4. MVP Core Team/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.

4. MVP Core Team/Goals for the Town's MVP Plan

Goals for North Readings MVP Plan:

1. Identify Climate Change Vulnerabilities, considering Infrastructural, Societal and Environmental factors and Develop Action Steps to make the Town more Resilient and Sustainable to extreme weather related conditions in the future.
2. Develop an MVP Plan that compliments and builds upon the Town's previous mitigation efforts over the past two decades and the 2016 Hazard Mitigation Plan
3. Develop and MVP Plan that satisfies the requirements of the MA EOEA, such that it receives approval and makes the Town Eligible for Future MVP Grants

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Let's Get to Work!!

Step B – Characterize Hazards

Step C- Identify Community Vulnerabilities and Strengths

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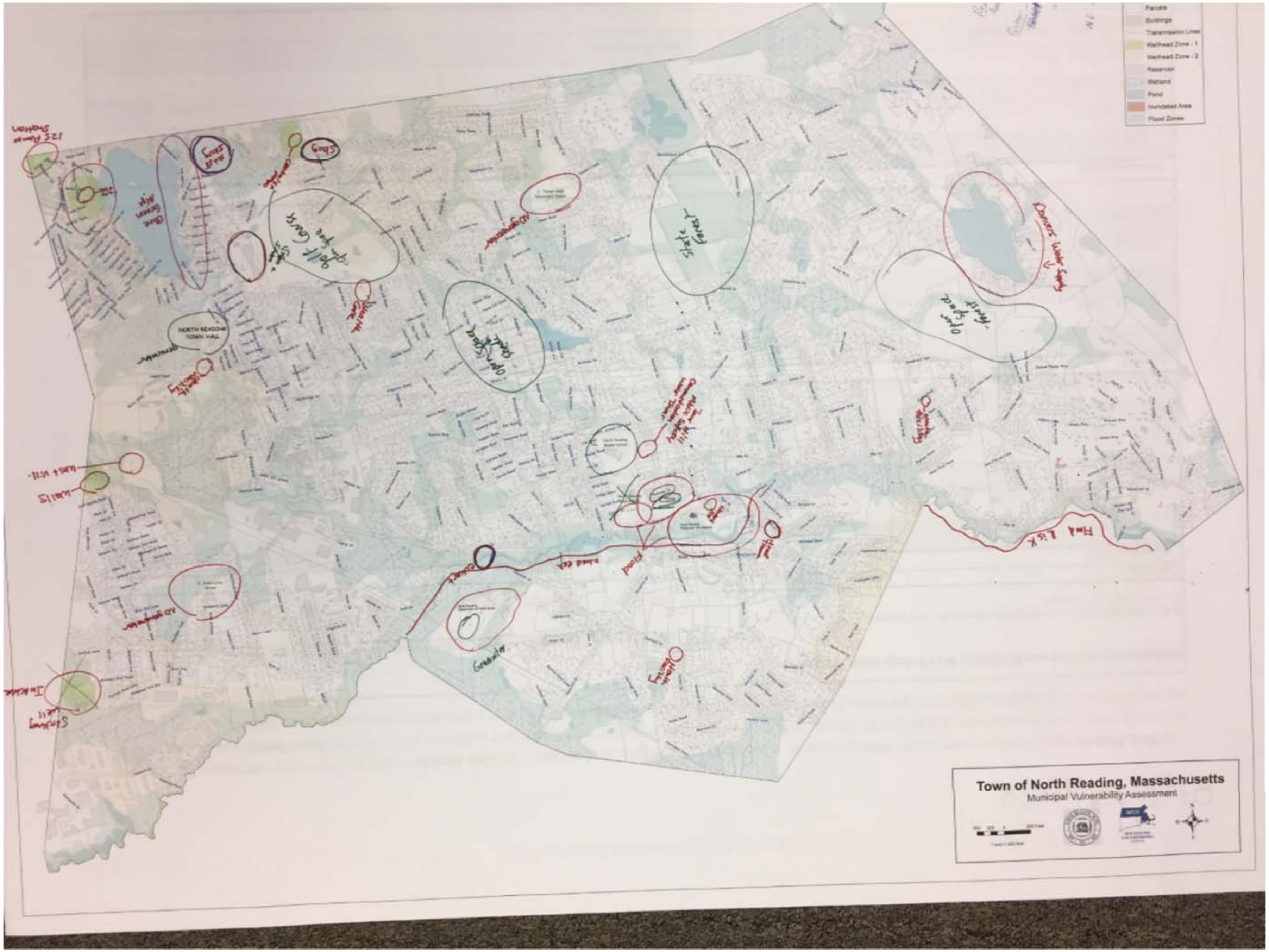
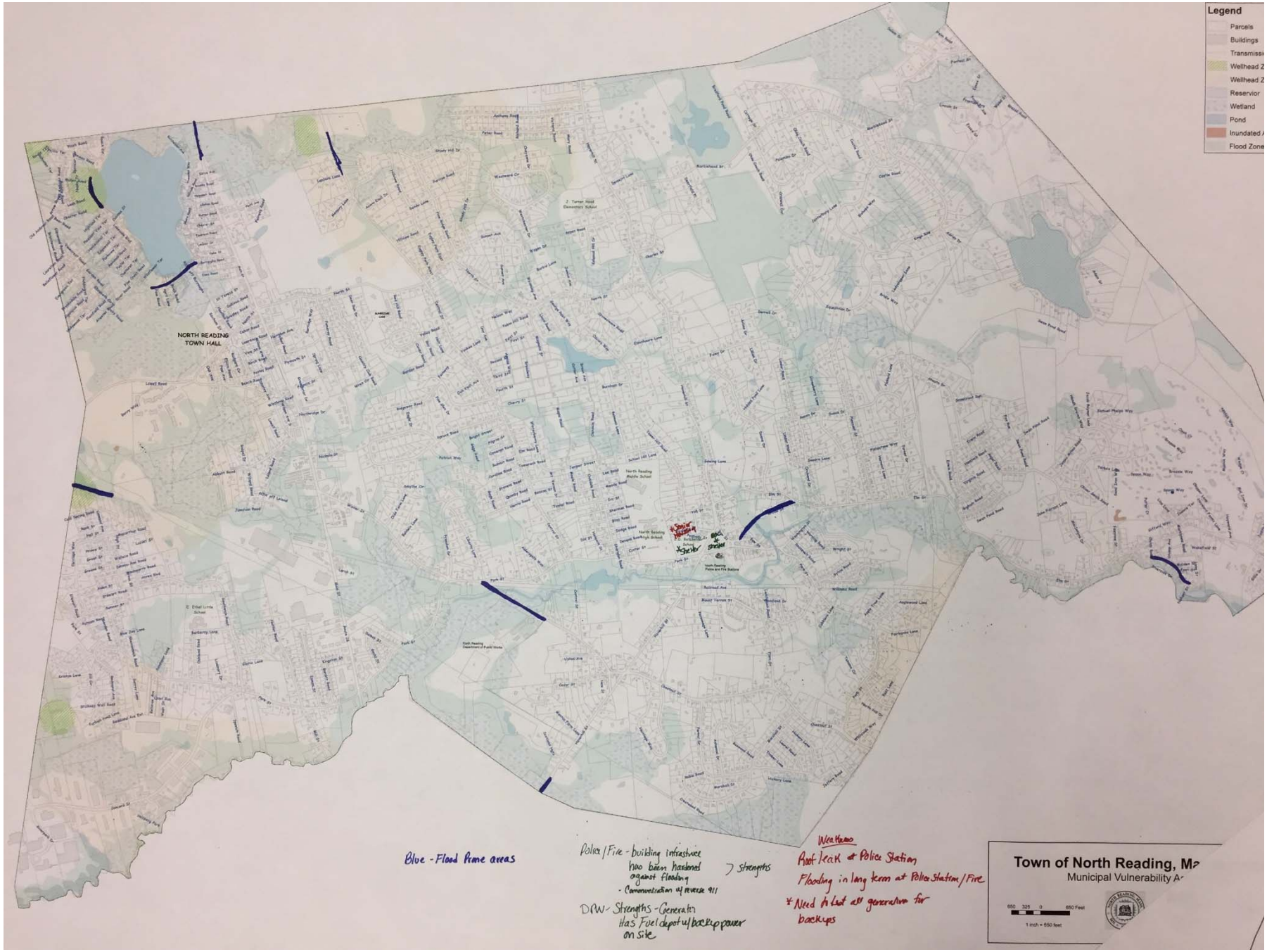
EXIT

EXIT


Parcels
Buildings
Transmission Lines
Wellhead Zone - 1
Wellhead Zone - 2
Reservoir
Wetland
Pond
Inundated Area
Flood Zones
NORTH READING TOWN HALL
State Forest
Flood
Town of North Reading, Massachusetts
Municipal Vulnerability Assessment


Legend
Parcels
Buildings
Transmiss
Wellhead Z
Wellhead Z
Reservior
Wetland
Pond
Inundated
Flood Zone
NORTH READING TOWN HALL
Town of North Reading, M
Municipal Vulnerability A
650 325 0 650 Feet
1 inch = 650 feet
Blue - Flood Prone areas
Police / Fire - building infrastruce has been hardened against flooding
- Communication w/ REVERE 911
} strengths
DPW - Strengths - Generator
Has Fuel depot w/ backup power on site
Weakness
Roof leak at Police Station
Flooding in long term at Police Station / Fire
* Need to list all generators for backups

Risk Matrix

The **Risk Matrix** captures the community's priority hazards, vulnerabilities, strengths, and actions. The **Risk Matrix** provides information necessary to develop strategies, inform community plans and advance conversations on how to lessen impacts from hazards and build resilience. Use the **Risk Matrix** and final summary report to inform ongoing discussions and decisions. Periodically revisit and update the **Risk Matrix** as your community makes progress on priority actions.

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

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

Features	Location	Ownership	V or S	Flood	Blizzard/Nor'easter	Wind	Extreme Cold/Heat	Priority H-M-L	Time Short Long Ongoing
Infrastructural									
Major Roadways - Multiple Locations	multiple locations	Town	V	road closed due to flooding	fallen trees/ power lines Snow removal	fallen trees/ power lines	water breaks close road	H	
DPW Buildings		Town	V+S	flooding closes access/roadway	Strength Newer vehicle equipment	trees fallen in driveway	Strength Fuel Station on site	M	
Police / Fire		Town	V+S	Presently Strength long term w/ increased flooding may become weakness	Site is undersized for Snow storage	none	pipes bursting during very cold	M	
School Buildings	multiple locations	Town	V+S	Strength Locations are out of floodplain	Strength Generator on site - need staff for plowing / snow removal	fallen trees/wires	pipes/meters breaking during extreme cold	L	
Water System	Town-wide	Town	V/S	access to buildings affected one Town locations can be flooded	access to West Village site through adjacent town		Strength System has redundancy to ensure continuity	H	
Drain System / RT 62 Culvert Wilmington	Town-wide	Town	V	most of pipe is comp and old outfall buried under debris	clogging due to snow banks	Leaves blocking catchbasins during storms			
Societal									
Senior Housing	Peabody CT	Town	S	on high ground	no Snow Storage available snow removal between buildings	limited encroaching trees Strength	aging water system multiple breaks occur	H	
Nursing Home	North Street	Private	S	on high ground	Strength have own removal	has own waste water treatment may not work during outage		M	
Trailer Home Park	RT 28	Private	V/S	flooding possible w/ heavier rain in active storms				L	
Martins Pond Neighborhood		Private/Town	V/S	Roads blocked by flood water	access by Police/Fire may not/out community communication			M	
Churches		Private/Town	V/S		Plowed by NRDPW when done planning roads community group communication			L	
Environmental									
Ipswich River	Townwide	Town	V	much of town in flood plain/ water quality issue	trees blocks riverway	trees block riverway	drought issues + water temp due to extreme heat	H	
Street Trees	Town-wide	Town	V/S	can be dislodged during flooding	tree branch breaking	block roadways when fall	help provide shade cooling during extreme heat	H	
Beaver Dams	Town-wide	Town	V	DPW has program in place to remove / maintain				L	
Ipswich River Park	IRP	Town	S/V	Flood driveway / walkways acts as flood storage	unplowed until after storm			L	
Septic System - Aging / Undersized	Town wide	Town	V	Systems fail during flooding					

Recommended Risk Matrix size for Workshops is 3' x 5' - large enough to legibly capture input and provide a focal point during and after Workshops.

Risk Matrix

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Community Resilience Building Workshop Risk Matrix

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DPW Buildings		Town	V+S	flooding closes access/roadway	Strength Newer removal equipment	trees fallen in driveway	Strength Fuel Station on site	M	
Police / Fire		Town	V+S	Possibility Strength long term w/ increased flooding may become weaknesses	site is undersized for snow storage	none	pipes bursting during very cold	M	
School Buildings	multiple locations	Town	V+S	Strength Locations are out of floodplain	Strength generator on site - need staff for plowing/snow removal	fallen trees/wires	pipes/motors breaking during extreme cold	L	
Water System	Town-wide	Town	V/S	access to buildings affected one/two locations can be flooded	access to West Village site through adjacent town		Strength System has redundancy to ensure continuity	H	
Drain System / RT 62 Culvert Wilmington	Town-wide	Town	V	much of pipe is comp and old outfall buried under debris	clogging due to snow banks	Leaves blocking catchbasins during storms			
Societal									
Senior Housing	Peabody CT	Town	S	on high ground	no snow storage available snow removal between buildings	limited encroaching trees Strength	aging water system multiple breaks nonpotable quality	H	
Nursing Home	North Street	Private	S	on high ground	Strength have own removal	has own waste water treatment may not work during outage		M	
Trailer Home Park	RT 28	Private	V/S	flooding possible w/ heavier rain in future storms				L	
Martins Pond Neighborhood		Private/Town	V/S	Roads blocked by flood water	access by Police/Fire limited in/out community communication			M	
Churches		Private/Town	V/S		Planned by NRDPW when done planning roads community groups communication			L	
Environmental									
Ipswich River	Town-wide	Town	V	much of town in flood plain/water quality issue	trees blocks riverway	trees block riverway	drought issues + water temp due to extreme heat	H	
Street Trees	Town-wide	Town	V/S	can be dislodged during flooding	tree branches breaking	block roadways when fall	help provide shade cooling during extreme heat	H	
Beaver Dams	Town-wide	Town	V	DPW has program in place to remove/maintain				L	
Ipswich River Park	IRP	Town	S/V	Flood driveway/walkways acts as flood storage	unplowed until after storm			L	
Septic System - Aging/Undersized	Town wide	Town	V	systems fail during flooding					

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WORKSHOP NO. 2

Risk Matrix

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Community Resilience Building Workshop Risk Matrix

H-**M**-**L** priority for action over the **S**hort or **L**ong term (and **O**ngoing)
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Top 4 Hazards (tornado, floods, wildfire, hurricanes, snow/ice, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Flood	Blizzard ~~Wind~~ Winter Storms	Wind ~~Extreme Temps~~	Extreme Cold + Heat ~~Drought~~	Priority H-M-L	Time Short Long Ongoing
Infrastructural									
Middle/High School	191 Park	municipal	S	High Elevation Large capacity for shelter Y	Y Fully generator	Y	Y	H	Ongoing
Roads/Culverts/Bridges	Various	public/private municipal	V	Y - become unpassable	Y - trees/branches down	Y trees/branches	Y - Water main breaks frost heaves	H	Ongoing
Public Safety Buildings (inadequate geographic coverage)	154-156 Park St.	Municipal	V	Y - flood wall inadequate IN/near floodplain	Y if flooding	N	N	H	O
Wells + Pumping Stations	Various	municipal	V	Y (contamination risk) Relocate Tpic isolated	Y Power outages	Y	N	M	L
MS4 - Municipal Separate Storm Sewer System	Various	municipal	V	Y - undersized/ contamination of H_2O	Y	N	N	M	O
~~Culverts~~ Electrical System	Various	RMLD	V/S	Y Power outage water infiltration of systems	Y Power outage Buildings w/o generators Food/Water/Heating/Potability/Cut	Y Power outage trees down wires down	Y (also as strength)	H	O
Societal									
Health Facilities	Various	Private	V	Some displacement system failure	Y Power loss system failure	Y Power loss down trees	Y People place worst/water breaks	H	ongoing
Mosquito Born illness	Various		V	Y Increased water standing/ increase population/ wide spread	N	N	Y Elevated heat Increased population Extended breeding	M	Long
State Housing/PC	Peabody Court	State	V	N	Y Power loss Down Trees	Y Power loss down trees	Y People overheat/ water breaks	H	Ongoing
~~Health Risk~~/water Contamination	River mi. Pond		V	Y Road water runoff	N	N	Y Drought determined water quality + availability	H	ongoing
Septic	All	Private + municipal	V/S	Y Private Septic overflowing. Septic strength/not a town wide system ~~[illegible]~~	N	N	N	M	ongoing
Environmental									
Trees - Street	Various	municipal/ private	V ~~S~~	~~S - for flood~~	Y Power lines	Y Power lines disperse wind	Y - Strength provide shade/cooling (disperse wind/ temp)	M	O
Open Space	Various	municipal/ private	S	Y ~~Dispersal energy of flood waters~~	N	~~N~~ Y	Y	M	O
Martins Pond	Martins Pond/ Boxwoods Rd.	State	V/S	Y - V	N	N	Y - ~~[illegible]~~ toxic algae blooms - water quality - heat +	H	O
Ipswich River/Martins Brook/Skugg River	See map	State/ private	V/S	Y	Y - ~~[illegible]~~ Hwy/ flooding	N	Y	H	O
Mosiq. Born illness Ponds + Wetlands									

Recommended Risk Matrix size for Workshops is 3' x 5' - large enough to legibly capture input and provide a focal point during and after Workshops.

Risk Matrix

The **Risk Matrix** captures the community's priority hazards, vulnerabilities, strengths, and actions. The **Risk Matrix** provides information necessary to develop strategies, inform community plans and advance conversations on how to lessen impacts from hazards and build resilience. Use the **Risk Matrix** and final summary report to inform ongoing discussions and decisions. Periodically revisit and update the **Risk Matrix** as your community makes progress on priority actions.

Community Resilience Building Workshop Risk Matrix

H-**M**-**L** priority for action over the **S**hort or **L**ong term (and **O**ngoing)
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Top 4 Hazards (tornado, floods, wildfire, hurricanes, snow/ice, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Flood	BLIZZARD ~~WIND~~ WINTER STORMS	WIND ~~EXTREME~~ FEMAS	EXTREME COLD + HEAT ~~DROUGHT~~	Priority H-M-L	Time Short Long Ongoing
Infrastructural									
Middle/High School	191 Park	Municipal	S	High Elevation Large capacity for Shelter ~~N~~ Y	Y Fully generator	Y	Y	H	Ongoing
Roads/Culverts/Bridges	Various	Public/Private Municipal	V	Y - become unpassable	Y - trees/branches down	Y trees/branches	Y - Water main breaks Frost heaves	H	ongoing
Public Safety Buildings (inadequate geographic coverage)	154-156 Park St.	Municipal	V	Y - flood wall inadequate in/near floodplain	Y if flooding	N	N	H	O
Wells + Pumping Stations	Various	Munipal	V	Y (contamination risk) - lakeside Tpic isolated	Y Power outages →	Y	N	M	L
~~Sk~~ MS4 - Municipal Separate Storm Sewer System	Various	Municipal	V	Y - undersized/ contamination of H_2O	~~Y~~ ~~N~~ Y	N	N	M	O
~~Culverts~~ Electrical System	Various	RMLD	V/S	Y Power outage water infiltration of systems	Y Power outage Billings w/ generators hard/little/flooding/power cut	Y Power outage trees down lines down	Y (also as strength)	H	O
Societal									
Health Facilities	Various	Private	V	Some displacement system failure	Y Power loss system failure	Y Power loss down trees	Y People vulnerabilities/water breaks	H	ongoing
Mosquito Born illness	Various		V	Y Increased water standing increase population/wide spread	N	N	Y Elevated Heat Increased population Extended breeding	M	Long
State Housing/PC	Peabody Court	State	V	N	Y Power loss Down Trees	Y Power loss down trees	Y People pipelines/ water breaks	H	Ongoing
~~Health Risk~~/water Contamination	River Mi. Pond		V	Y Roadwater runoff	N	N	Y Drought Decreased water quality + availability	H	ongoing
Septic	All	Private + municipal	V/S	Y Private Septic overflowing septics through/not a municipal system	N	N	N	M	ongoing
Environmental									
Trees - Street	Various	Municipal/ Private	V ~~S~~	S ~~- for~~ Flood	Y Powerlines	Y Powerlines disperse wind	Y - Strength provide Shade/cooling (Discourage wind/temp)	M	O
Open Space	Various	Municipal/ private	S	Y ~~Disperse energy of flood waters~~	N	~~N~~ Y	Y	M	O
Martins Pond	Martins Pond/ Burroughs Rd.	State	V/S	Y - V	N	N	Y - ~~water~~ toxic algae blooms - Water quality - heat	H	O
Ipswich River/Martins Brook/Skugg River	See map	State/ private	V/S	Y	Y - melting/ flooding	N	Y	H	O
Mosiq Born illness Ponds + Wetlands									

and provide a focal point during and after Workshops.

Risk Matrix

ACTION ITEMS

The **Risk Matrix** captures the community's priority hazards, vulnerabilities, strengths, and actions. The **Risk Matrix** provides information necessary to develop strategies, inform community plans and advance conversations on how to lessen impacts from hazards and build resilience. Use the **Risk Matrix** and final summary report to inform ongoing discussions and decisions. Periodically revisit and update the **Risk Matrix** as your community makes progress on priority actions.

Community Resilience Building Workshop Risk Matrix

H-**M**-**L** priority for action over the **S**hort or **L**ong term (and **O**ngoing)
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Features	Location	Ownership	V or S	Top 4 Hazards (tornado, floods, wildfire, hurricanes, snow/ice, drought, sea level rise, heat wave, etc.): FLOOD	WINTER STORMS NOR'EASTER	WIND	EXTREME COLD/HEAT	Priority H-M-L	Time Short Long Ongoing
Infrastructural									
GI Retrofits → ROADWAYS / CULVERTS	VARIOUS	PUBLIC/PRIVATE	V/S	3., 11., 16., 17., 23 (ESTABLISH GI GUIDELINES; COMPLETE STREETS)	12.		12.		
DPW BUILDING	CHESTNUT	PUBLIC	V/S	10. 11.,	10., 12., 19.	10.	10., 12.		
POLICE/FIRE (Drainage → Evidence)	PARK ST.	"	V/S	11.	19.				
SCHOOL BUILDINGS	VARIOUS	"	S	11.	19.				
WATER SYSTEM	TOWN WIDE	"	V/S	20.	19.		Recharge Guidelines ← 7.	Water System Modeling	
DRAIN SYSTEMS (MS4)	"	"	V/S	5., 11.					
ELECTRICAL SYSTEMS	"	PRIVATE	V/S		13.	13.			
SEPTIC SYSTEMS → FLOOD MAPPING / GIS	"	"	V/S	15.					
Societal				7., 15.	7., 15.	7.	7.		
Senior Centre SENIOR HOUSING	PEABODY CT.	PUBLIC PRIVATE	V/S	1.	13. 18.	13. 18.	18.		
NURSING HOMES	NORTH ST.	"	V/S	1.	13.	13.			
HEALTH FACILITIES (HOMES)	VARIOUS	"	S	1. ?	13. ?	13. ?	(?)		
TRAILER HOME PARK	RT. 28	"	V/S	1.	13.	13.			
WATERSHED ASSOCIATIONS	MARTINS POND IPSWICH R.	"	S	1., 4., 6.	4, 13.	4, 13	4.		
CHURCHES	VARIOUS	"	S	1.	13.	13.			
Environmental									
OPEN SPACE	VARIOUS	Public	S	1.					
TREES - (STREETS)	"	Public Private	V/S		13.	13.			
IPSWICH RIVER / MARTINS BRK / SKUG R.	"	" "	V/S	15., 16.	15.		Recharge Guidelines Water Quality, Basic Flow		
PONDS & WETLANDS	"	" "	V/S	15. 17.					
BEAVER DAMS	"	" "	V	Coord w Con Com & BOH					

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PUBLIC LISTENING SESSION

North Reading MVP Public Listening Session
May 17, 2018
Attendees

Name	Association/Company/Dept./Group	Email Address
Danielle McKnight	N. Reading Town Planner	dmcknight@northreading.ma.gov
William Bellavance jr	CPC	William@bellavance.co
Michelle Mullet	FLINT MEMORIAL BOARD of TRUSTEES DEMOCRATIC DELEGATE - NORTH READING	michelle.mullet@icloud.com
Jane Krieger	citizen	Kriegerjane@verizon.net
Larry Soucie	Martin Pond Association	Larry Soucie@gmail.com
Gerry Noel	North Read BONS Buildings commissioner	gnoel@northreadingma.gov
JOHN KLIPFEL	N.READING ENG.	JKLIPFEL@NORTHREADINGMA.GOV
Chris Deming	NR DPW Operations Manager	CDEMING@NorthReadingma.gov
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Mark Clark	Acting DPW Director	mclark@northreadingma.gov
Peter Richardson	Green International	prichardson@greenintl.com

North Reading Municipal Vulnerability Preparedness (MVP) Plan

Peter A. Richardson, P.E., CFM,
LEED AP, ENV SP
(Certified MVP Provider)

May 17, 2018

North Reading
MASSACHUSETTS

GREEN INTERNATIONAL AFFILIATES, INC.
Civil and Structural Engineers

Building Strong Client Relationships Through Engineering Excellence

Agenda

- Overview of MVP Program
- Climate Change Projections
- Previous Mitigation Planning Efforts
- Development of the Town's MVP Plan
- Action Steps in Town's MVP Plan
- Questions/Discussion

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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

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Overview of MVP Program

MVP Plans must be prepared following the Community Resilience Building Workshop Guide found at:

www.CommunityResilienceBuilding.com

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Overview of MVP Program

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.

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Climate Change Projections

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

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Temperature Change Projections

Ipswich 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	6.88	+5.55 to +17.30	+8.48 to +30.62	+10.21 to +50.12	+11.88 to +68.93
	Winter	0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00
	Spring	0.34	+0.23 to +0.75	+0.35 to +1.37	+0.40 to +2.25	+0.24 to +3.83
	Summer	6.23	+4.81 to +15.24	+6.99 to +24.93	+8.69 to +40.55	+10.55 to +54.68
	Fall	0.31	+0.34 to +1.88	+0.70 to +4.75	+0.67 to +8.59	+1.14 to +11.81
Days with Maximum Temperature Over 95°F	Annual	0.62	+1.61 to +6.48	+2.29 to +12.74	+3.01 to +26.29	+4.58 to +40.81
	Winter	0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00
	Spring	0.00	+0.02 to +0.19	+0.03 to +0.38	+0.06 to +0.67	+0.06 to +1.37
	Summer	0.62	+1.51 to +5.95	+2.02 to +11.16	+2.85 to +22.65	+4.24 to +35.46
	Fall	0.00	+0.03 to +0.50	+0.05 to +1.41	+0.08 to +3.44	+0.15 to +4.77
Days with Maximum Temperature Over 100°F	Annual	0.05	+0.10 to +1.30	+0.22 to +3.34	+0.31 to +7.52	+0.24 to +14.18
	Winter	0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00
	Spring	0.00	+0.00 to +0.01	+0.00 to +0.03	+0.00 to +0.10	+0.00 to +0.36
	Summer	0.05	+0.10 to +1.25	+0.20 to +3.21	+0.28 to +7.16	+0.24 to +13.11
	Fall	0.00	+0.00 to +0.06	+0.00 to +0.18	+0.00 to +0.51	+0.00 to +1.00

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Rainfall Change Projections

Ipswich 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 Precipitation Over 1”	Annual	7.87	+0.10	to	+1.81	+0.43	to	+2.57	+0.94	to	+2.45	+1.06	to	+3.20
	Winter	1.96	+0.02	to	+0.63	+0.15	to	+1.09	+0.20	to	+1.45	+0.29	to	+1.60
	Spring	1.78	-0.19	to	+0.73	-0.03	to	+0.89	+0.10	to	+1.16	+0.06	to	+1.13
	Summer	1.69	-0.16	to	+0.45	-0.11	to	+0.51	-0.11	to	+0.55	-0.13	to	+0.51
	Fall	2.45	-0.27	to	+0.58	-0.18	to	+0.76	-0.42	to	+0.60	-0.42	to	+0.75
Days with Precipitation Over 2”	Annual	1.05	+0.02	to	+0.45	-0.01	to	+0.60	+0.09	to	+0.69	+0.14	to	+0.82
	Winter	0.19	-0.04	to	+0.13	+0.00	to	+0.15	+0.00	to	+0.22	+0.04	to	+0.29
	Spring	0.22	-0.06	to	+0.18	-0.05	to	+0.21	-0.06	to	+0.27	+0.00	to	+0.33
	Summer	0.27	-0.09	to	+0.12	-0.06	to	+0.14	-0.04	to	+0.14	-0.05	to	+0.16
	Fall	0.38	-0.04	to	+0.23	-0.02	to	+0.22	+0.02	to	+0.20	-0.06	to	+0.28
Days with Precipitation Over 4”	Annual	0.05	-0.01	to	+0.14	+0.00	to	+0.15	-0.01	to	+0.12	-0.01	to	+0.20
	Winter	0.00	+0.00	to	+0.00	+0.00	to	+0.00	+0.00	to	+0.01	+0.00	to	+0.02
	Spring	0.00	-0.02	to	+0.04	+0.00	to	+0.04	-0.01	to	+0.05	-0.01	to	+0.08
	Summer	0.00	-0.01	to	+0.04	-0.01	to	+0.04	-0.02	to	+0.04	-0.02	to	+0.05
	Fall	0.00	-0.02	to	+0.08	-0.02	to	+0.08	-0.02	to	+0.09	-0.04	to	+0.12

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Rainfall/Dry Days Change Projections

Ipswich 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	45.59	-0.11 to +4.29	+0.04 to +5.35	+0.54 to +6.61	+0.73 to +7.00
	Winter	11.56	-0.33 to +1.69	+0.14 to +2.27	+0.20 to +2.96	+0.51 to +3.96
	Spring	11.63	-0.36 to +2.25	-0.05 to +2.12	+0.12 to +2.57	+0.12 to +2.57
	Summer	10.22	-0.36 to +1.26	-0.55 to +1.93	-0.81 to +2.01	-1.64 to +1.80
	Fall	12.24	-1.04 to +0.91	-1.10 to +1.44	-1.80 to +1.60	-1.61 to +1.33

Ipswich 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	16.79	-0.27 to +1.72	-0.05 to +2.50	-0.74 to +2.82	-0.15 to +3.09
	Winter	11.72	-0.77 to +1.27	-0.84 to +1.20	-0.96 to +2.25	-1.17 to +2.02
	Spring	11.18	-0.76 to +1.15	-1.20 to +1.17	-1.28 to +1.10	-1.28 to +1.04
	Summer	12.99	-0.65 to +1.83	-0.73 to +1.63	-0.94 to +2.94	-1.12 to +2.34
	Fall	12.3	+0.21 to +1.96	+0.15 to +2.86	-0.10 to +3.51	-0.06 to +3.19

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Previous Mitigation Planning Efforts

January 2016 Hazard Mitigation Plan Update

- 2016 Update to the 2006 Plan approved by FEMA/MEMA
- Adopted by Town on May 23, 2016
- Plan evaluates impacts from natural hazards: Floods, Winter Storms, Wind, Fire, Geologic, Heat, Cold, Drought
- Provides Mitigation Strategies
- Town is eligible for FEMA Hazard Mitigation Grants

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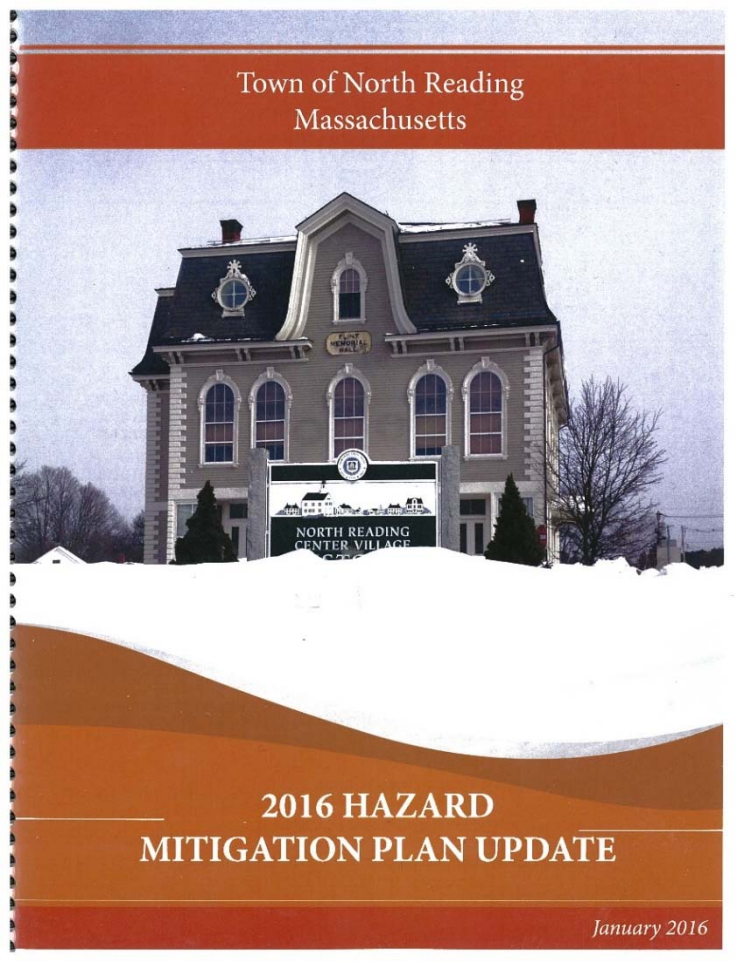
Previous Related Mitigation Planning Efforts



Ranking	Hazard
High Hazards	Nor'easter
	Flood
	Blizzard
	Hurricane
	Ice Storm
	Snow
Moderate Hazards	Heavy Rain
	Earthquake
	Tornado
	Drought
	HAZMAT
	Hail
	Lightning
	Microburst
	Beaver Dams
	Extreme Cold
Low Hazards	Ice Jams
	Extreme Heat
	Erosion
	Brush fire
	Dam Failure
	Landslide

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Previous Related Mitigation Planning Efforts

2016 Priority Level	Mitigation Action	Timeframe	Responsible Organization	Potential Funding Source	Estimated Cost
1	Establish a Floodplain and Stormwater Management Public Education Program.	2016	DPW	Town	$10,000
2	Develop a Town Community Emergency Response Team (CERT).	2016	Emergency Management	Town	$5,000
3	Adopt the Operation and Maintenance Plan for Martins Brook.	2016	Martin's Pond Association	Town	$5,000
4	Collect data to be used toward future benefit-cost-analysis.	2016-2017	DPW	Town	Low
5	Updates to the Stormwater Bylaw so all projects exceeding the 1-acre threshold comply with the bylaw.	2016-2017	Community Planning Commission, Town Planner	Town	Low
6	Coordinate with USGS and Ipswich River Watershed to access flow monitoring information along Ipswich River. Install monitors at key locations on Martins Brook.	2016-2017	DPW & Martin's Pond Association	Town/MA Riverways Program	$40,000
7	Expand the Town's GIS with pre-designed maps and the updated base map for asset management during disaster events.	2016	DPW	Town/ FEMA	$25,000
8	Support upgrade of the Benevento Culvert along Martins Brook.	2016-2018	Martin's Pond Association	Private	$500,000
9	Implement channel clearing and maintenance between Benevento and the pond.	2016-2017	Martin's Pond Association	Town	$20,000
10	Renovate DPW garage with facilities to accommodate Town employees during severe weather events and disasters.	2016-2020	DPW	Town/ FEMA	$150,000
11	Review current operation/maintenance procedures within the Town relative to cleaning storm drain systems. Consider creating a stormwater utility for funding for maintenance and capital improvements.	2016-2017	DPW	Town	$25,000

2016 Priority Level	Mitigation Action	Timeframe	Responsible Organization	Potential Funding Source	Estimated Cost
12	Build a storage shed for a season's supply of rock salt.	2016-2019	DPW	Town/ MassDOT	$200,000
13	Develop a public education campaign under the leadership of Reading Municipal Light District regarding tree care on private property relative to electric wires.	2016	DPW	Town/ RMLD	$10,000
14	Develop a comprehensive debris management response plan for post extreme weather events.	2016	DPW	Town	$25,000
15	Update the Ipswich River FEMA Flood Mapping Study.	2016-2020	Building Inspector & Town Engineer	FEMA	High
16	Replace the Chestnut Street Culvert over the Ipswich River and raise existing road grade to prevent overtopping.	2016-2019	DPW	Town/ FEMA	$750,000
17	Replace the Haverhill Street Culvert and raise the Haverhill Street roadway.	2016-2018	DPW	Town/ FEMA	$500,000
18	Purchase a generator for the senior center.	2016	Elder Services	Town/ FEMA	$20,000
19	Evaluate the structural capacity of flat roofs on critical and public facilities. Install strain gauges to monitor snow loads.	2016	DPW	Town/ FEMA	$35,000
20	Flood-proof the Town's water supply facilities up to the 500-year flood elevation, especially the Central Street well field pumping facility.	2016-2017	DPW & Utility Department	Town/ FEMA	$100,000
21	Move all critical equipment, debris, etc., out of the 100-year floodplain near the DPW garage.	2016-2017	DPW	Town	$50,000
22	Raise Profile of Burroughs Road to reduce overtopping and maintain access to west side of pond.	2016-2020	DPW	Town/ FEMA	$1,000,000
23	Detain stormwater upstream of Lindor Road by installing control weirs at three locations per Green International study.	2016-2017	DPW	Town	$25,000

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Development of Town's MVP Plan

Scope of Work:

- Establish MVP Core Team & Set Goals of MVP Plan
- Conduct (2) 4 hour Workshops to:
  - Characterize hazards
  - Identify Community Vulnerabilities/Strengths
  - Develop Action Steps to become more resilient to Climate Change
- Prepare a Final Report with Mitigation Actions
- Hold a public listening session by June 23, 2018

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MVP Core Team

- MVP Provider: Peter Richardson
- Emergency Management: Theo Kuliopulos
- Martins Pond Association: Janet Niccosia
- Building Inspector: Jim DeCola
- Planning Department: Danielle McKnight
- Conservation Commission: Leah Basbanes
- Water Department: Mark Clark
- Town Engineer: Mike Soraghan
- Fire Department: Barry Galvin
- Health Department: Bob Bracey
- Police Department: Mike Murphy/ Kevin Brennan
- School Department: Wayne Hardacker
- GIS (NECE): Bill Ross/Rebecca Dupont-Coutu
- Facilities Department: Julie Spurr-Knight

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MVP Plan Goals

Goals for North Readings MVP Plan:

- **Identify Climate Change Vulnerabilities, considering Infrastructural, Societal and Environmental factors and Develop Action Steps to make the Town more Resilient and Sustainable to extreme weather related conditions in the future.**
- **Develop an MVP Plan that compliments and builds upon the Town's previous mitigation efforts over the past two decades and the 2016 Hazard Mitigation Plan**
- **Develop an MVP Plan that satisfies the requirements of MA EOEA to make the Town eligible for future MVP Grants**

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MVP Workshops

Workshop Number 1 – March 21, 2018	Workshop Number 2 – March 27, 2018
MVP Provider: Peter Richardson	MVP Provider: Peter Richardson
Emergency Management: Theo Kuliopulos	Emergency Management: Theo Kuliopulos
Martins Pond Association: Janet Niccosia	Planning Department: Danielle McKnight
Planning Department: Danielle McKnight	Conservation Commission: Leah Basbanes
Conservation Commission: Leah Basbanes	Water Department/DPW: Mark Clark
Water Department/DPW: Mark Clark	DPW: Chris Deming
DPW: Chris Deming	Town Engineer: Mike Soraghan
Town Engineer: Mike Soraghan	Police Department: Derek Howe
Health Department: Bob Bracey	School Department: Wayne Hardacker
Police Department: Derek Howe	GIS (NECE): Rebecca Dupont-Coutu
School Department: Wayne Hardacker	GIS (NECE): Bill Ross
GIS (NECE): Rebecca Dupont-Coutu	Facilities Department: Julie Spurr-Knight
Facilities Department: Julie Spurr-Knight	RMLD: Tom Ollila
Ipswich River Watershed Assoc.: Wayne Castonguay	Tufts University: Darya Marttis
RMLD: Tom Ollila	
Tufts University: Darya Marttis	

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MVP Workshops

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

- Workshop #1: Characterize hazards/ Identify Vulnerabilities and Strengths
- Workshop #2: Develop Action Steps

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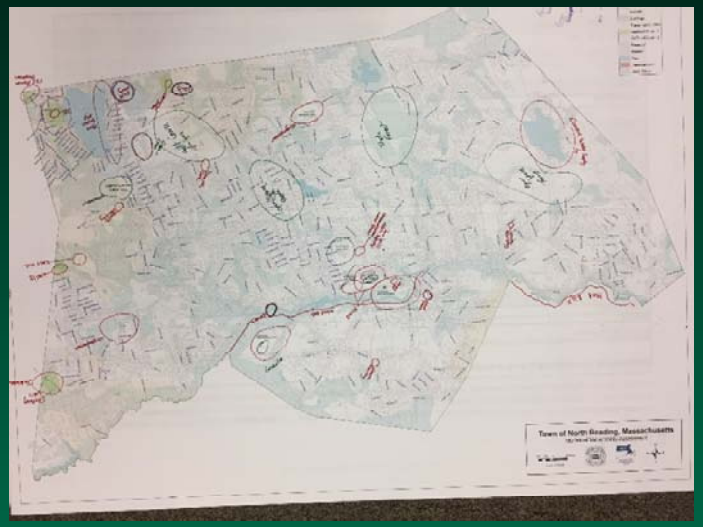
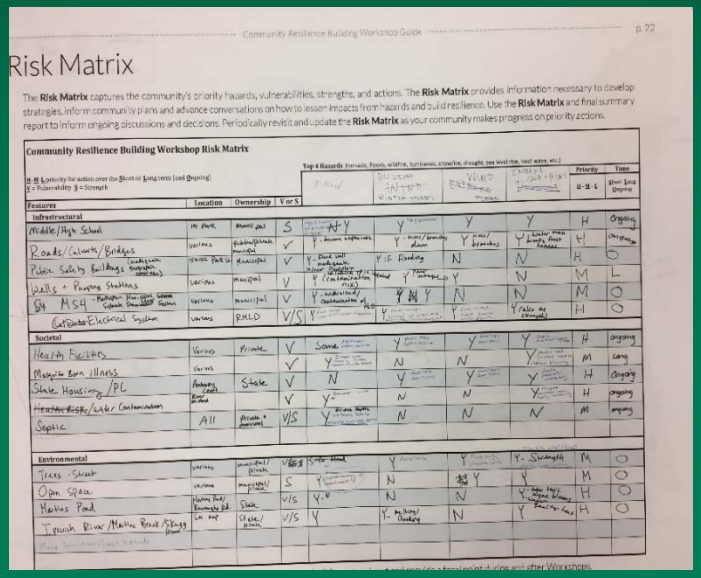
MVP Workshops

<u>Workshop # 1:</u>

- Top Four Hazards: Flooding; Winter Storms/Blizzards; Wind; Extreme Cold/Heat
- Identify Vulnerabilities
- Identify Strengths





Community Resilience Building Workshop Guide p. 22

Risk Matrix

The **Risk Matrix** captures the community's priority hazards, vulnerabilities, strengths, and actions. The **Risk Matrix** provides information necessary to develop strategies, inform community plans and advance conversations on how to lessen impacts from hazards and build resilience. Use the **Risk Matrix** and final summary report to inform ongoing discussions and decisions. Periodically revisit and update the **Risk Matrix** as your community makes progress on priority actions.

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, flood, wildfire, hurricane, snowfire, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S					Priority	Time
Infrastructural									
Middle/High School	[illegible]	[illegible]	S	[illegible]	[illegible]	[illegible]	[illegible]	H	Ongoing
Roads/Culverts/Bridges	Various	[illegible]	V	[illegible]	[illegible]	[illegible]	[illegible]	H	Ongoing
Public Safety Buildings	[illegible]	Municipal	V	[illegible]	Y: Flooding	N	N	H	O
Wells + Pumping Stations	Various	Municipal	V	[illegible]	[illegible]	[illegible]	N	M	L
[illegible]	Various	Municipal	V	[illegible]	[illegible]	[illegible]	N	M	O
Gas/Water/Electrical System	Various	RMLD	V/S	[illegible]	[illegible]	[illegible]	[illegible]	H	O
Societal									
Health Facilities	Various	Private	V	Some	[illegible]	[illegible]	[illegible]	H	ongoing
Mosquito Born Illness	Various		V	[illegible]	N	N	[illegible]	M	Long
Stable Housing/PC	Various	State	V	N	[illegible]	[illegible]	[illegible]	H	Ongoing
~~Heat/Air Quality~~/Water Contamination			V	[illegible]	N	N	[illegible]	H	ongoing
Septic	All	Private + Municipal	V/S	[illegible]	N	N	N	M	ongoing
Environmental									
Trees - Street	Various	Municipal/Private	V/S	[illegible]	[illegible]	[illegible]	[illegible]	M	O
Open Space	Various	Municipal/Private	S	[illegible]	N	[illegible]	[illegible]	M	O
Martins Pond	Various Body Boundary Rd	State	V/S	[illegible]	N	N	[illegible]	H	O
Ipswich River/Martins Pond/Bigg Pond	Lin. and	State/Private	V/S	[illegible]	[illegible]	N	[illegible]	H	O
[illegible]									

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MVP Plan Results

Vulnerable Areas and Attributes for North Reading based on Climate Change Projections

INFRASTRUCTURAL	SOCIETAL	ENVIRONMENTAL
• *School Buildings* • *DPW Building* • *Public Safety Building* • *Town Wells and Pumping Station and Water System* • *Roads/Culverts/Bridges* • *Drainage System* • *Electrical Grid* • *Septic Systems*	• *Health Facilities - (Group Homes)* • *State Housing* • *Senior Housing* • *Nursing Home* • *Trailer Park* • *Martins Pond Neighborhood*	• *Street Trees* • *Martins Pond* • *Ipswich River/Martins Brook/Skug River* • *Ponds/Wetlands* • *Ipswich River Park*

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MVP Plan Results

Current Strengths and Assets in North Reading related to Climate Change Resiliency

INFRASTRUCTURAL	SOCIETAL	ENVIRONMENTAL
• *Roadways* • *School Buildings* • *Public Safety Building* • *DPW Garage* • *Water System* • *Electrical Grid* • *Septic Systems*	• *Health/Elderly care Facilities* • *Watershed Associations* • *Churches* • *Relationships with Abutting Communities*	• *Rivers, Ponds and Wetlands* • *Open Space and Parks* • *Trees*

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MVP Plan Results

Workshop # 2:

- Review Action Steps in FEMA 2016 Hazard Mitigation Plan
- Revise or Update 2016 Action Steps and Develop new action steps for Climate Change Resiliency

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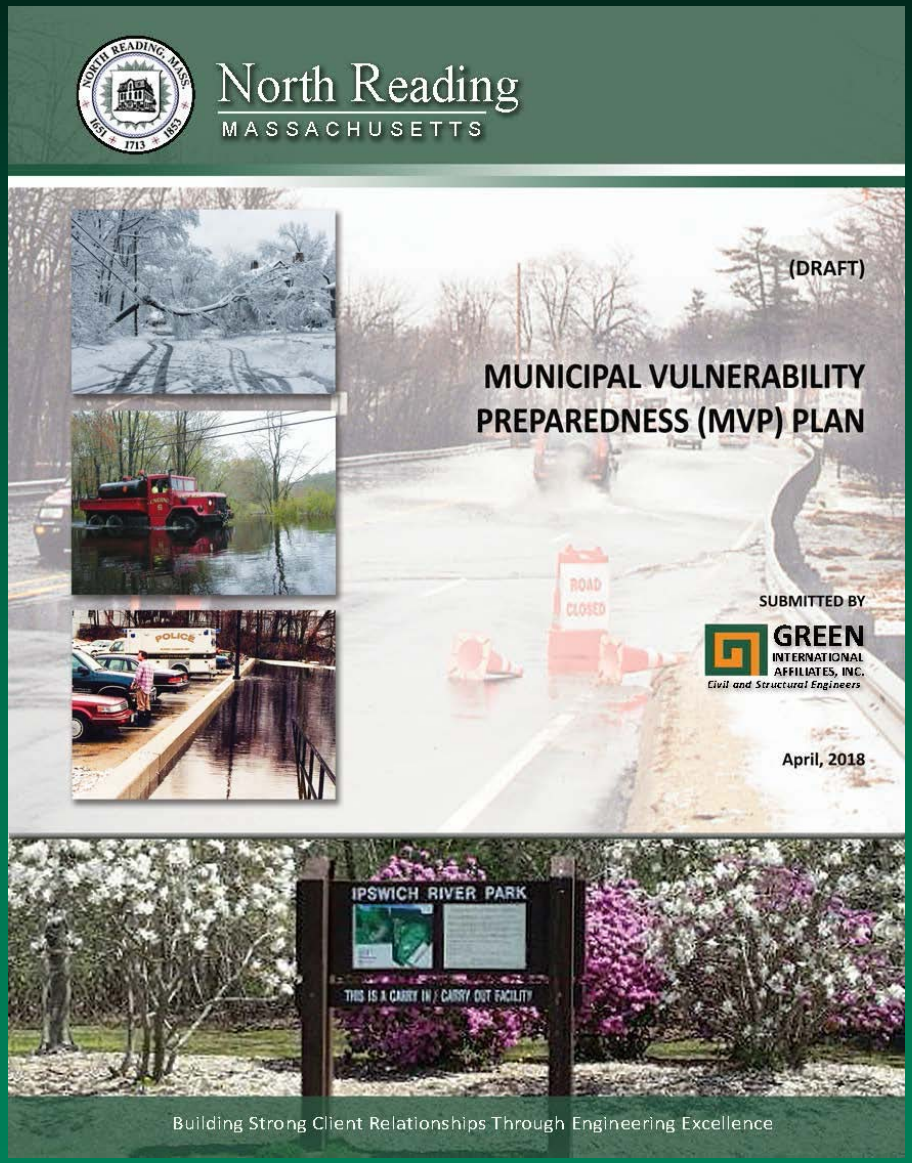
MVP Plan Report



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MVP Plan Report

Prioritized Action Steps in North Reading's MVP Plan

The action steps have been prioritized in Table 3 as follows:

Completed
Applicable to FEMA Hazard Mitigation Plan, but not MVP Plan
High MVP Priority
Medium MVP Priority
Low MVP Priority

Municipal Vulnerability Preparedness (MVP) Plan
North Reading, Massachusetts — April 2018

Project No.	Mitigation Action	Timeframe	Responsible Organization	Potential Funding Source	Estimated Cost
1	Establish a Floodplain and Stormwater Management Public Education Program.	2018	DPW	Town	$10,000
2	Develop a Town Community Emergency Response Team (CERT).	2018	Emergency Management	Town	$5,000
3	Adopt the Operation and Maintenance Plan for Martins Brook.	2018	Martin's Pond Association	Town	$5,000
4	Collect data to be used toward future benefit-cost-analysis.	2018-2019	DPW	Town	Minimal Town Funds
5	Updates to the Stormwater Bylaw so all projects exceeding the 1-acre threshold comply with the bylaw.	2018-2019	Community Planning Commission, Town Planner	Flood	Minimal Town Funds
6	Coordinate with USGS and Ipswich River Watershed to access flow monitoring information along Ipswich River. Install monitors at key locations on Martins Brook.	2016-2017	DPW & Martin's Pond Association	Grants	$40,000
7	Expand the Town's GIS with pre-designed maps and the updated base map for asset management during disaster events.	2018	DPW	Town	Minimal Town Funds
8	Support upgrade of the Benevento Culvert along Martins Brook.	2018-2020	Martin's Pond Association	Private	$500,000
9	Implement channel clearing and maintenance between Benevento and the pond.	2018-2019	Martin's Pond Association	Town	$20,000
10	Renovate DPW garage with facilities to accommodate Town employees during severe weather events and disasters. **Create Emergency Action Plan for access through flooded access roads**	2018-2020	DPW	Town/ FEMA	$150,000

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MVP Plan Report

Municipal Vulnerability Preparedness (MVP) Plan
North Reading, Massachusetts
April 2018

Project No.	Mitigation Action	Timeframe	Responsible Organization	Potential Funding Source	Estimated Cost
11	Review current operation/maintenance procedures within the Town relative to cleaning storm drain systems. Consider creating a stormwater utility for funding for maintenance and capital improvements.	2018-2019	DPW	Town	$25,000
12	Rehabilitate Three salt storage shed for a season's supply of rock salt.	2018-2020	DPW	Town/ MassDOT	$200,000
13	Develop a public education campaign under the leadership of Reading Municipal Light Department regarding tree care on private property relative to electric wires.	2018	DPW	Town/ RMLD	$10,000
14	Develop a comprehensive debris management response plan for post extreme weather events.	2018	DPW	Town	$25,000
15	**Update the Ipswich River FEMA Flood Mapping Study. Develop H&H Models for both Ipswich River and Martins Brook Watersheds that consider Climate Change Projections**	**2018**	**Building Inspector & Town Engineer**	**FEMA**	**$100,000**
16	Replace the Chestnut Street Culvert over the Ipswich River and raise existing road grade to prevent overtopping	2018-2020	DPW	Town/ FEMA	$750,000
17	Replace the Haverhill Street Culvert and raise the Haverhill Street roadway.	2018-2020	DPW	Town/ FEMA	$500,000
18	Purchase a permanent generator for the senior center.	2018	Elder Services	Town/ FEMA	$20,000
19	Evaluate the structural capacity of flat roofs on critical and public facilities. Install strain gauges to monitor snow loads.	2018	DPW	Town/ FEMA	$35,000

Municipal Vulnerability Preparedness (MVP) Plan
North Reading, Massachusetts
April 2018

Project No.	Mitigation Action	Timeframe	Responsible Organization	Potential Funding Source	Estimated Cost
20	Flood-proof the Town's water supply facilities up to the 500-year flood elevation, especially the Central Street well field pumping facility.	2018-2019	DPW & Utility Department	Town/ FEMA	$100,000
21	Move all critical equipment, debris, etc., out of the 100-year floodplain near the DPW garage.	2016-2017	DPW	Town	$50,000
22	Raise Profile of Burroughs Road to reduce overtopping and maintain access to west side of pond.	2018-2022	DPW	Town/ FEMA	$1,000,000
23	Detain stormwater upstream of Lindor Road by installing control weirs at three locations per Green International study.	2018-2019	DPW	Town	$25,000

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Question and Answers from Public Listening Session
North Reading Town Hall, May 17, 2018

The following is a summary of the questions asked by attendees of the public listening session and the responses provided by Mr. Richardson and other MVP Core Team members present:

Question #1: How will the Ipswich River change when the Bostik dam comes down?

Response: ***The flood profile for the Ipswich River will be lowered somewhat with the removal of the Bostik Dam for a few thousand feet upstream of the dam. However, beyond this point upstream of the dam, the geometry of the river valley itself becomes the hydraulic control and the dam no longer controls flood elevations, such that the impact from the dam removal is limited to a few thousand feet upstream of the dam. The USACE performed a backwater analysis that demonstrates this a number of years ago.***

Question # 2: Are only public wells shown in the MVP Maps?

Response: ***Yes, only public wells are shown in the plan. Private wells are not shown.***

Question # 3: Is there any discussion about looping certain water mains?

Response: ***No, water system vulnerabilities identified through the MVP process were limited to protection of the Town's wells and pumping station, which are located in the floodplain. Specific long-term water distribution system improvements were not identified as action items under the MVP process and will be addressed through the Water Department's Capital Improvement Plan.***

Question #4: Are the culverts mapped?

Response: ***Roadway crossings of major flooding sources are shown in the MVP Plan and certain culverts have been identified as vulnerabilities requiring mitigation actions. However, not all roadway culverts are shown in the plan. A complete inventory of the Town's drainage system is being addressed as part of the Town's Municipal Separate Storm Sewer (MS4) permit under the US EPA NPDES.***

Question #5: Is the aquifer near Eisenhaures Pond shown in the plan?

Response: ***All Available GIS aquifer layers are included in the MVP Plan.***

Question 6: Is there any discussion in the plan about the importance of gates (emergency access gates) in the vicinity of Juniper road and Eisenhaures Pond?

Response: ***No, this was not identified as a vulnerability during the workshop process and the Fire Department typically handles access issues associated with locked emergency access gates in Town.***

Question #7: How will properties be impacted that rely on sump pumps to handle ground water?

Response: ***Significant increases in groundwater elevations are not anticipated as a result of climate change. If anything, increased heat and longer dry periods could lower groundwater elevations. However, increased rainfall intensity could result in short-term localized water table increases near certain homes. Therefore, properly installed and well-maintained sump pump systems should be considered where they are currently needed and these systems should be adequate in the future. [Note: sump pump systems are designed to prevent groundwater infiltration into basements and are not flood protection systems that are designed to handle inundation from surface flooding]***

Question #8: Does the dry river basin (in summer) affect our drinking water?

Response: ***Given that the Town will be acquiring its drinking water from the Town of Andover and only partially supplementing its water supply from the Town's wells in the future, reduced base flow in the Ipswich River basin is no longer the concern it once was when the Town was relying solely on its wells.***

APPENDIX B – MAP OF VULNERABLE AREAS AND ASSETS

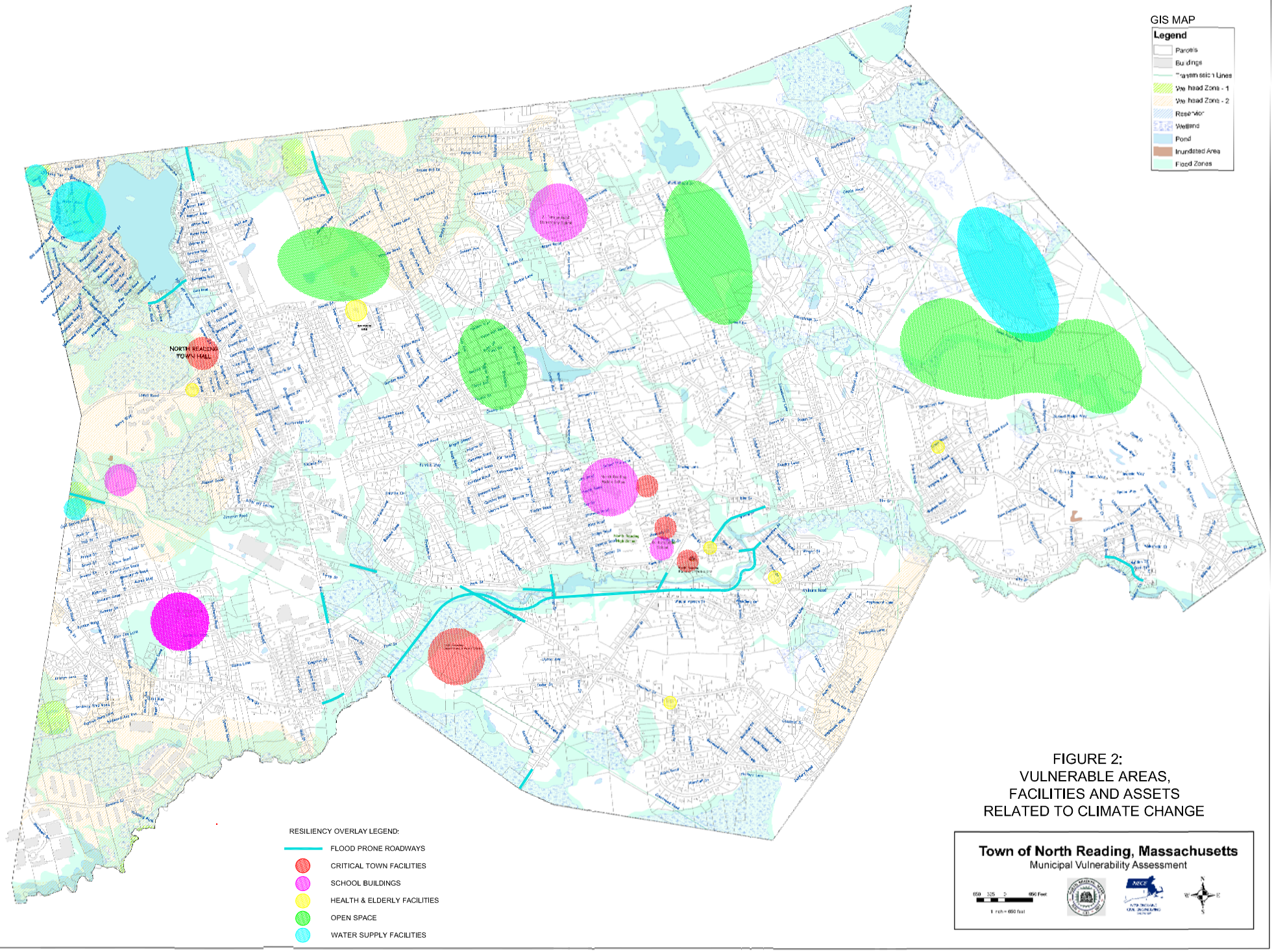

FIGURE 2:
VULNERABLE AREAS,
FACILITIES AND ASSETS
RELATED TO CLIMATE CHANGE

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