TOWN OF NATICK

MAY 31, 2018

COMMUNITY RESILIENCY BUILDING

SUMMARY OF FINDINGS

Dug Pond
Source: Town of Natick website

PREPARED AND PRESENTED BY

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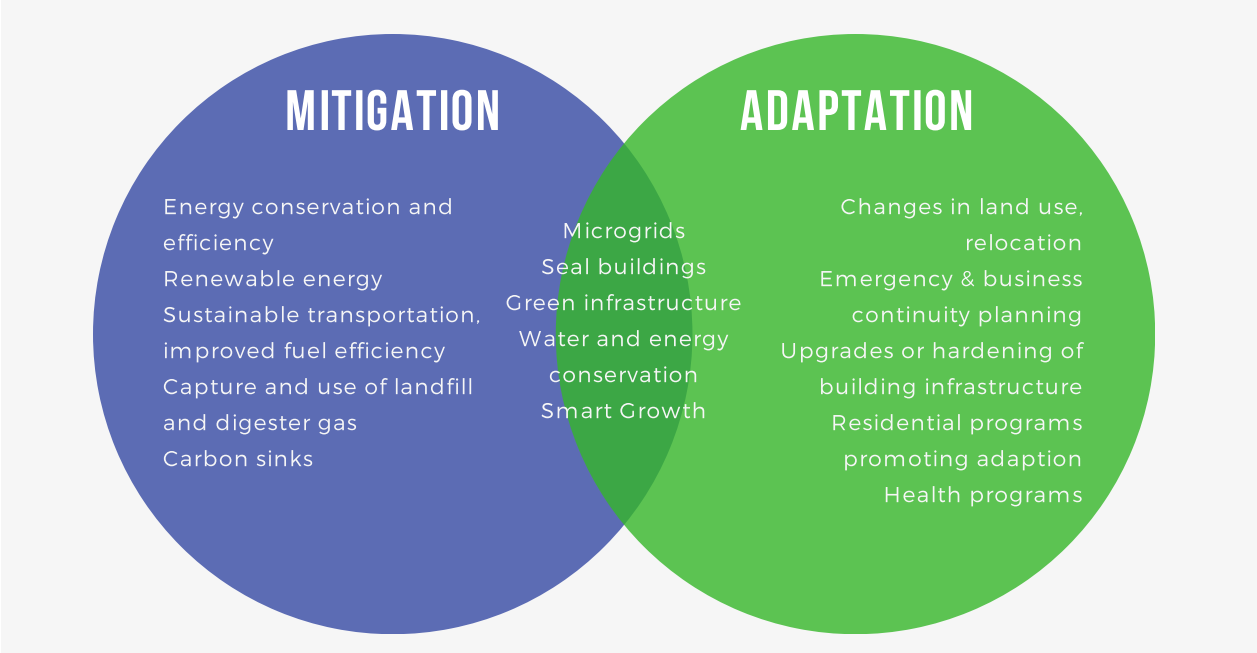
OVERVIEW

As the Commonwealth advances an integrated climate change strategy under Executive Order 569, Massachusetts cities and towns are working in parallel at the local and regional level on resiliency planning and climate preparedness efforts. The intense storm events of the last decade and noticeable changes in weather patterns have reinforced this urgency and compelled leading communities like the Town of Natick to proactively plan for potential impacts from natural and climate-related hazards.

The Town of Natick recognizes the importance of advancing both mitigation and adaptation strategies to deal with the challenges of climate change. The combined effect of mitigation and adaptation will be more effective in reducing the exposure and vulnerability of Natick's citizens, economy, infrastructure, and ecosystems to current and future hazards.



With this in mind, the Town of Natick applied for and received a Municipal Vulnerability Preparedness (MVP) program grant from the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) to complete a Town-wide vulnerability assessment and develop an action-oriented resiliency plan following the Community Resilience Building (CRB) framework developed by The Nature Conservancy. The CRB framework employs a unique "anywhere at any scale", community-driven workshop process to increase awareness of risks from natural and climate-related hazards and assess community vulnerabilities and strengths. Completion of the CRB process will enable the Town to achieve MVP designation status from EEA by June 2018 and receive preference for future state grants.

COMMUNITY RESILIENCE BUILDING WORKSHOPS

In Natick, the CRB framework was actualized through two four-hour Community Resilience Building workshops on October 12, 2017 and October 24, 2017. The list of workshop invitees and workshop content was guided by input from an interdisciplinary working group comprised of Town-staff and consultants from Stantec and Mass Audubon.

Workshop participants identifying community vulnerabilities
Source: Stantec

The Workshop's central objectives were to:

- Define top local natural and climate-related hazards of concern
- Identify existing and future strengths and vulnerabilities
- Develop prioritized actions for the community
- Identify immediate opportunities to collaboratively advance actions to increase resilience

Approximately 50 participants from town departments/committees/boards, state agencies, community organizations, businesses, and other interest groups attended each workshop. The workshops included a combination of large group presentations and small group discussions.

The large group presentations outlined the workshop process/goals, presented helpful hazard. community, and climate data, shared example actions, and provided an update on local planning efforts and non-profit initiatives. Participants also had an opportunity to work together in small groups consisting of 6-8 people with different roles, responsibilities, and expertise to foster an exchange of ideas and perspectives. Spokespersons from the small groups then reported back to the larger group. This format, rich with information, experience, and dialogue, produced the findings outlined in this summary report. The report provides an overview of the top hazards and vulnerable areas, current concerns and challenges presented by the hazards, current strengths and assets, and top recommendations to improve the Town's resilience to natural and climate-related hazards today and in the future.

Workshop attendees and other interested stakeholders are encouraged to provide comments, corrections, and updates on the summary of findings transcribed in this report to jwmartin@natickma.org. The Town of Natick's ongoing community resilience building efforts will benefit from the participation of all those concerned.

TOP HAZARDS & VULNERABLE AREAS

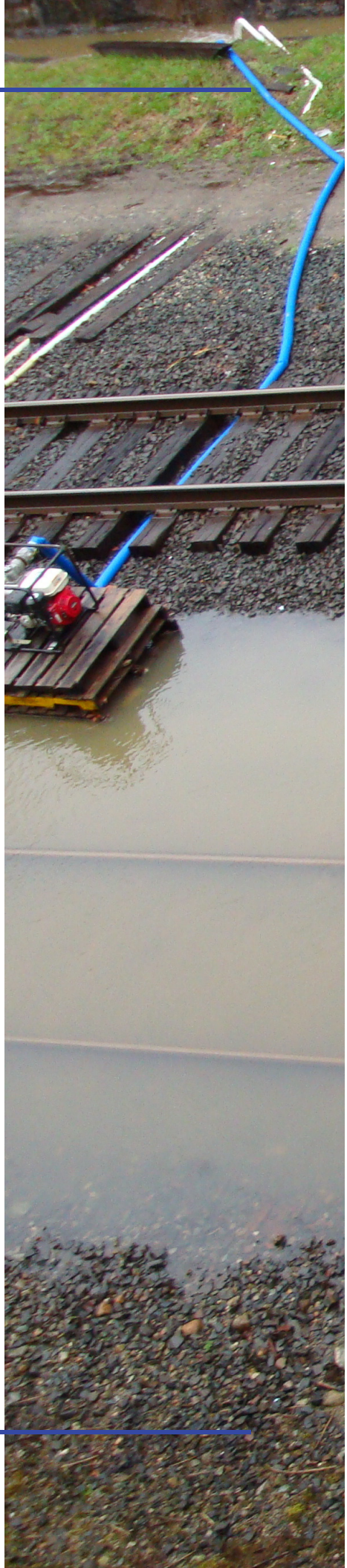
During the Community Resilience Building (CRB) Workshop, participants were asked to identify the top natural hazards for the Town of Natick. Stormwater flooding from intense storms and resulting riverine flooding were identified as the hazard of greatest concern by most participants. Extreme winter storms with snow, ice, and wind were also listed as a priority hazard by workshop attendees. Finally, environmental changes associated with climate change, particularly higher temperatures, periods of extended drought and increased extreme precipitation events, were also highlighted as major concerns for the Town. These hazards have direct and increasing impacts on Town residents, their neighborhoods and the Town's resources, including natural areas (wetlands, forests, parks), roads, drinking and wastewater systems, and other critical infrastructure.

TOP HAZARDS

- Precipitation-Based and Riverine Flooding
- Extreme Snow and Ice Events
- Higher Temperatures
- Severe Drought
- Wind

AREAS OF CONCERN

- Neighborhoods: South Natick, Elderly Communities (Multiple throughout Town)
- Ecosystems: Lake Cochituate, Charles River, Broadmoor Wildlife Sanctuary, Invasive Species, Aquifer, Lookout Farm, Town Parks
- Transportation: Commuter Rail stations, Interstate 90, Route 9, Route 135, Route 27, Route 16, Boston Marathon Route, Multimodal Intersections, Unaccepted Streets, Speen Street
- Infrastructure: Dams (Jennings Pond, Lake Cochituate, South Natick, Beaver Brook), Hospital, Natick Mall, Pole Based Utilities, Sewer System, Wells, Emergency Operations Center, Eversource Electrical Substations, MathWorks, TJX, MWRA Sewer



Flooding of Natick commuter rail line
Source: Brian Mahaney, 2010

CURRENT CONCERNS & CHALLENGES PRESENTED BY HAZARDS

The Town of Natick has several concerns about, and faces multiple challenges related to, the impacts of weather-related events. In recent years, the Town has experienced a series of highly disruptive and damaging weather events including the floods of 2010, Tropical Storm Irene (August 2011), Tropical Storm Sandy (October 2012), winter Nor'easter Nemo (February 2013), and the Winter of 2015 snow storms. Impacts from Irene and Sandy included heavy rain-induced flooding, wind damage, and power outages. Nemo and the Winter of 2015 snow storms dropped several feet of snow on the Town knocking out power and isolating residents and neighborhoods. The frequency and intensity of these events already experienced in Massachusetts is expected to increase due to climate change, exacerbating existing local vulnerabilities. This has motivated communities like Natick to comprehensively improve resilience at the municipal, county, and regional levels.

Natick Fire Department on a call during a snowstorm
Source: Paul Keleher, 2011

Recent extreme weather events have highlighted how hazards impact different areas of Town, from the urbanized downtown to the hilly terrain surrounding the town center. The low elevation of South Natick includes the Charles River and is prone to frequent flooding and evacuations. The hilly terrains of North Natick and East Natick are more prone to the effects of wind and power outages. Longer periods of increased temperatures, particularly in July and August, have raised concerns regarding the availability of drinking water for residents, as well as the health effects on the multiple elderly communities in Natick. The combination of these issues presents a challenge to emergency preparedness and response, and requires comprehensive yet tailored actions for establishing mitigation priorities for areas of the Town.

The workshop participants generally agreed that more intense and frequent storms affected the daily activities of residents and there was a need to prepare with communication and contingency plans for worst case scenarios during different times of the year.

SPECIFIC CATEGORIES OF CONCERNS & CHALLENGES

ROAD NETWORK

One of the primary concerns expressed by participants was the vulnerability of the Town's road network during and after routine and extreme events. Road closures prevent emergency management services from reaching impacted areas and reduce public access to evacuation routes and critical facilities like gas stations, grocery stores, and pharmacies. In addition, impassable roads can limit public access to sheltering facilities in the Town.

It was clear at the Workshop that Town residents are reliant on Routes 9, 16, 135, and Interstate 90 (MassPike). Route 9 floods often at the "sunkaway,", a low-lying area along Route 9 to the East of Town near the Wellesley border. Route 16 floods in multiple locations along the Charles River and is impassable a few times per year. Route 135 floods between Lake Cochituate and Fiske Pond during intense precipitation events.

Flooding of Route 135 and Fisk Pond
Source: Brian Mahaney, 2010

VULNERABLE POPULATIONS

The greatest social concern was neighborhood isolation during flooding events and loss of power during winter and wind storms. An additional concern included public health and safety impacts due to heat waves on an aging population. There are several neighborhoods at risk of being cut off from the rest of the Town due to flooding or downed trees over critical roads. This is particularly dangerous for the elderly and medically vulnerable residents who live in these areas.

Cedar Gardens and Coolidge Gardens were singled out as elderly and disabled housing complexes with residents that require medical assistance. Several other nursing homes, rehabilitation facilities, and housing projects were noted as susceptible to impacts from natural hazards.

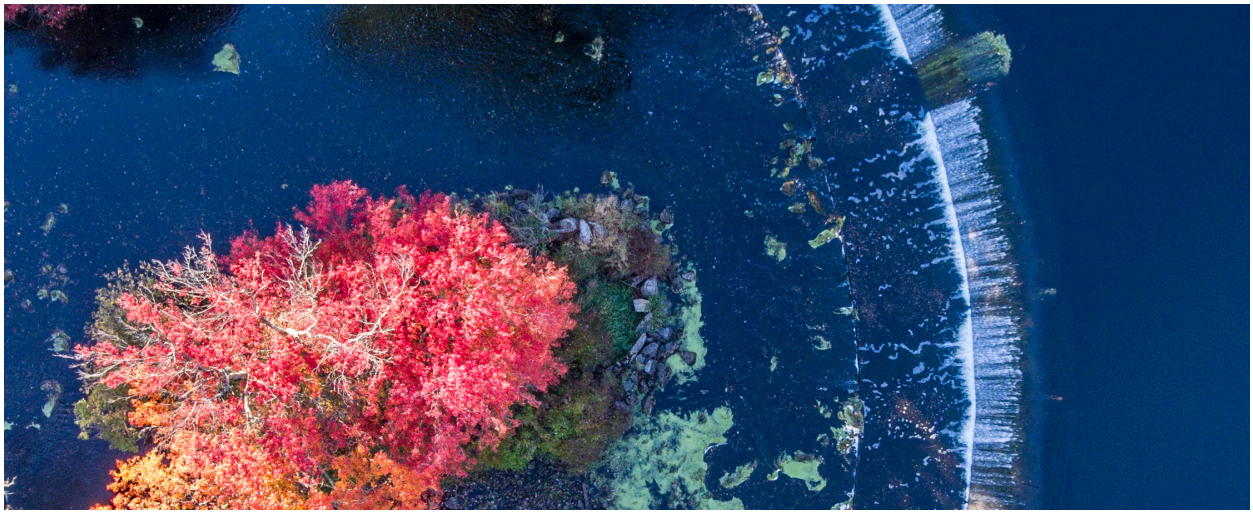
WETLANDS

One of the key challenges raised during the Workshop is the lack of awareness amongst residents of the benefits and critical services provided by the wetlands, as well as the lack of knowledge regarding regulations in place for wetland protection. Wetlands and riparian areas are not being valued and incorporated as natural infrastructure that can help reduce risk and improve resilience. South Natick contains many wetlands in and around the Charles River and Mass Audubon's Broadmoor Wildlife Sanctuary.

DAMS

Workshop participants had serious concerns about safety and flooding concerns with all of the dams listed below. Impacts from catastrophic failure would include floodwaters traversing and expanding throughout South Natick, Broadmoor Wildlife Sanctuary, Route 16, Route 9, Route 135, and Interstate 90.

Natick-based Dams with Massachusetts Office of Dam Safety (ODS) Rating
Charles River (High hazard)
Lake Cochituate (High hazard)
Fisk Pond (Low hazard)
Jennings Pond (Low hazard)
Beaver Brook (Not yet rated)



Aerial photo of Charles River Dam in South Natick
Source: Town of Natick, GIS

DRINKING WATER SUPPLY

The availability of drinking water on a day-to-day basis during the summer months could affect businesses and residents close to Lake Cochituate, Fisk Pond, and Dug Pond. These locations are served by the public water wells at Springvale, Evergreen, Pine Oaks, and Morses Pond. Participants highlighted the need for a forward-looking contingency plan to account for vulnerabilities to the quality and quantity of this resource, which supplies a significant portion of the population of Natick with water. Residents elsewhere in Town are served by private wells. For both private and public sources, access to drinking water has been compromised during power outages and periods of drought.

EMERGENCY MANAGEMENT & EVACUATION

There seems to be a lack of adequate education of, and communications with, residents regarding emergency management and evacuation procedures. Participants were unsure whether Natick has predetermined evacuation routes and what is expected of residents in advance of major events. Natick does have pre-determined evacuation routes, though they are not well marked and are unknown to many Natick residents.

ELECTRICAL DISTRIBUTION SYSTEMS

Electric service outages can be caused by all identified types of natural hazards. The power distribution system was cited as one of the most critical pieces of infrastructure in Town and can impact all residents regardless of where they live. Mature trees and overhanging limbs along roadways and other transportation corridors (such as the rail trail) are a primary culprit because they can bring down power lines. Power interruptions due to storms can cause disruption to heating or cooling systems. Workshop participants noted that elderly and less mobile residents are at particular risk during electric service outages.

Double utility poles near Natick Center
Source: Town of Natick, 2018

RAILROAD STATIONS & RAIL LINE

Natick is served by the MBTA Commuter Rail (Framingham/Worcester line), with two stations. The Natick Center and West Natick stations and the rail line provide a critical artery for access to employment and to facilitate transportation in Massachusetts between Worcester, Natick, and Boston. The rail line and stations, especially the Natick Center station, frequently flood during heavy precipitation events. The Town recognizes that the resilience of this asset is paramount to the long-term viability of their community.

CURRENT STRENGTHS & ASSETS

As a result of Natick's recent experiences with extreme weather, the town is well acquainted with the existing strengths within the community. Reinforcing and expanding these supportive practices and assets will generate greater benefits to the community through increased resiliency against future storm, with greater frequencies and intensities, as well as long term impacts from the ongoing increases in air temperature and precipitation.

Belkin Family Lookout Farm, Source: Alex Banakas, 2011

Strengths and assets of note include:

- Responsive and committed leadership by the Town's elected officials.
- Natick's residents. On a neighborhood level, residents face common challenges and have demonstrated a desire to help one another recover quickly. In the aftermath of recent large storm events, residents witnessed a heightened sense of neighborhood and community. A community sense of pride is also developed around Natick's public infrastructure and spaces, such as the Natick Common and the Natick Farmer's Market.
- The large open spaces, such as Mass Audubon's Broadmoor Wildlife Sanctuary, Lookout Farm, Natick Community Farm, and the Sassamon Trace Golf Course, serve as sponges during heavy precipitation and recharge groundwater as well as reducing local heat islands and providing cooling spaces for people and wildlife.
- Supportive social services such as the activities and transportation systems for seniors, youth, and families, the Council on Aging, as well as faith-based organizations.
- Renewable energy capacity. The community has constructed several solar installations on Town property and private buildings which put additional energy into the electric grid.
- The Natick Mall provides a common place for social interactions, as well as a sheltering location during storm events.
- Interstate 90 (MassPike), Route 9, Route 135, Route 27, Route 16, and the Commuter Rail transportation corridors provide key connections between Worcester and east towards Boston.
- Natick has a large, natural aquifer, surrounded by large expanses of natural groundwater recharge areas.

TOP RECOMMENDATIONS TO IMPROVE RESILIENCE

Workshop participants identified more than 40 actions the Town of Natick, in collaboration with residents, local business owners, neighboring municipalities, and state agencies, should take to improve resilience. These actions were categorized into the following groups:

- Low Impact Development
- Emergency Response
- Power
- Water Management
- Stakeholder Engagement
- Vulnerable Populations
- Open Space & Land Management

End of second workshop, actions identified on table.
Source: Stantec

Actions were then prioritized by participants through a post-workshop online survey and were further vetted by Town of Natick leadership to identify which departments will be responsible for leading and supporting the implementation of each action. Actions identified were also compared with Natick's 2018 Hazard Mitigation Plan, which was finalized in April 2018. Actions that were included in the Hazard Mitigation Plan, but not initially identified in the CRB workshops were added to the community's list of recommendations.

Recommendations were then presented to the Natick Board of Selectmen on May 14, 2018. They were also shared with residents during two public listening sessions on April 25, 2018 and May 16, 2018.

A full list of the final recommendations, organized by high, medium and low priorities, is provided on the following pages. Note, actions that were identified in the CRB workshops and as a mitigation activity in Natick's 2018 Hazard Mitigation Plan are marked with a single asterik (*); actions that were identified in Natick's 2018 Hazard Mitigation Plan only are noted with two asteriks (**).

HIGH PRIORITY ACTIONS, PART I

CATEGORY	ACTION	LEAD DEPT.	SUPPORT
LOW IMPACT DEVELOPMENT	Integrate cost-effective green and resilient infrastructure in upcoming public projects, including the construction of new public buildings, roadway improvement projects and the downtown parking garage.	Selectmen	Community & Economic Dev. KMS Building Committee W. Natick Fire Building Comm. DPW/Engineering Planning Board Conservation Commission Sustainability Committee
	Introduce infiltration regulations for new construction.	Health	Building Dept. Conservation Commission DPW/Engineering
	Encourage Low Impact Development (LID) in regulations for new construction and major renovations.	Community & Economic Dev.	Planning Board Conservation Commission DPW/Engineering
	Incorporate updated climate data into permitting processes (i.e. use NOAA Atlas 14 rainfall data for stormwater design, identify heat islands, etc).	Community & Economic Dev.	DPW/Engineering Conservation Commission Planning Board
EMERGENCY RESPONSE	Educate residents on hazards that threaten the community, the steps they can to mitigate damages to their property, and details on emergency shelters and cooling stations.**	Emergency Management	Community & Economic Dev. Board of Selectmen Police Health Fire LEP Committee
	Prepare an "After the Storm Recovery" Plan for the Community.*	Emergency Management	LEP Committee Police Health Fire Selectmen DPW IT
	Increase generator capacity at existing and new Town facilities. Utilize Wilson Middle School and planned Kennedy Middle School (construction scheduled for 2020) as shelters.	Facilities DPW/EMD	Natick Public Schools Health Police Fire LEP Committee KMS Building Committee

HIGH PRIORITY ACTIONS, PART II

CATEGORY	ACTION	LEAD DEPT.	SUPPORT
POWER	As rising temperatures increase strains on our electrical grid, actively encourage and incentivize energy efficiency across public and private sectors to reduce the demand for electricity and prevent brownouts.	Selectmen	DPW/Municipal Energy Economic Dev. Sustainability Committee Eversource
	Educate and incentivize the development of local renewable energy systems and microgrids.	Selectmen	Community & Economic Dev. Sustainability Committee Eversource
	More closely coordinate town approvals and projects to prioritize the installation of underground utilities.	Selectmen	DPW/Engineering Eversource
WATER MANAGEMENT	Develop and implement water conservation and stormwater management campaign with property owners.	DPW/ Engineering	DPW/Water Selectmen
	Install green infrastructure on public and private property to decrease pollutant loading of nitrogen, phosphorus and total suspended solids from increased stormwater to local water bodies.	DPW/ Engineering	DPW/Highway-LFNR Conservation Commission Parks and Recreation
	Conduct feasibility study of stormwater utility for infrastructure upgrades and maintenance.	DPW/ Engineering	Selectmen DPW/Highway
	Develop a strategy and implementation plan to address properties/streets subject to flooding from poor drainage and run-off.**	DPW/ Engineering	DPW/Highway Building Department Central MA Mosquito Control
	Identify ownership and responsibility for Beaver Brook Dam. Have a dialogue with the Town of Framingham and neighbors on how to address flooding issues.	DPW/ Engineering	Selectmen Conservation Commission
	Identify and record low-lying areas, stormwater pathways and potential stream gauge locations.	DPW/ Highway	Conservation Commission

HIGH PRIORITY ACTIONS, PART III

CATEGORY	ACTION	LEAD DEPT.	SUPPORT
STAKEHOLDER ENGAGEMENT	Increase awareness/collaboration with community partners on climate change and associated public health impacts.	Selectmen	Health Community Services
	Coordinate with state and federal agencies to continue bridge and culvert replacement.	DPW/ Engineering	Transportation Advisory MassDOT & USDOT
	Partner, educate, and incentivize the business community to strengthen sustainable development and commerce.	Community & Economic Dev.	Selectmen
VULNERABLE POPULATIONS	Further assess vulnerable populations and identify strategies for mitigating risk to those populations.	Community Services	Health LEP Committee
	Advocate for improvements to public and low-income housing that address changing climate conditions (e.g. higher temperatures, more intense storms).	Community Services	Natick Housing Authority Affordable Housing Trust Health
OPEN SPACE & LAND MANAGEMENT	Assess community interest, and if appropriate take steps for a new Town-wide vote on the Community Preservation Act.	Community & Economic Dev.	Conservation Commission Selectmen
	Allocate resources to proactively manage Natick's conservation land for the provision of ecosystem services such as flood control, nutrient cycling, and purification of air and water.	Community & Economic Dev.	Conservation Commission Selectmen DPW Recreation and Parks
	Identify and acquire prioritized open space parcels for increased flood storage/protection.*	Community & Economic Dev.	Conservation Commission Open Space Advisory
	Acquire properties in the Special Flood Hazard/Repetitive Flood Loss Areas.**	Community & Economic Dev.	Conservation Commission Selectmen

MEDIUM PRIORITY ACTIONS

CATEGORY	ACTION	LEAD DEPT.	SUPPORT
LOW IMPACT DEVELOPMENT	Updated Complete Streets Policy to include green infrastructure component.	DPW/ Engineering	Selectmen DPW/Highway
EMERGENCY RESPONSE	Provide more indoor and outdoor cooling centers to improve resilience during high heat conditions.	Facilities	LEP Committee
	Strategize and synergize preparedness and response efforts to all residents; engage civic and religious groups in this task.	Emergency Management	Police LEP Committee Community Services
POWER	Conduct geothermal and microgrid feasibility studies.	Selectmen	Community & Economic Dev. DPW/Municipal Energy Facilities Eversource
WATER MANAGEMENT	Adopt local regulations requiring the non-use of private irrigation wells during droughts/water bans.	Selectmen	Health DPW/Water Conservation Commission Community & Economic Dev
	Develop Operations and Maintenance Plans for Town-owned dams, such as Jennings Pond and Charles River, and State-owned dams such as Fiske Pond Dam**	DPW/ Engineering	DPW/Highway MA DCR
STAKEHOLDER ENGAGEMENT	Provide residents with tools to conduct resiliency audits for homes, businesses, and neighborhoods.	Selectmen	Community Services LEP Committee
	Educate homeowners about drinking water contamination and use of private wells.	Health	DPW/Water
VULNERABLE POPULATIONS	Develop and implement outreach campaign for residents/businesses located within a dam inundation zone.**	DPW/ Engineering	MA DCR
	Create a neighbor-helping-neighbor network (e.g., projects incl. sheltering and shoveling).	Community Services	LEP Committee
OPEN SPACE & LAND MANAGEMENT	Increase tree canopy in and on streets, sidewalks, parks, and open spaces to reduce heat island effects, particularly in low income areas.	DPW/ LFNR	Recreation & Parks Conservation Commission Community & Economic Dev
	Develop and implement hazardous vegetation abatement and forest management projects.*	Community & Economic Dev.	DPW/LFNR DPW/Engineering Recreation and Parks Conservation Commission

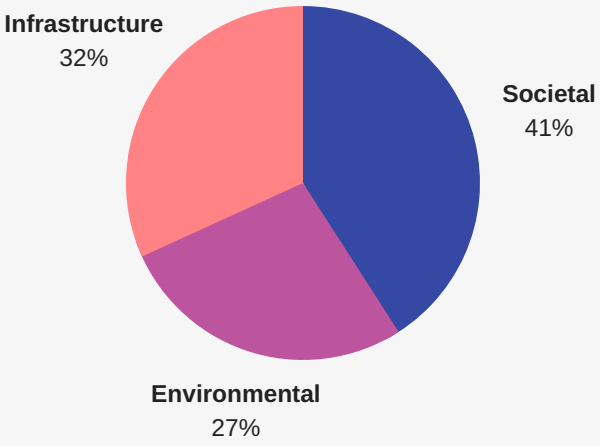
LOW PRIORITY ACTIONS

CATEGORY	ACTION	LEAD DEPT.	SUPPORT
LOW IMPACT DEVELOPMENT	Retrofit of paved parking areas within the Town to improve drainage and increase filtration.**	DPW/ Engineering	DPW/Highway Community & Economic Dev.
EMERGENCY RESPONSE	Consider hiring a disaster preparedness employee for the Town.	Selectmen	LEP Committee Community Services
	Work with state and neighboring municipalities to map, maintain and publish evacuation route information.*	Emergency Management	Police LEP Committee DPW/GIS
	Increase urgent care capacity in town via hospitals, care facilities, and nursing facilities to reduce reliance on Boston facilities.	Health	Community & Economic Dev. LEP Committee MetroWest Medical Center
	Distribute information on evacuation routes and emergency shelters to hotels, Bed and Breakfasts, real estate agencies dealing with seasonal rentals, and other facilities and events hosting tourists.*	Emergency Management	Selectmen Police DPW/GIS LEP Committee Community & Economic Dev.
POWER	Conduct feasibility/engineering study to earthquake-proof municipally-owned buildings.**	Selectmen	DPW/Engineering Facilities
WATER MANAGEMENT	Assess opportunities for hydro-power generation with planned improvements of the Charles River Dam.*	Selectmen	DPW/Energy DPW/Municipal Energy Eversource
	Install stream gauges with alarm system for flooding.	DPW/ Highway	Conservation Commission LEP Committee

WORKSHOP PARTICIPANTS

Approximately 40 participants from Town departments, committees/boards, state agencies, community organizations, businesses, and other interest groups were in attendance at each workshop.

The backgrounds of workshop participants were balanced across the three different community features assessed.



- Bacon Free Library
- Eversource
- First Congregational Church
- Keep Natick Beautiful
- Lookout Farm
- Mass Audubon
- Mass Audubon, Broadmoor Wildlife Sanctuary
- Massachusetts Department of Conservation and Recreation (DCR)
- Massachusetts Department of Transportation (MassDOT)
- Massachusetts Water Resources Authority (MWRA)
- Mathworks
- MetroWest Chamber of Commerce
- MetroWest Medical Center
- Morse Institute Library
- Natick Cultural District
- Natick Community Organic Farm
- Natick Mall
- Natick Public Schools
- Natick Service Council
- Natick Residents
- Sherwood Plaza
- Soldier Systems Center
- Town of Natick, Administrator
- Town of Natick, Board of Selectmen
- Town of Natick, Community & Economic Development
- Town of Natick, Community Services
- Town of Natick, Conservation Commision
- Town of Natick, Council on Aging
- Town of Natick, Public Works
- Town of Natick, Engineering
- Town of Natick, Facilities
- Town of Natick, Finance Committee
- Town of Natick, Fire
- Town of Natick, Health
- Town of Natick, Human Services
- Town of Natick, Open Space Advisory Committee
- Town of Natick, Operations
- Town of Natick, Planning Board
- Town of Natick, Police
- Town of Natick, Recreation and Parks
- Town of Natick, Sustainability
- Town of Natick, Sustainability Committee
- Town of Natick, Tree Warden
- Town of Natick, Water and Sewer
- Town of Natick, Transportation Advisory Committee
- Walnut Hill School for the Arts

CITATION

Natick (2017) Community Resilience Building Workshop Summary of Findings. Mass Audubon and Stantec. Natick, Massachusetts.

MVP WORKING GROUP

- Richard Ames, Town of Natick, GIS Coordinator, Department of Public Works
- Stefanie Covino, Mass Audubon, Coordinator, Shaping the Future of Your Community Program
- Jen Ducey, Stantec, Senior Associate
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- Hillary King, Planner, Stantec
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- Jillian Wilson-Martin, Town of Natick, Sustainability Coordinator

WORKSHOP FACILITATORS

- Jen Ducey, Stantec
- Hillary King, Stantec
- Stefanie Covino, Mass Audubon
- Jackson Rand, Stantec
- Amelia Casey, Stantec

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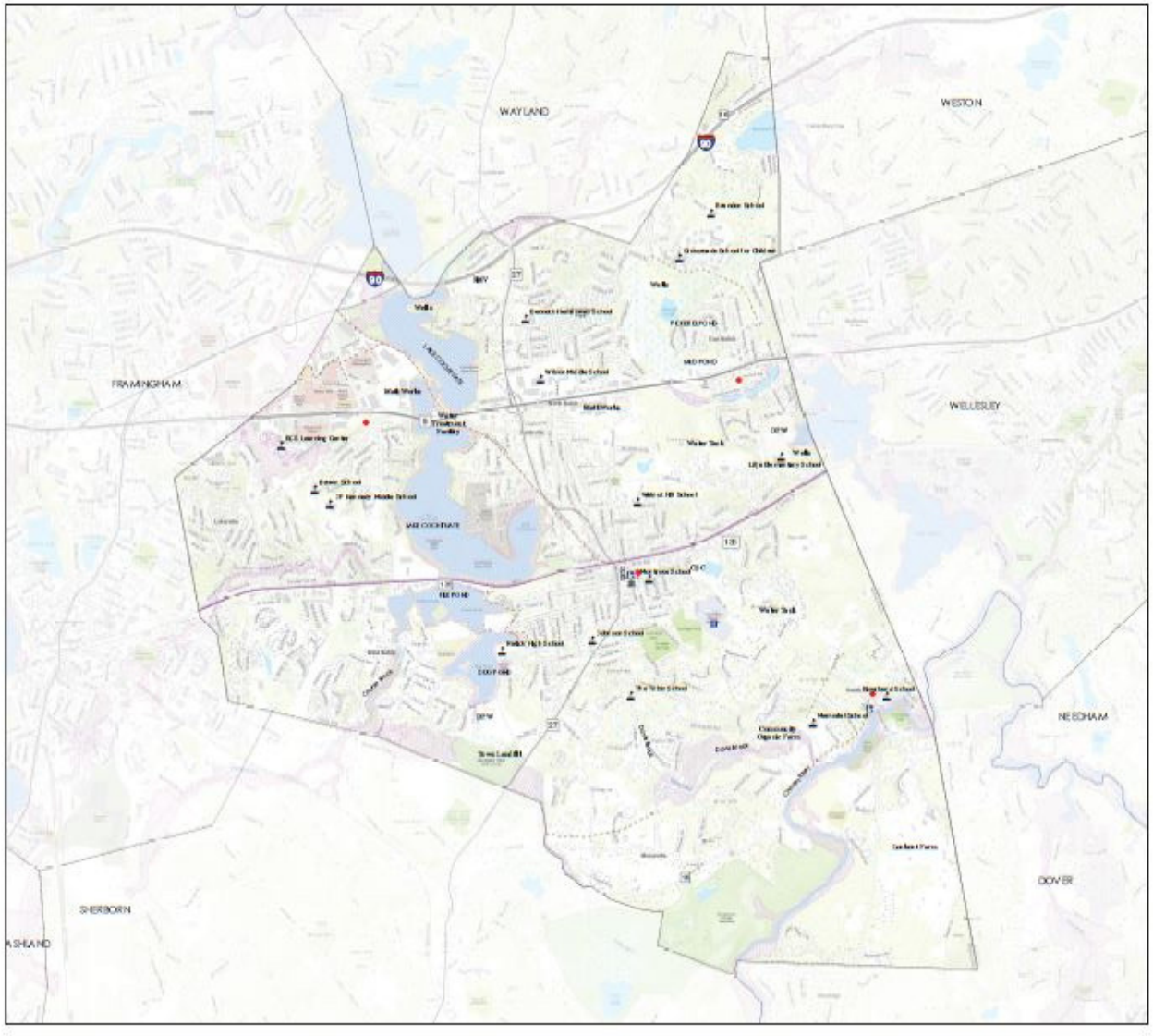
Special thanks to the many community leaders who attended Natick's CRB workshops. The expertise and feedback provided by these individuals was invaluable.

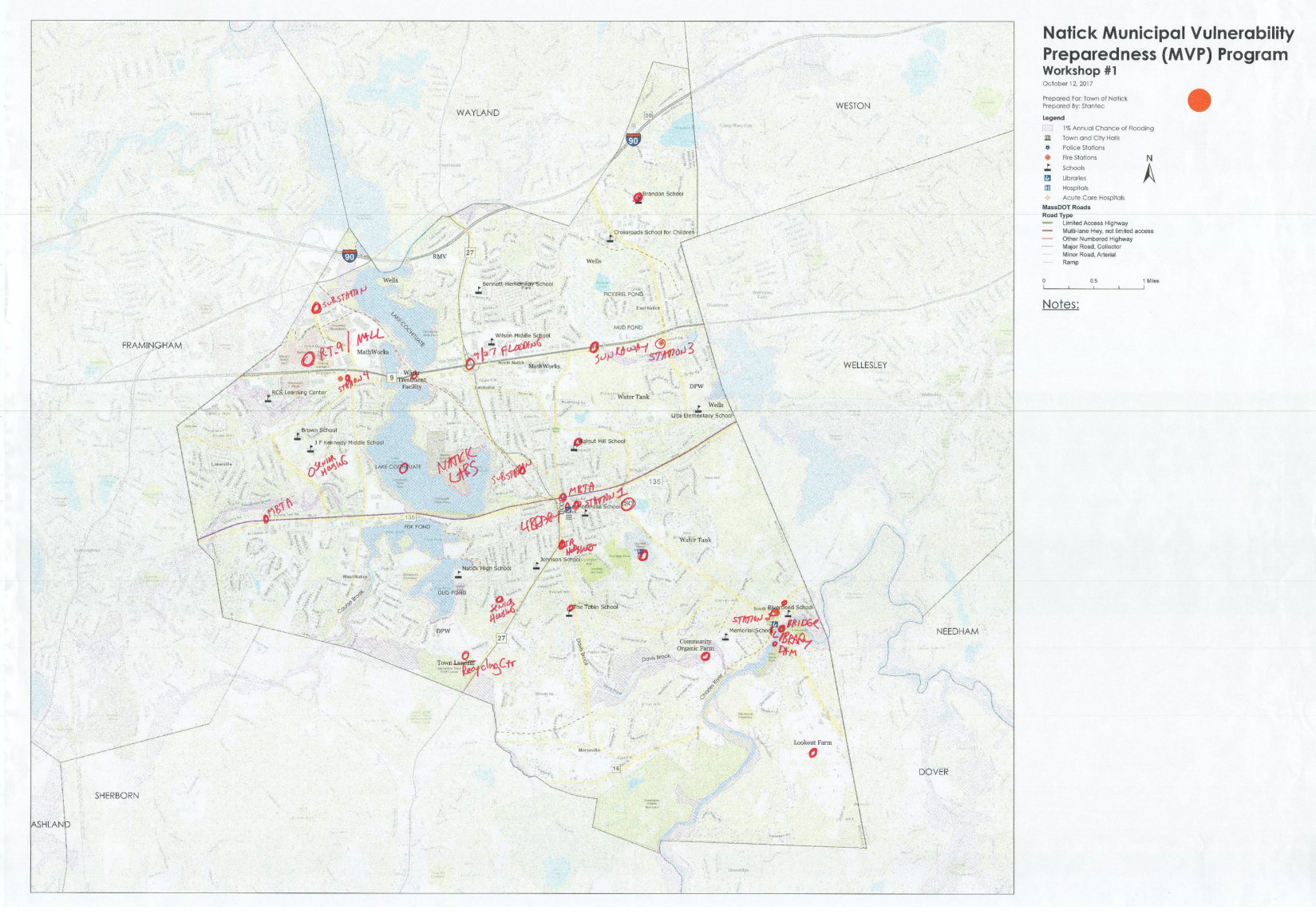
The workshop process would also not have been successful without the facilitation and note-taking of many volunteers. Thank you for your help!

- Dan Brown, Mass Audubon
- Ruby Woodside, Second Nature
- Sara Burns, The Nature Conservancy
- Trish Garrigan, Environmental Protection Agency
- Abby Fiske
- Bill Giezentanner
- Judith Holt
- Shirley Hui

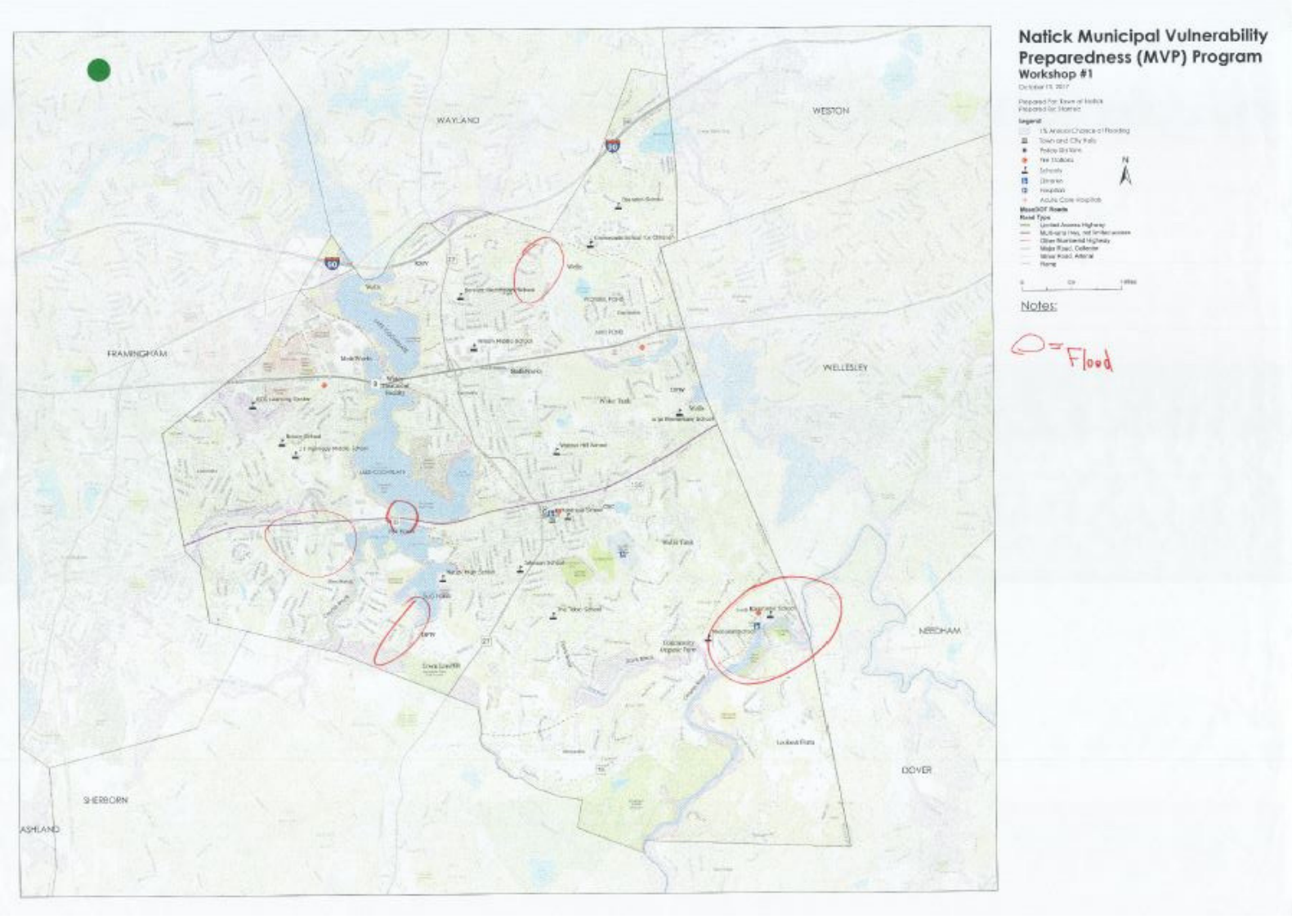
WORKSHOP BASE MAP



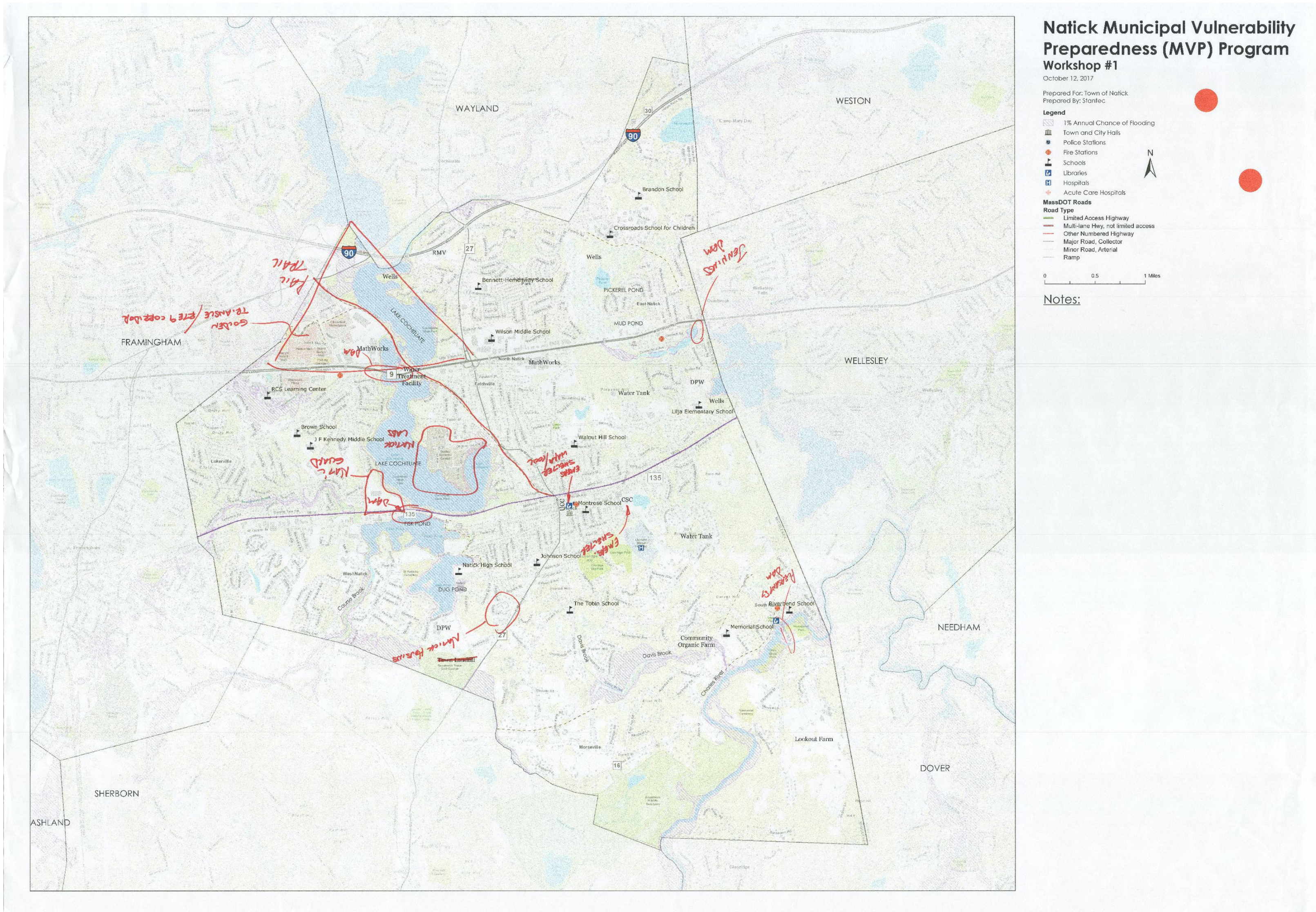
PARTICIPATORY MAPPING RESULTS: ORANGE TEAM



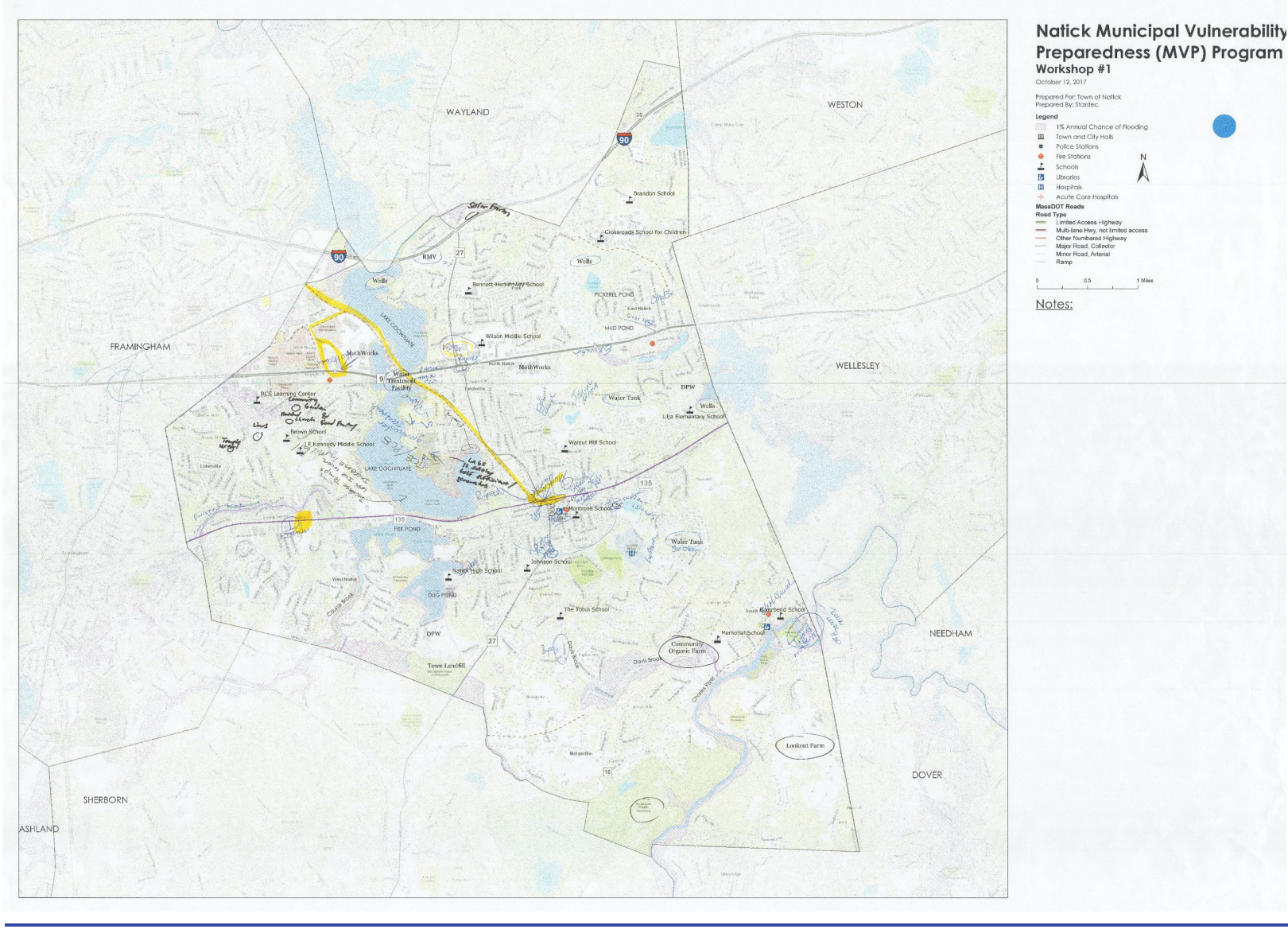
PARTICIPATORY MAPPING RESULTS: GREEN TEAM



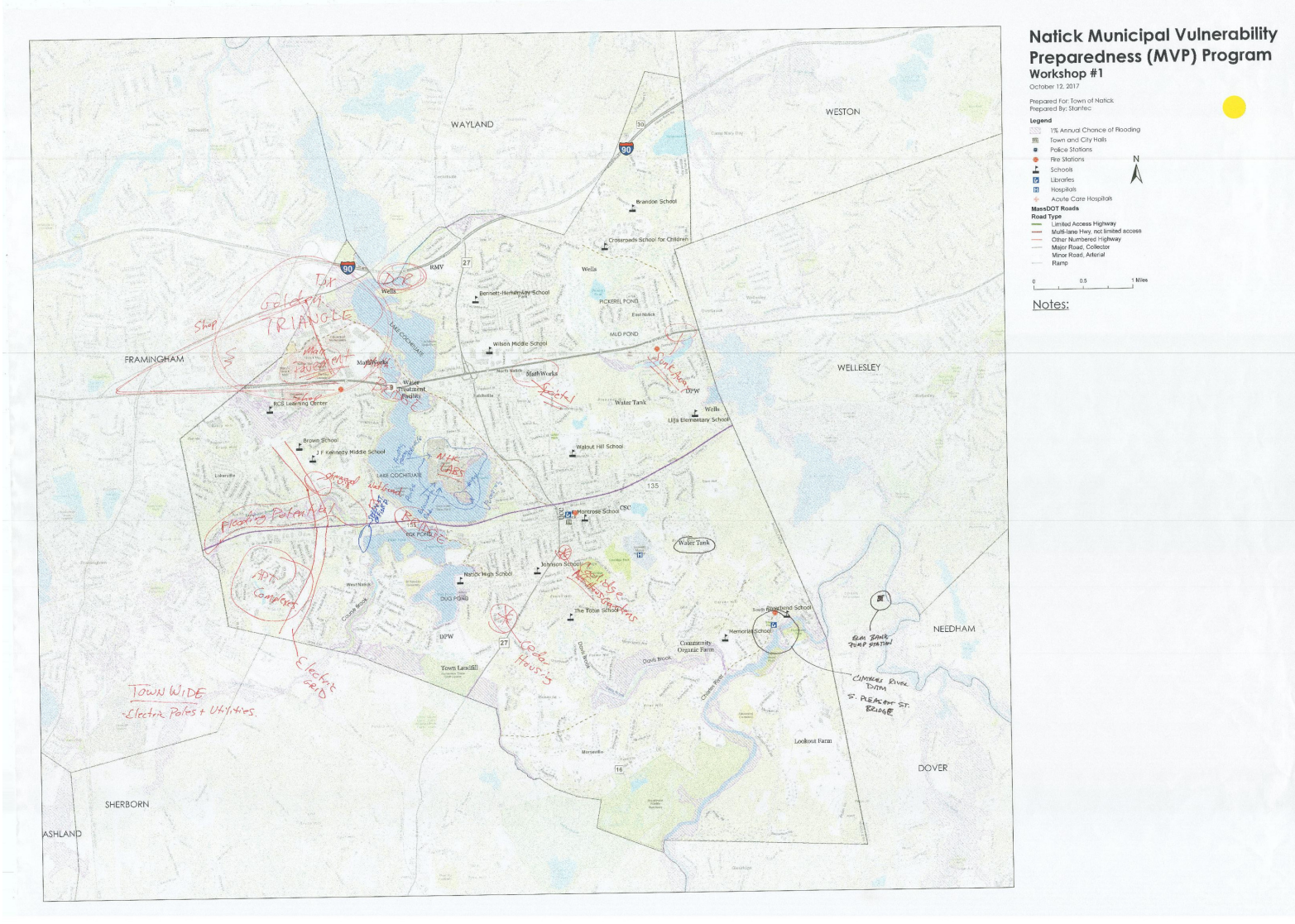
PARTICIPATORY MAPPING RESULTS: RED TEAM



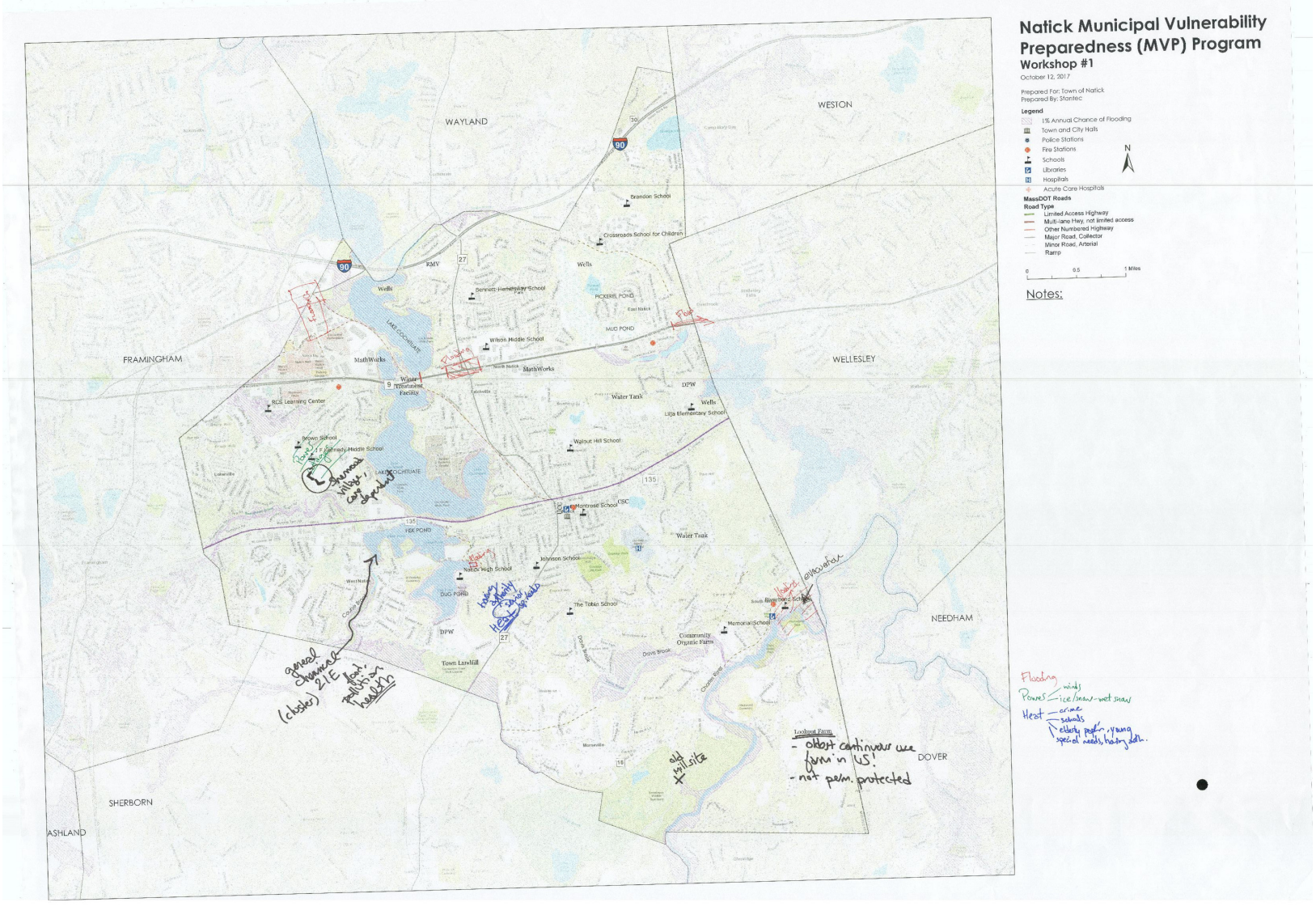
PARTICIPATORY MAPPING RESULTS: BLUE TEAM



PARTICIPATORY MAPPING RESULTS: YELLOW TEAM



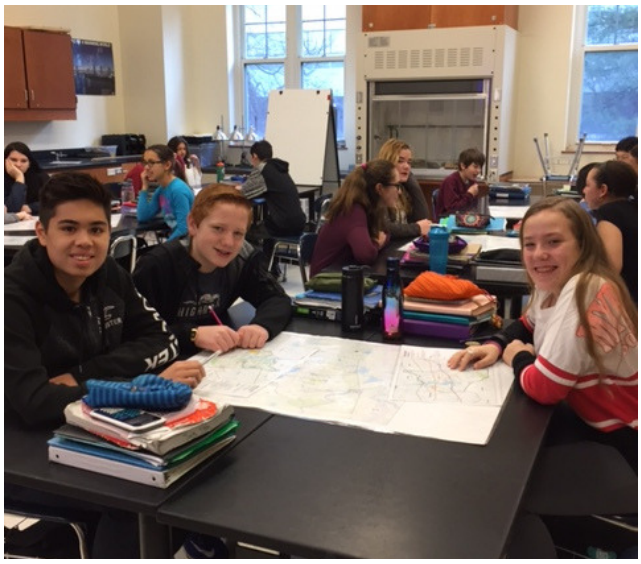
PARTICIPATORY MAPPING RESULTS: BLACK TEAM



STUDENT RECOMMENDATIONS

Fostering a generation of climate leaders will be key to the success of local, state and national climate adaptation efforts, and Natick Public Schools is committed to ensuring its students understand and are prepared to address future challenges.

Climate change is a core part of Natick Public Schools' Earth Science curriculum and is addressed in detail in the 8th grade. Wilson Middle School teacher, Sheila Pogarian, teaches this class and attended the Community Resilience Building (CRB) workshops in October 2018. Inspired by the workshops, Ms. Pogarian completed a modified version of the CRB framework with four 8th grade classes in February 2018. Below is a summary of their findings and recommendations.



Students map local strengths and vulnerabilities
Source: Natick Public Schools

The students brought up several examples both from their own experience and from asking a parent about these hazards. Specific examples identified by the students included:

- Microbursts (several students experienced in their yards)
- Bomb cyclone January 2018
- Many examples of floods from heavy rains
- Extreme heat during 2015 marathon, summers of 2016, 2017
- 90 inches of snow in 2015
- Several examples of downed power lines.
- Halloween snow and ice storm 2011
- Water bans in summer

HAZARDS IDENTIFIED

- Extreme Heat
- Heat Island Effect
- Hurricanes
- Wind TornadoesDrought
- Blizzards/Nor'easters
- Torrential Rain
- Extreme Precipitation
- MIcrobursts

ACTIONS RECOMMENDED

- Replace power lines with underground lines; make poles of stronger material
- Increase number of hospitals
- Develop microgrids
- Create regulations mandating "green construction"
- Establish rain gardens to address areas of flooding during storms
- Conduct education campaigns about natural resources, water conservation, climate change
- Identify/map areas where elderly and vulnerable populations live
- Provide elderly with communication tools
- Replace bridge on Route 27
- Coordinate with National Guard and Soldier System Center
- Partner with Soldier Systems Center to provide residents with military meals in disasters

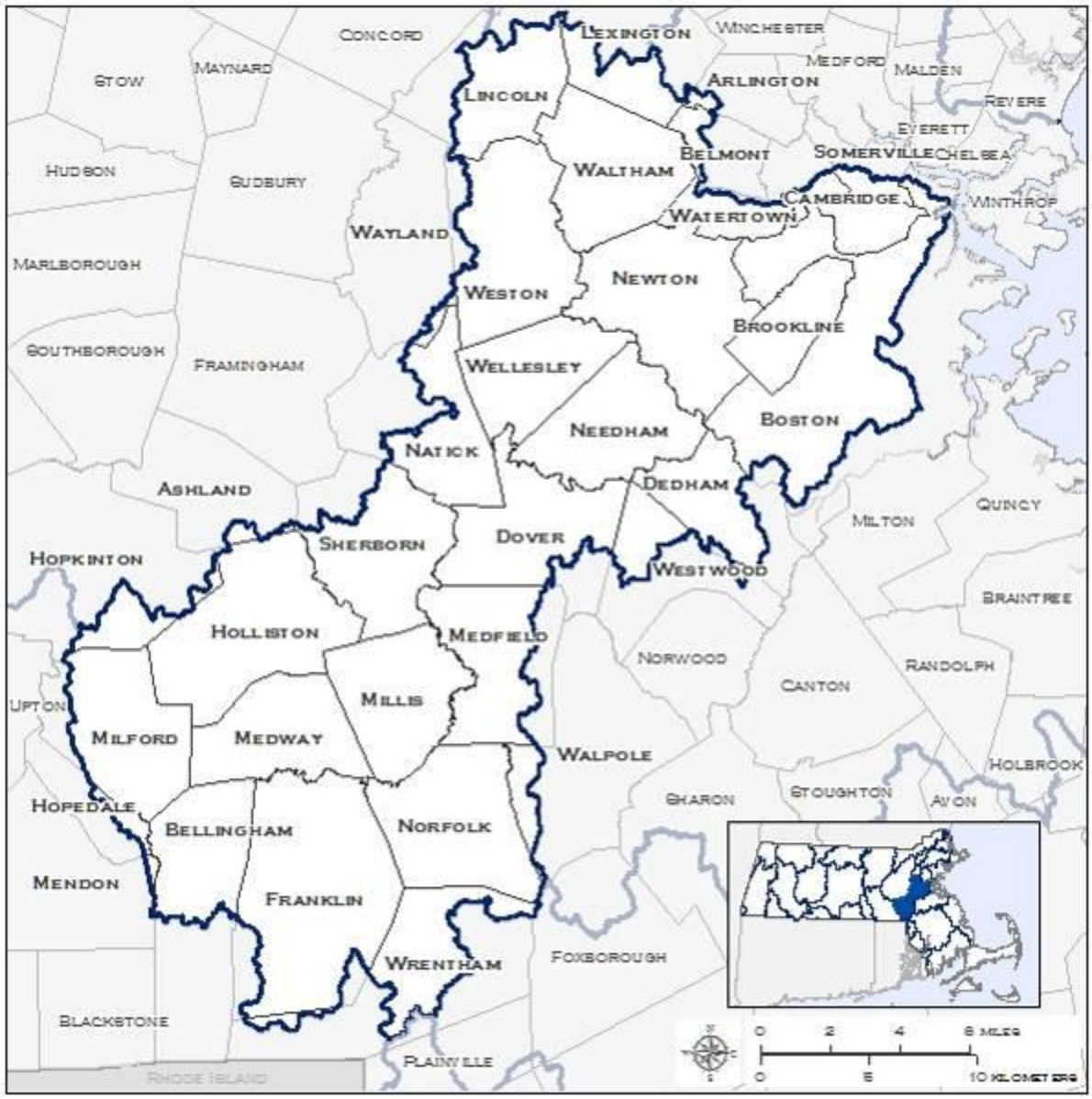
CHARLES RIVER BASIN CLIMATE PROJECTIONS

The following pages provide down-scaled projections for changes in temperature, precipitation, and sea level rise for the Charles River Basin, which comprises the majority of land in Natick. These projects were developed by researchers from the Northeast Climate Science Center at the University of Massachusetts Amherst, with support from the Executive Office of Energy and Environmental Affairs.

CHARLES BASIN

MUNICIPALITIES WITHIN CHARLES BASIN:

Ashland, Arlington, Bellingham, Belmont, Boston, Brookline, Cambridge, Dedham, Dover, Franklin, Holliston, Hopedale, Hopkinton, Lexington, Lincoln, Medfield, Medway, Mendon, Milford, Millis, Natick, Needham, Newton, Norfolk, Sherborn, Somerville, Walpole, Waltham, Watertown, Wayland, Wellesley, Weston, Westwood, and Wrentham



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

CHARLES BASIN

Charles 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	49.38	+2.05 to +4.02	+2.67 to +6.07	+3.23 to +8.79	+3.49 to +10.72
	Winter	28.53	+1.87 to +4.29	+2.52 to +6.43	+3.14 to +8.21	+3.58 to +9.58
	Spring	47.21	+1.49 to +3.29	+2.21 to +5.47	+2.41 to +7.82	+2.99 to +9.59
	Summer	69.8	+2.02 to +4.24	+2.62 to +6.98	+3.12 to +10.20	+3.72 to +12.67
	Fall	51.6	+2.03 to +4.80	+3.60 to +6.46	+3.37 to +9.28	+3.85 to +11.50
Maximum Temperature	Annual	60.08	+1.86 to +3.81	+2.48 to +5.92	+2.95 to +8.83	+3.18 to +10.62
	Winter	38.29	+1.52 to +3.92	+2.10 to +5.89	+2.60 to +7.50	+2.96 to +8.71
	Spring	58.1	+1.41 to +3.24	+1.94 to +5.42	+2.33 to +7.92	+2.90 to +9.57
	Summer	80.95	+1.88 to +4.33	+2.51 to +6.92	+3.06 to +10.39	+3.55 to +12.86
	Fall	62.58	+2.17 to +4.58	+3.40 to +6.64	+3.23 to +9.31	+3.67 to +11.76
Minimum Temperature	Annual	38.68	+2.15 to +4.28	+2.91 to +6.17	+3.51 to +8.75	+3.81 to +10.80
	Winter	18.76	+2.22 to +4.86	+2.91 to +6.97	+3.74 to +8.86	+4.12 to +10.28
	Spring	36.32	+1.57 to +3.40	+2.47 to +5.81	+2.55 to +7.63	+3.07 to +9.46
	Summer	58.64	+2.05 to +4.36	+2.72 to +7.25	+3.18 to +10.01	+3.89 to +12.47
	Fall	40.62	+1.97 to +4.95	+3.55 to +6.40	+3.54 to +9.12	+4.04 to +11.40

- The Charles 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 2.5 °F to 6.9 °F (3-9% increase); end of century increase of 3.6 °F to 12.9 °F (4-16% increase).
    - Fall mid-century increase of 3.4°F to 6.6°F (5-11% increase); end of century increase by and 3.8 °F to 11.8 °F (6-19% increase).
- Seasonally, minimum winter and fall temperatures are expected to see increases throughout the 21st century.
    - Winter mid-century increase of 2.9 °F to 7 °F (16-37% increase); end of century increase by 4.1 °F to 10.3 °F (22-55% increase).
    - Fall mid-century of 3.6 °F to 6.4 °F (9-16% increase); end of century increase of 4.0 °F to 11.4 °F (10-28% increase).

CHARLES BASIN

Charles 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	8.95	+7.08 to +19.58	+10.01 to +35.04	+12.74 to +56.79	+15.17 to +75.87
	Winter	0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00
	Spring	0.51	+0.10 to +0.72	+0.24 to +1.48	+0.28 to +2.60	+0.24 to +4.19
	Summer	8.05	+6.21 to +16.77	+8.42 to +29.96	+11.02 to +45.92	+13.47 to +59.41
	Fall	0.39	+0.57 to +2.43	+0.97 to +5.49	+1.00 to +9.62	+1.51 to +12.74
Days with Maximum Temperature Over 95°F	Annual	1.15	+2.15 to +8.28	+3.17 to +15.90	+3.79 to +31.89	+5.68 to +48.95
	Winter	0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00
	Spring	0.01	+0.03 to +0.22	+0.02 to +0.43	+0.06 to +0.89	+0.08 to +1.69
	Summer	1.12	+2.03 to +7.58	+2.81 to +14.42	+3.54 to +28.61	+5.42 to +41.97
	Fall	0.01	+0.10 to +0.78	+0.16 to +1.55	+0.17 to +3.66	+0.32 to +5.35
Days with Maximum Temperature Over 100°F	Annual	0.05	+0.24 to +1.76	+0.39 to +4.80	+0.58 to +10.99	+0.79 to +20.49
	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 +0.04	+0.00 to +0.14	+0.00 to +0.38
	Summer	0.05	+0.20 to +1.59	+0.36 to +4.62	+0.55 to +10.30	+0.76 to +18.92
	Fall	0.00	+0.00 to +0.12	+0.00 to +0.25	+0.01 to +0.72	+0.02 to +1.29

- Due to projected increases in average and maximum temperatures throughout the end of the century, the Charles basin is also expected to experience an increase in days with daily maximum temperatures over 90 °F, 95 °F, and 100 °F.
    - Annually, the Charles basin is expected to see days with daily maximum temperatures over 90 °F increase by 10 to 35 more days by mid-century, and 15 to 76 more days by the end of the century.
    - Seasonally, summer is expected to see an increase of 8 to 30 more days with daily maximums over 90 °F by mid-century.
    - By end of century, the Charles basin is expected to have 13 to 59 more days.

CHARLES BASIN

Charles 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	4.7	-1.23 to -2.57	-1.48 to -3.17	-1.71 to -3.42	-1.76 to -3.59
	Winter	4.64	-1.22 to -2.44	-1.46 to -3.04	-1.67 to -3.33	-1.72 to -3.5
	Spring	0.06	-0.15 to +0.02	-0.15 to +0.00	-0.01 to -0.20	-0.01 to -0.20
	Summer	0.00	-0.00 to -0.00	-0.00 to -0.00	-0.00 to -0.00	-0.00 to -0.00
	Fall	0.01	-0.00 to -0.00	-0.01 to -0.00	-0.01 to -0.00	-0.01 to -0.00
Days with Minimum Temperature Below 32°F	Annual	136.36	-10.38 to -25.73	-16.89 to -38.60	-20.22 to -52.35	-22.22 to -63.10
	Winter	81.31	-2.63 to -7.17	-3.40 to -11.99	-5.10 to -19.82	-6.44 to -25.53
	Spring	31.73	-2.98 to -10.63	-5.85 to -14.62	-6.94 to -19.10	-7.82 to -20.44
	Summer	0.00	-0.07 to -0.00	-0.12 to -0.00	-0.10 to -0.00	-0.09 to -0.00
	Fall	23.29	-4.43 to -9.42	-6.96 to -11.83	-7.57 to -15.49	-6.97 to -17.59

- Due to projected increases in average and minimum temperatures throughout the end of the century, the Charles 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 3 to 12 fewer days by mid-century, and 6 to 26 fewer by end of century.
    - Spring is expected to have 6 to 15 fewer days by mid-century, and 8 to 20 fewer days by end of century.
    - Fall is expected to have 7 to 12 fewer days by mid-century, and 7 to 18 fewer days by end of century.

CHARLES BASIN

Charles 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	6328.79	-482.80 to -1015.09	-659.94 to -1443.88	-777.15 to -1935.50	-875.21 to -2311.14
	Winter	3302.52	-169.76 to -396.84	-218.96 to -596.73	-278.46 to -745.47	-323.04 to -880.92
	Spring	1661.09	-121.25 to -276.56	-181.72 to -457.01	-203.93 to -611.33	-263.54 to -723.96
	Summer	84.5	-28.58 to -50.11	-37.84 to -66.50	-43.38 to -74.61	-45.10 to -78.21
	Fall	1274.38	-142.80 to -342.13	-260.75 to -422.77	-242.72 to -596.72	-258.78 to -682.61
Cooling Degree-Days (Base 65°F)	Annual	608.49	+228.69 to +462.31	+297.76 to +788.87	+347.81 to +1225.11	+407.01 to +1598.14
	Winter	nan	-0.41 to +2.30	-1.37 to +2.65	+0.85 to +2.80	+1.12 to +4.47
	Spring	25.37	+12.07 to +29.93	+19.51 to +58.93	+23.22 to +102.84	+21.45 to +140.46
	Summer	525.96	+155.73 to +344.85	+192.29 to +579.28	+236.22 to +867.11	+284.90 to +1089.31
	Fall	54.14	+39.03 to +103.48	+55.23 to +176.77	+64.43 to +274.41	+93.13 to +360.52
Growing Degree-Days (Base 50°F)	Annual	2650.53	+407.43 to +808.80	+552.96 to +1276.46	+628.97 to +1988.88	+720.08 to +2491.33
	Winter	6.62	-0.41 to +13.05	+0.65 to +15.00	+4.01 to +24.04	+3.15 to +30.97
	Spring	317.54	+64.59 to +140.52	+89.94 to +248.03	+95.73 to +391.83	+110.39 to +507.62
	Summer	1821.53	+185.88 to +389.66	+239.97 to +641.38	+286.30 to +938.17	+341.56 to +1164.84
	Fall	501.28	+115.58 to +304.16	+194.56 to +423.26	+184.29 to +629.36	+233.48 to +798.72

- Due to projected increases in average, maximum, and minimum temperatures throughout the end of the century, the Charles 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 7-18% (219-597 degree-days) by mid-century, and a decrease of 10-27% (323-881 degree-days) by the end of century.
    - The spring season is expected to decrease in heating degree-days by 11-28% (182-457 degree-days) by mid-century, and by 16-44% (264-724 degree-days) by the end of century.
    - The fall season is expected to decreases in heating degree-days by 20-33% (261-423 degree-days) by mid-century, and by and 20-54% (259-683 degree-days) by the end of century.
- Conversely, due to projected increasing temperatures, summer cooling degree-days are expected to increase by 37-110% (192-579 degree-days) by mid-century, and by 54-207% (285-1089 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 13-35% (240-641 degree-days) by mid-century, and by 19-64% (342-1165 degree-days) by end of century.
- Spring is expected to see an increase by 28-78% (90-248 degree-days) by mid-century and 35-160% (110-508 degree-days) by end of century.
- Fall is expected to see an increase by 39-84% (195-424 degree-days) by mid-century and 47-159% (233-799 degree-days) by end of century.

CHARLES BASIN

Charles 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	7.69	+0.30 to +2.15	+0.79 to +2.95	+1.17 to +3.10	+1.30 to +4.23
	Winter	1.96	-0.00 to +0.81	+0.26 to +1.14	+0.43 to +1.53	+0.43 to +1.91
	Spring	1.56	-0.11 to +0.60	+0.01 to +0.92	+0.12 to +1.11	+0.24 to +1.28
	Summer	1.83	-0.10 to +0.58	-0.05 to +0.77	-0.17 to +0.75	-0.17 to +0.75
	Fall	2.34	-0.30 to +0.78	-0.19 to +0.98	-0.37 to +0.72	-0.43 to +0.89
Days with Precipitation Over 2"	Annual	0.8	-0.00 to +0.41	+0.07 to +0.48	+0.09 to +0.51	+0.11 to +0.68
	Winter	0.1	-0.02 to +0.10	-0.01 to +0.13	-0.01 to +0.17	-0.00 to +0.22
	Spring	0.11	-0.01 to +0.10	-0.02 to +0.12	-0.02 to +0.14	+0.01 to +0.23
	Summer	0.37	-0.09 to +0.15	+0.00 to +0.24	-0.08 to +0.18	-0.05 to +0.19
	Fall	0.22	-0.12 to +0.21	-0.04 to +0.21	-0.06 to +0.22	-0.07 to +0.25
Days with Precipitation Over 4"	Annual	0.04	-0.04 to +0.09	+0.00 to +0.10	-0.02 to +0.10	-0.02 to +0.15
	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 +0.01	+0.00 to +0.00	+0.00 to +0.01
	Summer	0.02	-0.03 to +0.05	-0.02 to +0.06	-0.01 to +0.06	-0.03 to +0.06
	Fall	0.02	-0.02 to +0.05	-0.02 to +0.06	-0.03 to +0.04	-0.02 to +0.07

- The projections for expected number of days receiving precipitation over one inch are variable for the Charles 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 by 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 by 0-1.2 days by the end of century.

CHARLES BASIN

Charles 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	46.55	-0.04 to +4.77	+0.23 to +6.13	+1.24 to +7.47	+0.74 to +8.18
	Winter	11.73	-0.43 to +1.96	+0.14 to +2.43	+0.40 to +3.01	+0.32 to +4.14
	Spring	11.71	-0.05 to +2.13	-0.01 to +2.09	+0.19 to +2.42	+0.12 to +2.44
	Summer	10.9	-0.39 to +1.58	-0.40 to +2.12	-0.95 to +2.56	-1.46 to +2.32
	Fall	12.24	-1.16 to +1.25	-1.24 to +1.71	-1.62 to +1.59	-1.76 to +1.67

- Similar to projections for number of days receiving precipitation over a specified threshold, seasonal projections for total precipitation are also variable for the Charles basin.
    - The winter season is expected to experience the greatest change with an increase of 1-21% by mid-century, and of 3-35% by end of century.
    - Projections for the summer and fall seasons are more variable, and could see either a drop or increase in total precipitation throughout the 21st century.
        - The summer season projections for the Charles or basin could see a decrease of 0.4 to an increase of 2.1 inches by mid-century (decrease of 4% to increase of 19%), and a decrease of 1.5 to an increase of 2.3 inches by the end of the century (decrease of 13% to increase of 21%).
        - The fall season projections for the Charles basin could see a decrease of 1.2 to an increase of 1.7 inches by mid-century (decrease of 10% to increase of 14%), and a decrease of 1.8 to an increase of 1.7 inches by the end of the century (decrease of 14% to increase of 14%).

Charles 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	16.92	-0.47 to +1.46	-0.65 to +2.35	-1.00 to +2.97	-0.77 to +2.71
	Winter	11.52	-0.59 to +1.49	-0.57 to +1.62	-0.73 to +1.91	-1.07 to +1.80
	Spring	11.47	-1.02 to +0.75	-1.18 to +1.21	-1.57 to +1.38	-1.26 to +1.21
	Summer	12.44	-0.86 to +1.69	-1.05 to +2.10	-1.15 to +2.59	-1.08 to +1.97
	Fall	12.6	-0.11 to +1.95	-0.20 to +2.94	-0.34 to +3.06	-0.13 to +3.20

- Annual and seasonal projections for consecutive dry days, or for a given period, the largest number of consecutive days with precipitation less than 1 mm (~0.04 inches), are variable throughout the 21st century.
    - For all the temporal parameters, the Charles basin is expected to see a slight decrease to an increase in consecutive dry days throughout this century.
    - Seasonally, the fall and summer seasons are expected to continue to experience the highest number of consecutive dry days.
        - The fall season is expected to experience an increase of 0-3 days in consecutive dry days by the end of the century.