

# CITY OF WORCESTER



## Municipal Vulnerability Preparedness Plan: Findings & Recommendations

June 2019



## Table of Contents

Acknowledgments.....	3
Executive Summary – Municipal Vulnerability Preparedness Planning.....	4
Worcester Community Resilience Building Workshop - Summary of Findings & Recommendations .....	5
1. Overview .....	5
2. Community Resilience Building Workshop Overview.....	8
2.1 Climate Change-Related Natural Hazards.....	9
2.2 Community Vulnerabilities by Hazards.....	14
2.3 Community Vulnerabilities by Feature (Infrastructural, Societal, Environmental) .....	24
2.4 Summary of Community Strengths and Assets.....	29
3. Recommendations to Improve Resilience .....	30
3.1 Prioritized Recommendations.....	30
3.2 Other Potential Actions of Lower Priority.....	34
3.3 Findings from the Public Listening Session .....	35
4.1 Project Team and Workshop Participants .....	36
4.2 Citations and References .....	39

Appendix A: Presentation from the Community Resilience Building Workshop (1/25/2019)

Appendix B: Worcester Flooding and Critical Assets Map

Appendix C: Final risk matrix resulting from the CRB workshop

Appendix D: Presentation from the Listening Session (6/13/2019)

## **Acknowledgments**

Special thanks to:

- Massachusetts Executive Office of Energy and Environmental Affairs for providing the City with grant funding to implement the Community Resiliency Building (CRB) process.
- Core Group members and workshop participants for investing their time, focus, and passion into the workshop and moving the identified priorities forward.



*Worcester City Manager, Edward M. Augustus Jr., welcomes attendees on the morning of the Municipal Vulnerability Preparedness Community Resilience Building Workshop organized by the City of Worcester's Division of Energy and Asset Management (EAM).*

## **Executive Summary – Municipal Vulnerability Preparedness Planning**

The **City of Worcester** is taking proactive measures to preserve the natural environment and protect its community members from the impact of climate change-related hazards. Using the planning grant funding made available through the Massachusetts Executive Office of Energy and Environmental Affairs' (EEA) Municipal Vulnerability Preparedness (MVP) program, the City aims to build on the work recently completed through their Hazard Mitigation Plan (HMP).

This Report summarizes the City's MVP resiliency planning efforts. The City collaborated with community stakeholders through a Community Resilience Building (CRB) workshop (held on January 25, 2019) to identify climate change-related natural hazards that impact Worcester, discussed the community strengths and vulnerabilities to those hazards, and developed priority actions to address climate change issues.

For Worcester, community stakeholders identified the three (3) focal climate-change hazards, or the natural weather-related events that are influenced or exacerbated by changing climate trends, which are ***flooding from extreme precipitation (heavy rain)***, ***ice and snowstorms coupled with extreme cold***, and ***extreme heat coupled with drought***. The CRB Workshop participants identified community features that could be source of vulnerability from the perspective of those three climate-change hazards:

<b>Infrastructural</b>	<b>Societal</b>	<b>Environmental</b>
Transportation	Community Populations	Water Features
Utility Infrastructure	Social Services	Surface Features
Buildings/Structures		Soil/Air Quality

Together, the CRB workshop participants identified a list of priority actions to focus the City's resiliency planning efforts including investing in stormwater infrastructure improvements, engaging community members to prepare for climate change, and protecting open green space and water resources.

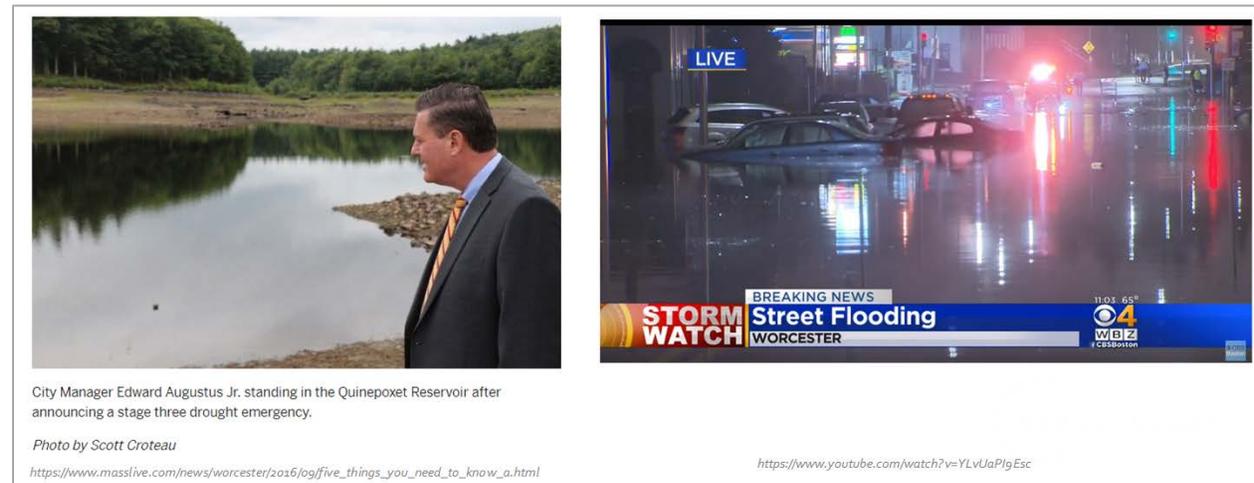
The City presented the findings from the CRB workshop to the general public at-large during a listening session meeting on June 13, 2019 at Worcester City Hall.

# Worcester Community Resilience Building Workshop - Summary of Findings & Recommendations

## 1. Overview

In recent years, the effects of climate change that **City of Worcester** has been experiencing have become more apparent. Climate change manifests itself in a number of extreme, and often conflicting, weather events.

As New England now has more intense precipitation events, the City was twice designated America's 2<sup>nd</sup> Snowiest U.S. City (population 100,000 or more) during the winters of 2012-2013 (109" of snow) and 2014-2015 (120" of snow)<sup>1</sup>. Over the last ten years climate change has also led to more extreme and prolonged heat waves during the summer months. In 2016, the City was in Stage III drought, yet, in the fall of that same year, an intense rain event caused severe flash flooding, exposing the City's stormwater system vulnerabilities.



*In October, 2016, the City was in the midst of a severe drought (stage III), while also being affected by one of the most severe and damaging rain events in its history.*

As climate change intensifies weather events, it is becoming ever so important for the City to plan and prepare for the hazards caused by such extreme weather events.

## Municipal Vulnerability Preparedness Program

The Municipal Vulnerability Preparedness (MVP) program is a new grant and designation program for cities and towns. Launched in 2017, the MVP program builds on Governor Baker's Executive Order 569 ('Establishing an Integrated Climate Change Strategy for the Commonwealth'), as well as other administration-led state and local partnerships, to support Massachusetts municipalities to plan and implement key climate change resiliency adaptations. Funding for MVP Planning grants is first used to

<sup>1</sup> [www.goldensnowglobe.com](http://www.goldensnowglobe.com)

complete vulnerability assessments and to develop action-oriented resiliency plans, which help communities to do the following:

- Define extreme weather, natural and climate related hazards in their communities
- Understand how their community may be impacted by climate change with a Massachusetts specific climate change clearinghouse with the latest science and data (<http://www.resilientma.org>)
- Identify existing and future community vulnerabilities and strengths related to: a) infrastructure b) environment and c) society
- Develop and prioritize actions for the community
- Identify opportunities to take action to reduce risk and build resilience.

Once the resiliency plan is completed and approved by the state, MVP Action grants can be applied for to implement key actions identified through the planning process.

In 2018, Worcester received a \$100,000 Municipal Vulnerability Preparedness (MVP) Planning grant to assist it with implementation of the Community Resilience Building (CRB) planning process<sup>2</sup>, as well as conducting several risk and vulnerability assessments, and developing educational and outreach materials for Worcester residents related to climate change and flooding.

Additionally, the City is undertaking a number of other planning efforts, which could help inform best approaches for addressing the projected climate change impacts. Some of these efforts include the City's 5-year Hazard Mitigation Plan<sup>3</sup>, the soon to be completed 50-year Integrated Water Resource Management Plan, the forthcoming Master Plan, the Open Space & Recreation Plan, and the recently launched Green Worcester Strategic Plan. The proposed recommendations from the CRB planning process should be integrated into these and similar planning initiatives as well as relevant implementation projects.

## **Community Resilience Building (CRB) Workshop Planning Process**

The CRB preparation process was carried out over several months and culminated in an intensive, one-day CRB Workshop with community stakeholders on January 25, 2019 at Worcester City Hall.

The City's Division of Energy and Asset Management organized the workshop in collaboration with a Core Group that was established at the commencement of the CRB planning process. The Core Group was composed of several City departments representing public works, schools, planning, environment, and emergency services.

The City selected Kleinfelder as the state-certified MVP consultant to provide technical assistance on this project. The Core Group, with help and guidance from Kleinfelder, met prior to the workshop and selected goals, identified potential hazards, and set the expectations for the CRB Workshop.

Approximately 50 community members participated in the collaborative workshop, including Core Group members, City department staff, City committee representatives, residents, and constituents

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<sup>2</sup> The CBR framework was developed and tested by The Nature Conservancy. [www.communityresiliencebuilding.com](http://www.communityresiliencebuilding.com)

<sup>3</sup> Adopted by the City Council on February 26, 2019

from non-profit organizations, utility companies, local businesses, and academic institutions. Workshop participants were assigned to six diversified teams for completing various tasks during the workshop.

The workshop raised awareness, facilitated dialogue and experience-sharing, and generated ideas and momentum for building a more resilient Worcester.

The workshop's objectives were as follows:

- Define the top climate-related hazards impacting the City;
- Identify areas particularly vulnerable to those hazards related to the City's social, environmental, and infrastructure frameworks;
- Identify potential challenges in addressing those issues;
- Document community strengths to assist addressing hazards; and
- Provide recommendations to improve resilience by leveraging those community strengths as assets and reducing vulnerabilities.

This report provides a summary of the concerns, ideas, and priorities shared by these participants during Worcester's CRB Workshop.

*Table group discussions and presentations*



## 2. Community Resilience Building Workshop Overview

On January 25, 2019, the City held a one-day Community Resilience Building Workshop.

The City of Worcester is subject to the effects of natural weather-related events that are influenced or exacerbated by changing climate trends, or what are commonly known as climate change hazards.

At the beginning of the CRB Workshop, following introductions and opening words, Kleinfelder presented six recognized climate change hazards relevant to Worcester:

1. Heavy rainfall
2. Ice/snow storms
3. Wind
4. Brush Fires
5. Extreme Heat, and
6. Drought

Kleinfelder presented historical climate data and the best-available climate change projections related to the frequency, magnitude, and impact of these climate hazards. **The full presentation is attached as Appendix A.** The presented information was based on City-wide and regional climate change projections from the Massachusetts State Hazard Mitigation and Climate Adaptation Plan, FEMA flood maps, and local knowledge from City staff.

The presentation included a map (**Worcester Flooding and Critical Assets Map - Appendix B**) that overlaid climate change hazards related to flooding<sup>4</sup> with the City's critical assets.<sup>5</sup> The same map was used for the small group break-out sessions throughout the day.

Following the climate change hazard presentation, stakeholders participated in a full-group discussion about how each hazard had impacted Worcester in the past and offered climate-related concerns about the future. Anecdotal stories were shared surrounding the extreme rainfall and snow events.

Afterward, participants worked in six small groups to identify infrastructural (e.g. pump stations), societal (e.g. public health), and environmental (e.g. water quality) features of the community that may be impacted by the identified climate change hazards. Infrastructural features are the built aspects that support the City's functionality. Societal features are those that reflect the conditions and population demographics of the Worcester community. Environmental features are the natural aspects of the City and the current condition of those elements. Features were defined by their location, their ownership, and whether the participants considered the feature a vulnerability and/or a strength from the standpoint of resiliency for the Worcester community.

The six groups shared their findings with the entire group, and in the second part of the workshop, worked on identifying potential actions to improve community resilience to extreme weather events.

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<sup>4</sup> Information used to develop the flooding map was based on Worcester's Customer Service Request System (CSRS) data for reported flooding events between 2006 and 2016.

<sup>5</sup> Derived from Worcester's 2018 Draft Hazard Mitigation Plan and the accompanying critical assets GIS layer.

## 2.1 Climate Change-Related Natural Hazards

During a meeting prior to the CRB Workshop, the Core Group identified two top hazards: heavy rain (flooding) and ice/snow storms.<sup>6</sup> The Core Group initially suggested combining multiple hazards with a close association and a high probability of occurring at the same time.

At the beginning of the CRB Workshop, the full stakeholder participant group was asked to identify a third, and possibly fourth climate change hazard, in addition to the two already cited. Following a group discussion, the workshop attendees reached a consensus to add extreme cold to the previously identified ice/snow storms hazard and selected a third primary climate change hazard as the combination of extreme heat and drought.

At the conclusion of the climate change hazards discussion, workshop participants identified the following three climate change hazards (not ranked) as those having the greatest direct impact on Worcester in the recent past, and/or anticipated to be of greater concern in the future:

→ **Flooding from extreme precipitation (heavy rain)**



→ **Ice/snowstorms coupled with extreme cold**



→ **Extreme heat coupled with drought**



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<sup>6</sup> According to the [www.goldensnowglobe.com](http://www.goldensnowglobe.com), Worcester has been in the top 10 snowiest U.S. Cities 5 times in the last decade:

2017-2018 – 96.1” (6th)

2016-2017 – 78.3” (5th)

2014-2015 – 119.7” (2nd)

2012 – 2013 – 108.9” (2nd)

2010 – 2011 – 92.6” (7th)

## Hazard - Flooding From Extreme Precipitation (heavy rain)



The impacts of flooding events are well-documented throughout the City and the occurrence of heavy rainfall events is projected to increase in the future. The City is frequently impacted under current conditions by extreme precipitation resulting in flooding in several low-lying areas as well as areas with finite stormwater drainage capacity. These areas include the Green Island, Southgate Street, and Pelham Street areas, to name a few.

The Green Island neighborhood area, which experiences frequent and extreme cases of flooding, is a prime reflection of the challenges faced by the City during periods of heavy rainfall. Participants commented on the area as a low-lying part of Worcester's hilly landscape with a mainly impervious surface characteristic and combined sewer – the factors that lead to increased stormwater surface runoff and local area flooding.

Future projections indicate that infrastructure systems will become further stressed under these extreme weather events. This hazard impacts public transportation, can result in significant property loss, and can create public health and safety issues.



A flooded underpass on Cambridge Street during an extreme rainfall event in Worcester in July of 2018.  
Photo credit: Matthew Healey from The Boston Globe

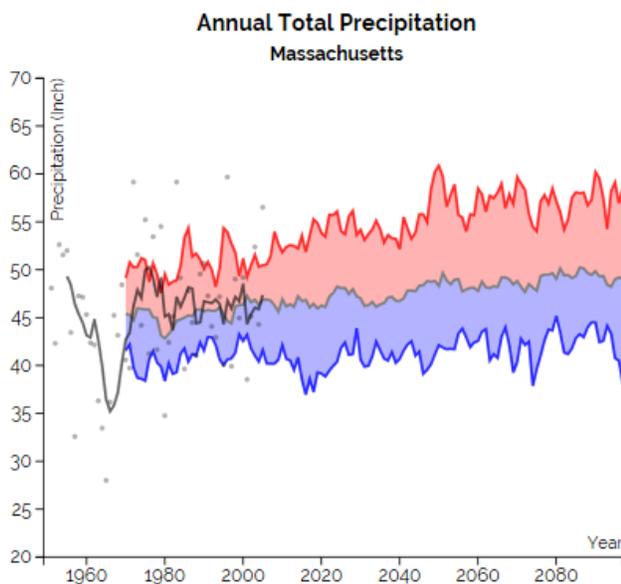


Figure 1: Projected Annual Total Precipitation in Massachusetts 1960-2100

Source: [www.resilientMA.org](http://www.resilientMA.org)

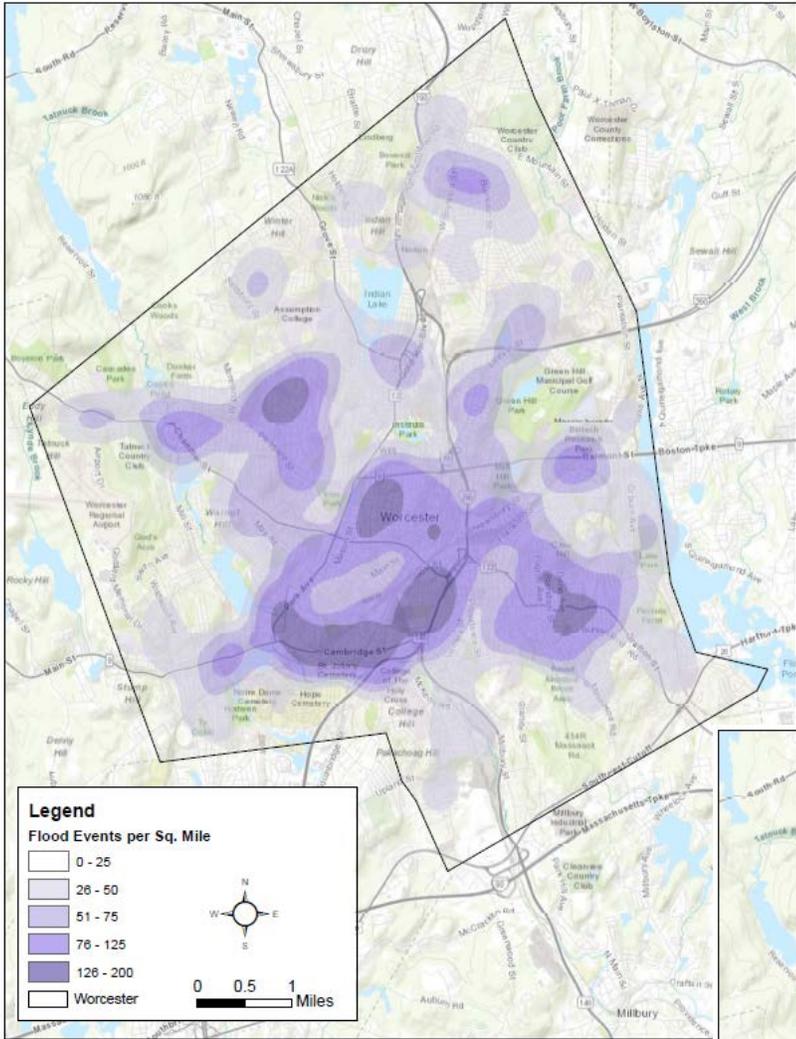
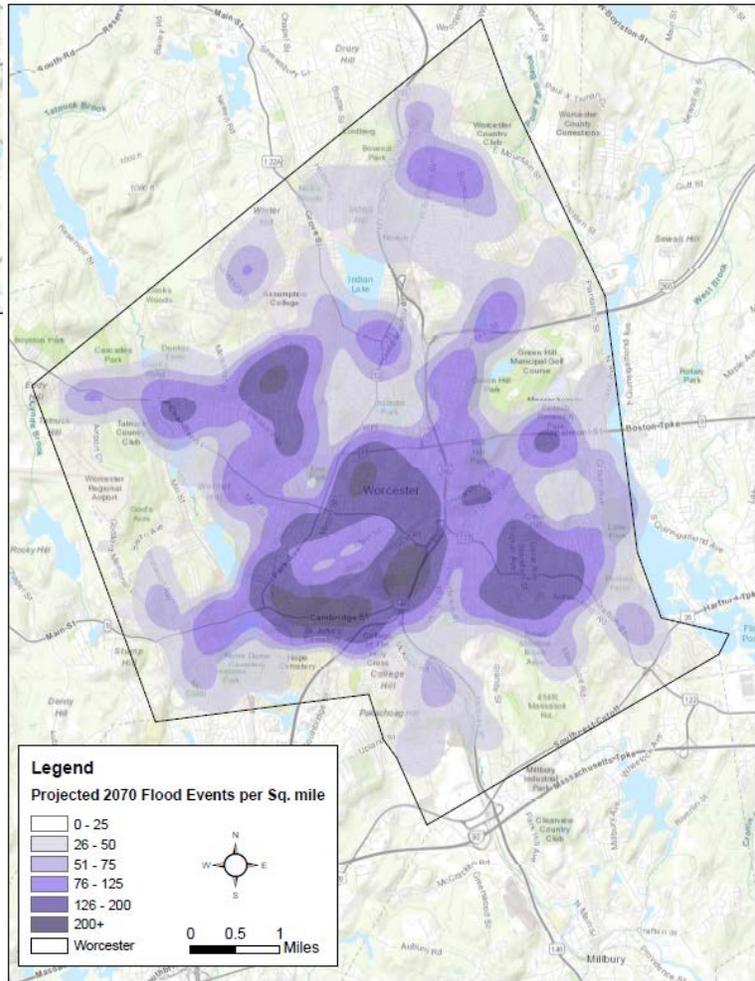


Figure 2: Depiction of current flooding due to finite stormwater drainage capacity, and 2070 flooding projections.

Source: City of Worcester data and [www.resilientma.org](http://www.resilientma.org)



## Hazard - Ice/Snowstorms and Extreme Cold



During the heavy snowfall events, ice storms and extreme cold of the winter months, the City's energy infrastructure is subjected to increased stresses, such as gas line breaks (due to frost heaves acting on buried pipes) and electrical lines damage (due to strong winds and heavy weight of ice). Workshop participants believed that these impacts are exacerbated by the steep roadway slopes and local microclimates that develop as a result of the varying topography across the entire city. This hazard also has a detrimental societal effect due to its impact on roadways, public transportation, and above ground utilities. Participants discussed how low income and vulnerable populations, who rely disproportionately more on public services, were more severely impacted by heavy snow and ice storms.



A snowstorm in 2015 in Columbus Park neighborhood of Worcester.

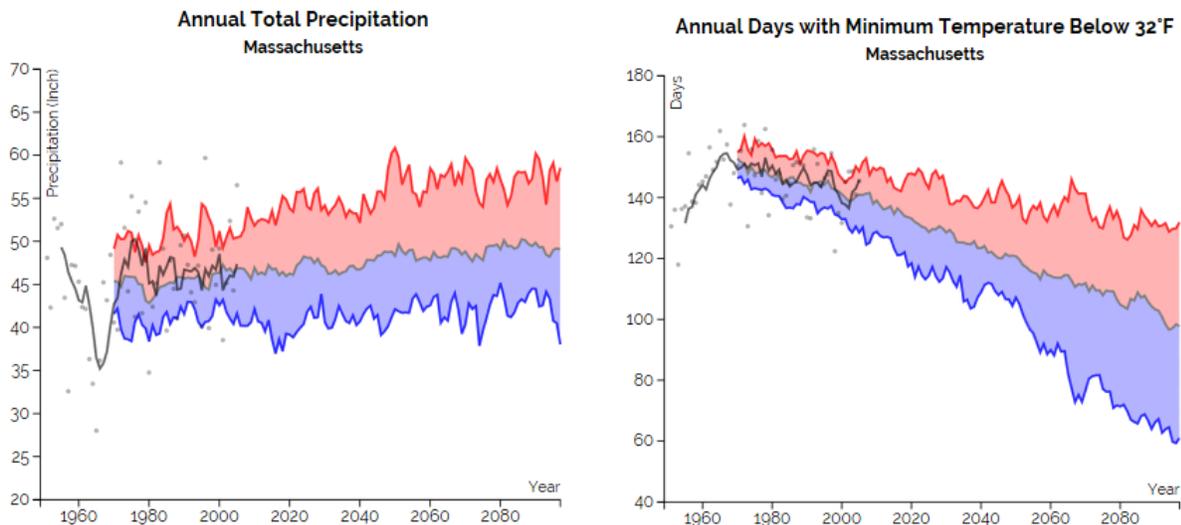


Figure 3: Worcester is susceptible to large snow and ice storm events due to:

- Annual precipitation volume in winter is projected to increase 30% due to climate change.
- Annual days below freezing is projected to decrease over the next 80 years due to climate change.
- Projected rising temperatures will cause more winter precipitation to fall as rain or freezing rain instead of snow.
- Therefore, there will be higher chance of ice and freezing rain storms

Source: [www.resilientma.org](http://www.resilientma.org)



### Hazard - Extreme heat/Drought

While this has not historically been a frequent hazard for the City, it was identified as a hazard of concern because climate projections indicate that temperature-related extreme events (degree and duration) will become more frequent and intense in the future. This hazard has an impact on community facilities and residents, especially vulnerable populations such as economically disadvantaged or elderly populations, who are at higher risk for heat-related illness and may not have access to air conditioning.

This is also a concern for future droughts such as the one the City experienced in 2016, causing a temporary shortage of available drinking water supply and resulting in the purchase of additional water from the Massachusetts Water Resources Authority (MWRA), costing the city over \$3 million.

Responding to these climate change hazards produces an added strain on the City’s existing resources.

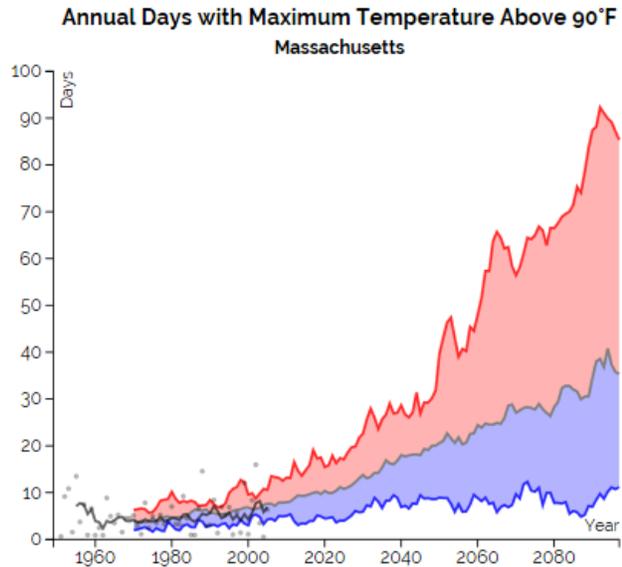


Figure 4: Projected Annual Days with Max Temperature Above 90 F Total Precipitation in Massachusetts 1960-2100

Source: [www.resilientma.org](http://www.resilientma.org)



Low water levels at Pine Hill and Quinapoxet Reservoirs, some of the sources for Worcester's drinking water, during Stage III drought in 2016

## 2.2 Community Vulnerabilities by Hazards

The CRB Workshop continued with a discussion about the City's vulnerabilities to the identified hazards. Past and present extreme weather events exposed aspects of the City that are vulnerable to the impacts of climate change hazards. These vulnerabilities include the City's built and natural environment as well as the populations that live and work within the Worcester community. Kleinfelder presented the following at-risk aspects of the City based on the findings of the City's draft Hazard Mitigation Plan and anecdotal data provided by City staff:

- Infrastructural aspects such as the transportation network, utility systems, and municipal buildings
- Societal aspects such as sensitive populations and access to municipal services
- Environmental aspects such as the natural water systems, urban open space and forestry, air quality, and subsurface soil conditions

The list below summarizes the vulnerable features of the Worcester community as identified by participants during the CRB Workshop small group sessions.

For the purpose of this report, vulnerability is defined as the exposure to one of the three selected climate change-related hazards and the sensitivity or adaptive capacity of the community feature. These features are organized into three categories: the infrastructure (built facilities and assets), the society (people and services), and the environment (water systems, trees, and open space).





## Features most vulnerable to flooding from extreme precipitation hazard

During the CRB Workshop, participants voiced their concerns that the three identified hazards will likely impact Worcester with increasingly more damaging and disruptive extreme weather events. Some of the challenges faced when combating climate change and these climate-related hazards are presented below as discussed in detail during the workshop's small group sessions.

The impacts of flooding events are well-documented throughout the City. The Green Island area in the southern portion of the city experiences frequent and extreme cases of flooding, and serves as a prime example of the challenges faced by the City during periods of heavy rainfall. The Green Island area is low-lying and is mostly located within the 100-year floodplain. It acts as a drainage outlet (into Blackstone River, behind Walmart on Route 146) for its watershed, which comprises a large portion of the City's area. The neighborhood has a lot of impervious surfaces and is surrounded by a large combined sewer area, where sanitary and stormwater sewer flows are combined during heavy rain events and often discharged into the Blackstone River. During intense and/or prolonged rains, water levels in the river begin to rise. When that happens, the stormwater cannot enter the river channel, in turn backing up into the streets, resulting in Green Island street flooding and, at times, property damage.

Future projections indicate that infrastructure systems will become further stressed under these extreme weather events. To prepare themselves accordingly, the City is developing the Worcester Integrated Plan with the intent of optimizing their capacity to improve the water resource-related services and infrastructure, including stormwater, drinking water, and wastewater.



*A public event where educators set up kayak rides to teach people about the Blackstone canal, currently piped underneath downtown Worcester.*



*Mill Brook conduit extension under Worcester downtown.*



Figure 5-A: Approximate delineation of the Green Island neighborhood (between Quinsigamond Avenue, Millbury Street, and Kelley Square)

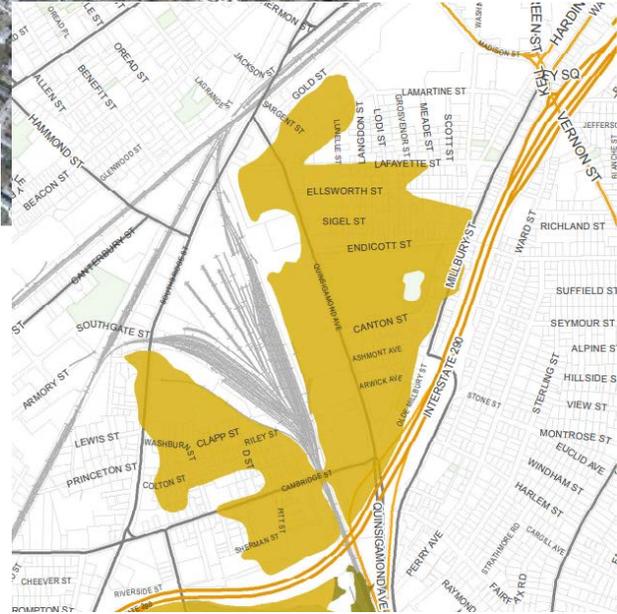
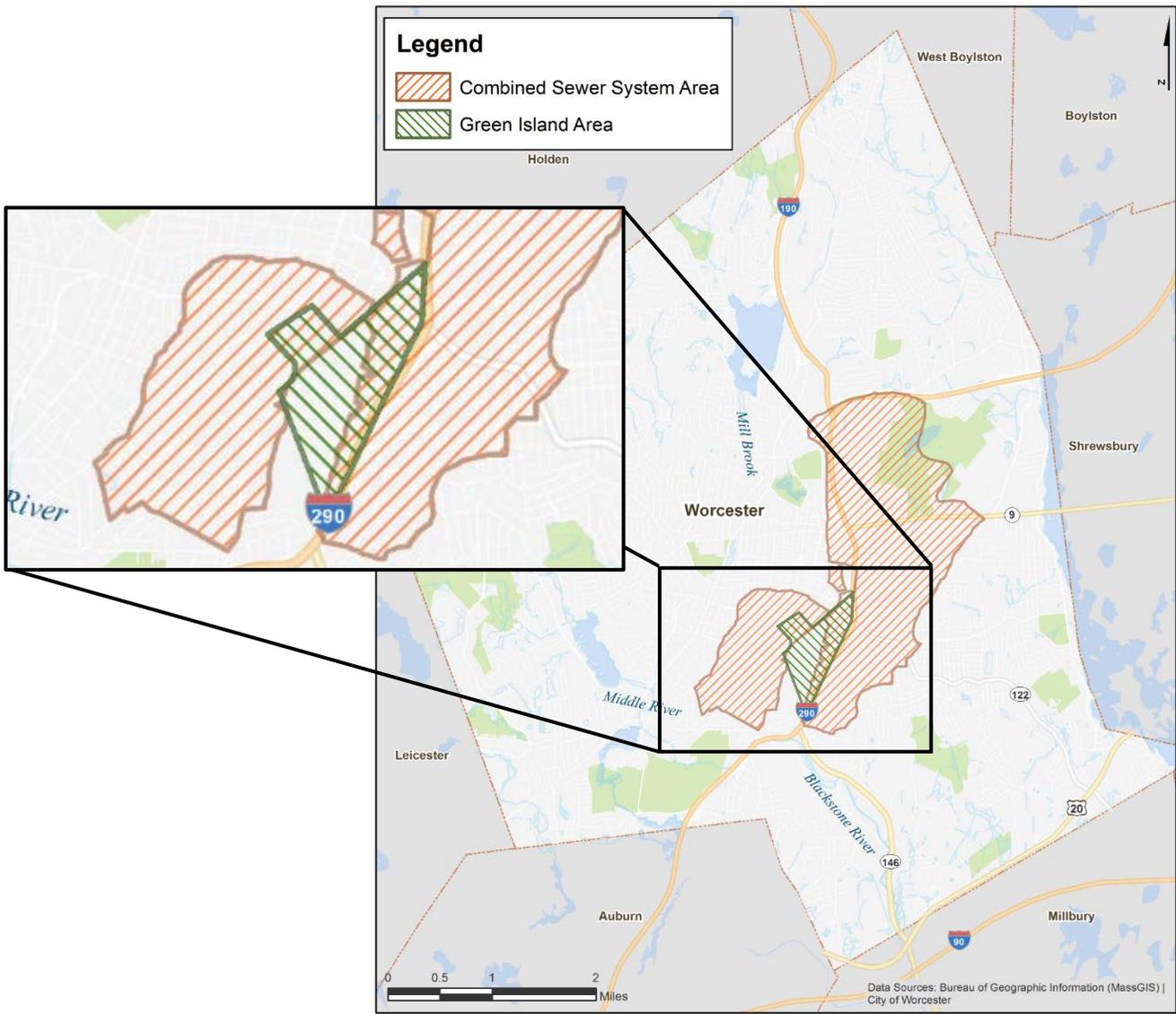


Figure 1-B: 100-year flood zone (i.e. 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage) in the Green Island area depicted in orange color – based on the historic data to predict flooding events, and not accounting for climate change impacts.



*Figure 6: City's combined sewer system area, where sanitary sewerage and storm water runoff are combined during heavy and/or prolonged rain events, is particularly susceptible to surface flooding.*

## Infrastructural Vulnerabilities:



### • Transportation:

- Worcester Regional Transit Authority (WRTA) Depot
- railroad tracks and railroad bridges
- highways and roadways throughout City
- sloped roadways along Belmont Street
- low bridges along Cambridge Street
- Quinsigamond Avenue
- Southbridge Street
- Hammond Street
- Millbury Street along the Blackstone River
- Southwest Cutoff (MA-20) under the Grafton Street overpass
- Major Taylor Boulevard near the DCU Center



*Concerns:* Obstructed emergency access/evacuation routes, negative economic impacts on commuters and local businesses.

### • Utilities:

- stormwater infrastructure
- wastewater/combined sewer infrastructure
- electric power lines
- communication infrastructure throughout the City

*Concerns:* clogged catch basins, undersized culverts, inadequate conveyance capacity, poor surface water quality, disrupted emergency communications, power outages and service interruptions.

### • Buildings:

- DCU Center
- medical facilities throughout City
- emergency response services/shelters
- old and aging housing stock
- old and aging schools

*Concerns:* obstructed access to emergency shelter, negative impact on economic business opportunities, obstructed access to/from medical services, residential and commercial property damage.

### • Other Assets:

- upland retaining walls
- dams

*Concerns:* the lack of adequate structural condition information; potential of failure and resulting property damage.



## **Societal Vulnerabilities:**

- **Populations:**
  - large non-English speaking demographic
  - large homeless population
  - elderly community
  - widely distributed neighborhoods of variable density
  - wide disparity in education levels
  - large environmental justice community

*Concerns:* inadequate modes of emergency communication and alerts, limited access to municipal services, low homeownership rates, limited access to recreational areas, transient and immigrant population with lack of local knowledge on resources and service providers.

- **Social Services:**
  - public transportation
  - emergency services
  - community centers
  - health care services
  - housing services

*Concerns:* perception of inadequate capacity for sheltering vulnerable populations by some members of the public, inequitable access to social services, lack of inclusivity, lacking inter-departmental knowledge sharing and collaboration within city government.



## **Environmental Vulnerabilities:**

- **Water Features:**
  - waterways
  - wetlands
  - lakes and ponds
  - aquatic life

*Concerns:* combating invasive species, degrading water quality, trash accumulation in public spaces, and the lack of enforcement on other pollution prevention measures.

- **Surface Features:**
  - hill topography and tree canopy throughout City

*Concerns:* managing surface runoff and foliage build-up in stormwater infrastructure.

- **Soils:**
  - brownfield/hazardous waste sites throughout the City.

*Concerns:* managing risk for groundwater contamination and pollution of waterways from industrial sites.



## Features most vulnerable to ice/snowstorms and extreme cold hazard

Worcester’s transportation infrastructure and energy facilities are impacted by heavy snow and ice storms during the winter months. The workshop participants expressed concern about the resilience of aboveground utilities – in the street’s right of way and especially in the homes’ backyards, some of which have electrical utility lines, proving access for repair vehicle difficult at times.

Intense winds that occur during these extreme ice/snow events can result in fallen trees or branches damaging electric power and communication lines and creating hazardous conditions along roadways. The City has focused on collaboration between the City’s Urban Forestry division, utility companies, and the City’s emergency management systems, but there are competing City- wide issues that also place stress on the City’s available funding and resources.



Worcester’s MBTA commuter line stop (at Union Station) during a snowstorm.

The City’s vulnerable populations are also impacted by the ice/snow events and the extreme cold. Participants voiced concern about the homeless population and elderly residents during these extreme cold situations. The vulnerabilities are exacerbated by the City’s aging housing stock, which is typically less energy efficient and exhibits structural deterioration, thus more susceptible to damage from the ice/snow and extreme cold climate change hazard.



### Infrastructural Vulnerabilities:

- Transportation:
  - old bridges (Southgate Street)
  - highway and roadway potholes throughout City
  - sloped roadways along Belmont Street
  - low bridges along Cambridge Street

*Concerns:* Obstructed emergency access/evacuation, inefficient pavement management/deicing, negative economic impacts on commuters and local businesses.

- Utilities:
  - drinking water infrastructure
  - natural gas pipes
  - electric power lines
  - communication infrastructure throughout the City



*Concerns:* managing frozen water pipes, disrupted emergency communications, power outages and service interruptions.

- Buildings:
  - Worcester Technical High School
  - emergency response services/shelters
  - old and aging housing stock
  - old and aging schools

*Concerns:* obstructed access to emergency shelters, negative impact on economic business opportunities, obstructed access to/from medical services, residential property damage.



### **Societal Vulnerabilities:**

- Populations:
  - large non-English speaking demographic
  - large homeless population
  - elderly community
  - wide disparity in education levels
  - large environmental justice community

*Concerns:* inadequate modes of emergency communication and alerts, limited access to municipal services, low homeownership rates, transient population with lack of local knowledge on resources and service providers.

- Social Services:
  - public transportation
  - emergency services
  - community centers
  - health care services
  - housing services

*Concerns:* perception of inadequate capacity for sheltering vulnerable populations by some members of the public, inequitable access to social services, lack of inclusivity, lacking inter-departmental knowledge sharing and collaboration within city government.



### **Environmental Vulnerabilities:**

- Surface Features:
  - hill topography
  - tree canopy throughout City

*Concerns:* managing roadway and sidewalk surface icing conditions, power outages due to downed trees.



## Features most vulnerable to extreme heat and drought hazard

In 2016, the City experienced a drought causing a temporary shortage in the available drinking water supply in their reservoir system. To prevent the disruption in water service to the end users, the City purchased water from the Massachusetts Water Resource Authority, pulling water from an existing interconnection with the MWRA's systems at a cost of three million dollars (\$3M). This unanticipated cost limits the City's capacity to respond to other issues during times of emergency.

The workshop participants discussed concerns about the impact of increased heat/drought-related events on the City's open space and recreational waterways. Participants suggested that water scarcity and temperature increases can result in a growth in the invasive species populations. This can contribute to the degradation of water quality. The participants also discussed how the City's ongoing effort to protect vulnerable populations from the heat/drought hazard which will become further stressed in the future climate change projection scenarios.



*A small group facilitator leads discussion at a small table during the MVP workshop.*



### Infrastructural Vulnerabilities:

- Transportation: highways and roadways throughout City.  
*Concerns:* managing the heat island effect.
  
- Utilities:
  - drinking water reservoirs,
  - electric power lines and communication infrastructure throughout the City.*Concerns:* managing drinking water reservoir quantity and quality, disrupted emergency communications, power outages (brownouts) and service interruptions.
  
- Buildings:
  - emergency response services/shelters,
  - old and aging housing stock,
  - old and aging schools.*Concerns:* managing thermal regulating components of buildings, lack of air conditioning in shelter locations (high schools' gymnasiums) inadequate energy efficiency of buildings, lack of alternative neighborhood energy options.



## Societal Vulnerabilities:

- Populations:
  - large non-English speaking demographic
  - large homeless population
  - elderly community
  - wide disparity in education levels
  - large environmental justice community.

*Concerns:* inadequate modes of emergency communication and alerts, overstressed municipal services, limited access to recreational areas, transient population with lack of local knowledge on resources and service providers.

- Social Services:
  - public transportation
  - emergency services
  - community centers
  - health care services

*Concerns:* perception of inadequate capacity for sheltering vulnerable populations by some members of the public, overstressed healthcare providers, inequitable access to social services, lack of inclusivity, lacking inter-departmental knowledge sharing and collaboration within city government.



## Environmental Vulnerabilities:

- Water Features:
  - waterways
  - reservoirs
  - wetlands
  - lakes and ponds
  - aquatic life

*Concerns:* combatting invasive species, degrading water quality, limited access to recreational water sources.

- Surface Features:
  - hill topography
  - tree canopy throughout City

*Concerns:* lack of tree shade/tree cover.

- Air Quality:
  - urban forestry
  - residential brush fires

*Concerns:* managing air quality degradation due to brush fires.

## 2.3 Community Vulnerabilities by Feature (Infrastructural, Societal, Environmental)

3 flood-prone infrastructure items:

Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

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

Priority: II-M-L Time: Short Long Ongoing

Features	Location	Ownership	V or S	Hazard	Actions	Priority	Time
<b>Infrastructural</b>							
1. Hospitals & community health centers - need for backup power	Various	D	S	(tornado)	Use as example of BID (Best Practice) - Accessible to all	H	0
2. Hwy Access	West - Street	L/S	S/V	all	2.0. Hwy - roadways emergency route - community ID plan to communicate, public company to	II	3/10
3. Water - sewer (esp. CSO - K to 4 Channing Ave, Amherst)	Various	V	V	group wind	4.1. For the water of above - Planning Council or Public - Stop Discharge of Sewer	M	L/O
4. Electric / Transmission lines - old	Various	V/S	V	group flood	4.2. For the water of above - Planning Council or Public - Stop Discharge of Sewer	M	L/O
5. Power lines / Backup power system	Various	V/S	V	group flood	4.3. For the water of above - Planning Council or Public - Stop Discharge of Sewer	M	L/O
6. Fire Public (LCS), city infrastructure	Various	L/S	V	group flood	4.4. For the water of above - Planning Council or Public - Stop Discharge of Sewer	M	L/O
7. Stormwater	Various	L/S	V	group flood	4.5. For the water of above - Planning Council or Public - Stop Discharge of Sewer	M	L/O
8. Landfills, water treatment, emergency shelter	Various	L/S	V	group flood	4.6. For the water of above - Planning Council or Public - Stop Discharge of Sewer	M	L/O
9. Old housing stock - need for rehab, healthy / safe	Various	R/L	V	group flood	4.7. For the water of above - Planning Council or Public - Stop Discharge of Sewer	M	L/O
10. Schools - need for backup power, emergency shelter	Various	R/L	V	group flood	4.8. For the water of above - Planning Council or Public - Stop Discharge of Sewer	M	L/O
11. Universities - need for backup power, emergency shelter	Various	R/L	V	group flood	4.9. For the water of above - Planning Council or Public - Stop Discharge of Sewer	M	L/O
<b>Societal</b>							
1. Community center, recreation	Various	R/L	V	group flood	1.1. For the water of above - Planning Council or Public - Stop Discharge of Sewer	H	0
2. Fire / safety, police	Various	R/L	V	group flood	1.2. For the water of above - Planning Council or Public - Stop Discharge of Sewer	H	0
3. Emergency sheltering - evacuation routes + signage	Various	R/L	V	group flood	1.3. For the water of above - Planning Council or Public - Stop Discharge of Sewer	H	0
4. Hazardous materials - need for backup power, emergency shelter	Various	R/L	V	group flood	1.4. For the water of above - Planning Council or Public - Stop Discharge of Sewer	H	0
5. Public knowledge / awareness, or existing conditions of hazards	Various	R/L	V	group flood	1.5. For the water of above - Planning Council or Public - Stop Discharge of Sewer	H	0
6. Hazardous materials - need for backup power, emergency shelter	Various	R/L	V	group flood	1.6. For the water of above - Planning Council or Public - Stop Discharge of Sewer	H	0
7. Public transportation - culture	Various	R/L	V	group flood	1.7. For the water of above - Planning Council or Public - Stop Discharge of Sewer	H	0
8. Disaster response - need for backup power, emergency shelter	Various	R/L	V	group flood	1.8. For the water of above - Planning Council or Public - Stop Discharge of Sewer	H	0
9. Public health operations - need for backup power, emergency shelter	Various	R/L	V	group flood	1.9. For the water of above - Planning Council or Public - Stop Discharge of Sewer	H	0
<b>Environmental</b>							
1. Blue space	Various	L	S/V	group flood	1.1. For the water of above - Planning Council or Public - Stop Discharge of Sewer	H	0
2. Wetlands / Green space	Various	L	S/V	group flood	1.2. For the water of above - Planning Council or Public - Stop Discharge of Sewer	H	0
3. Urban tree canopy - need for backup power, emergency shelter	Various	L	S/V	group flood	1.3. For the water of above - Planning Council or Public - Stop Discharge of Sewer	H	0
4. Planning for power / backup power, emergency shelter	Various	L/S	V	group flood	1.4. For the water of above - Planning Council or Public - Stop Discharge of Sewer	H	0
5. A. Construction, conservation in projects	Various	L/S	V	group flood	1.5. For the water of above - Planning Council or Public - Stop Discharge of Sewer	H	0
6. B. Public design, sustainable design, backup power, emergency shelter	Various	L/S	V	group flood	1.6. For the water of above - Planning Council or Public - Stop Discharge of Sewer	H	0
7. Planning for Wildfire / Drought	Various	L/S	V	group flood	1.7. For the water of above - Planning Council or Public - Stop Discharge of Sewer	H	0
8. Blackstone River - Mill Park	Various	L/S	V	group flood	1.8. For the water of above - Planning Council or Public - Stop Discharge of Sewer	H	0

An example of a completed matrix of features, hazards, and action items for one (of six) small group during the workshop.

### Infrastructural Vulnerabilities

#### Energy Infrastructure

The workshop participants expressed concern about energy systems reliability decreasing due to the impacts of climate changes and changing patterns in energy use. Energy consumption will play a role in the level of stress placed on the energy infrastructure systems during these future climate change scenarios. Climate change will likely increase the number of days that buildings will require cooling and decrease the number of days that buildings require heating. The energy systems will experience an increased frequency of stressed periods, especially during the peak demand hours of the summer and winter months. Additionally, increased frequency and intensity of winter storm events will exacerbate the risk of failure for aboveground infrastructure including electrical transmission lines, and particularly those in close proximity to trees.

Workshop participants identified another concern in the lack of alternative energy power supply options or backup generators at critical City-owned facilities that may also be used as emergency shelters. The loss of electrical power could prevent these critical facilities from providing vital social services and public health support to vulnerable populations and the Worcester community as a whole.

The City has a mix of aboveground and underground energy infrastructure. Participants expressed that both types were vulnerable to climate change. Underground energy infrastructure is vulnerable to flooding while aboveground assets are vulnerable to ice and fallen trees from strong winds.

### ***Transportation Infrastructure***

Workshop participants identified concerning vulnerabilities in the transportation system with a specific focus on a few key locations most vulnerable to identified climate hazards. The reliability of WRTA bus services is vulnerable to flooding and participants were concerned about the potential impacts on life-safety and the local economy. Flooding and snowstorms are likely to increase roadway accidents, disrupt emergency response, and accelerate roadway degradation. The participants mentioned concern in the continuity of commuter rail service because of the residents who rely on the regional transportation system to commute to and from work in Boston and other areas. It was also noted that many of the roadway routes are exposed to flooding and this would impact the commutes of the Worcester community. Participants also reported that some roadway drainage systems are not adequately sized or designed for future extreme rainfall events.

### ***Communication System***

The lack of redundancy in the emergency communication system was a concern voiced by many workshop participants. Current emergency communication protocol requires citizens whose primary numbers are cell phones to “opt-in,” which limits the reach or effectiveness of the City’s messaging in an emergency. (Citizens with land-lines can be notified using a reverse 911 feature within the notification system). Additional avenues of communication require coordination between various emergency responders, multiple City departments, city organizations and groups, and the applicable state and federal agencies.

## **Environmental Vulnerabilities**

### ***Water Quality***

The water quality of surface water features, such as rivers, streams, and ponds, was identified by workshop participants as a concern for the community due to Worcester's industrial past. The groups discussed groundwater contamination issues from current and former factory sites. The participants believe that the water bodies adjacent to these industrial sites were particularly vulnerable during extreme precipitation events. They discussed how increased groundwater flow due to precipitation may transport contaminants from the soils and into the waterways. Participants then mentioned how some residents may lack adequate education about how their actions impact water quality. Participants also expressed concerns about sewer contamination from the combined sewer overflows in the wastewater collection system during heavy rainfall events.

### ***Trees and Vegetation***

Many cities like Worcester do not have enough vegetation to combat the urban heat island. Lack of urban tree canopy is a special concern in those areas that have high impervious surfaces and are in environmental justice areas where residents may not otherwise have access to shade and cooling.

Participants expressed concerns related to the risk of non-native species thriving in the warmer future conditions of Worcester.

Proper tree management was also a concern for workshop participants. Existing trees in poor health are a greater risk to nearby energy infrastructure and the general safety of the community because impaired root systems or branches are more susceptible to uprooting or breaking during a storm event.



*High amount of impervious surfaces and low tree canopy in the City's business districts.*

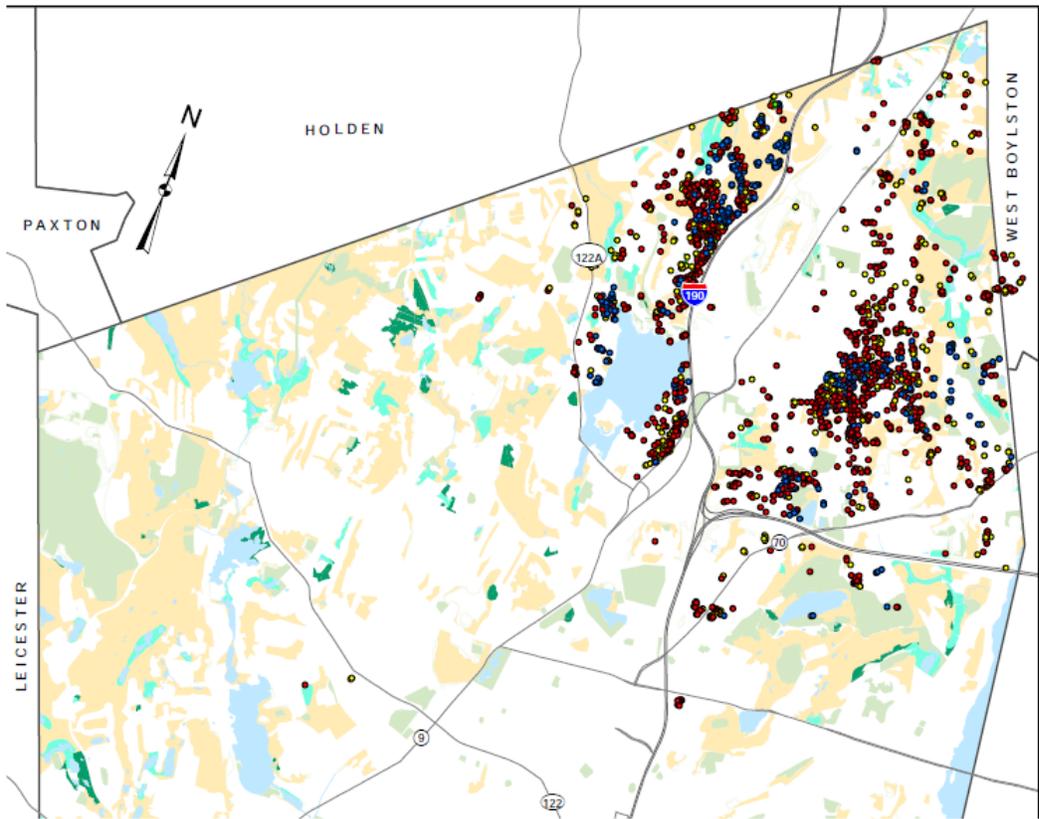


Figure 7: Infected trees by Asian Longhorned Beetle. The infected trees have been removed and consequently replanted with 30,000 new trees, by City of Worcester, Worcester Tree Initiative, and volunteers.

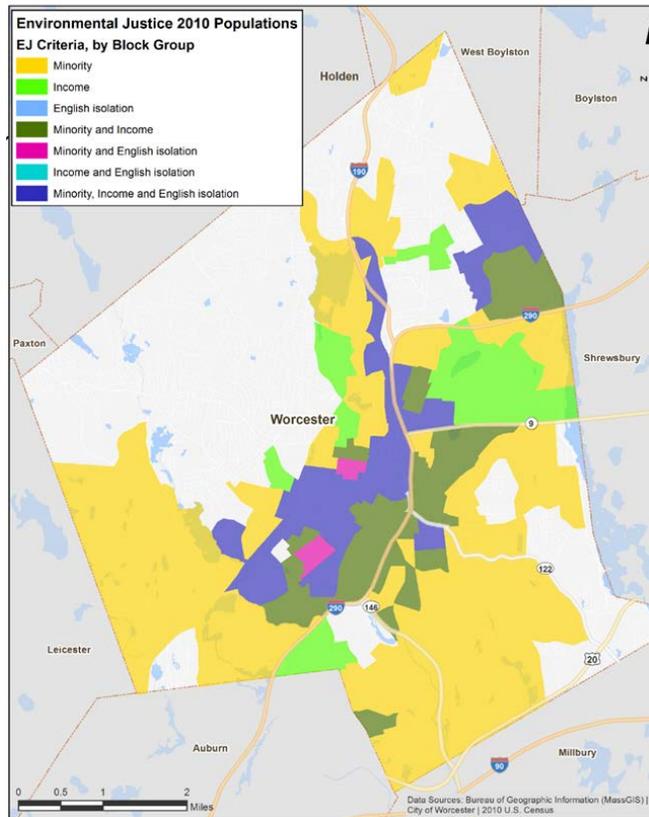
Source: Worcester Open Space & Recreation Plan, 2013. Figure 6a.

## **Societal Vulnerabilities**

### ***Vulnerable Populations***

Workshop participants discussed their concern for the vulnerable populations in Worcester. According to the census data and emphasized during the workshop, the City has a large and growing population of residents living at or below the poverty line and residents who are foreign-born. These demographic groups disproportionately depend on municipal and social services, such as bus transit, affordable housing, translation of emergency messages and notifications into their native languages, and access to medical services. Increasing climate hazards may disrupt these services. Vulnerable populations also face heightened health risks from exposure to climate hazards (such as extreme heat or cold), disruptions to utility services, and the burden of increased heating and cooling cost.

### **Environmental Justice Populations Map**



### ***Municipal Facilities***

Worcester's municipal buildings were identified by participants during the workshop as being vulnerable to several climate hazards. For example, some buildings' poor resiliency to the extreme heat related to the lack of proper air conditioning systems. Their poor resiliency to the extreme cold related to having inadequate heating systems. Certain environmental justice populations are particularly reliant on schools to be the primary form of childcare during work hours. Participants agreed that the impacts of school closures due to inadequate building systems are felt financially even more so by these populations. Participants also voiced a concern about the adequacy of certain school buildings if they are used as emergency shelters (e.g. lack of air conditioning in most schools preventing them from being used as shelters during heat waves).

## 2.4 Summary of Community Strengths and Assets

When planning for resiliency in the face of extreme weather events, the strengths of a community provide a strong foundation for gathering support and implementing change. The following list captures the wide range of strengths and assets identified by workshop participants to contribute to improved community resiliency:



- The City is interested in and committed to building resiliency, as demonstrated by the participation of a broad swath of stakeholders in the workshop. This stakeholder community can provide support to on-going efforts and maintain the momentum for implementation of next steps.
- The City has collaborative residents, well-informed municipal staff, and numerous available public facilities that can be leveraged in an emergency to facilitate emergency response as well as resiliency building measures.
- The City has a team of dedicated staff focused on implementing emergency response protocols and improving resiliency throughout the City.
- The City has numerous recreational open spaces and waterways throughout the City that can be enhanced to contribute to resiliency.
- The City already has a comprehensive transportation and roadway network that can be improved upon to further contribute to resiliency and facilitate emergency response.
- The City has an extensive and robust water supply reservoir system that can be enhanced to mitigate the impacts of drought-related events.
- The City's current efforts towards urban forestry management and wetlands conservation can be leveraged to facilitate enhanced resilient solutions to mitigate the City's natural hazards.

### 3. Recommendations to Improve Resilience

In the second part of the workshop, Kleinfelder presented examples of community resilience actions potentially relevant to Worcester (**Appendix A**). Participants then worked in small groups to generate lists of potential actions to reduce Worcester’s vulnerabilities and reinforce its strengths. Participants were asked to consider whether the actions address multiple hazards, whether there were intermediate steps, whether proposed actions strengthened existing initiatives, and then to factor in cost. Next, the small groups prioritized actions and differentiated them as short-term, long-term, or ongoing. As a final step of the CRB Workshop small group sessions, each group was asked to identify their top three recommendations to improve Worcester’s resilience to the identified climate hazards.

#### 3.1 Prioritized Recommendations

The following list of prioritized recommendations was generated from the workshop participant discussions and is intended to provide guidance on the City’s follow-up actions and next steps. This list was presented to attendees at the Listening Session held on June 13, 2019 at Worcester City Hall.

#### Priority Actions for Infrastructure Resiliency

*Action A: Invest in Improved Management and Maintenance of the City’s Stormwater System*

- Conduct **system wide hydrologic/hydraulic drainage evaluation and modeling** to ensure projects effectiveness, and make project prioritization.
- Develop **comprehensive flood mitigation solutions** for the City’s recurring flooding problems.
- Proceed with in-depth **analysis of the most at-risk areas to flooding** under future climate scenarios identified in the workshop preliminary analysis (see Appendix B).
- Consider **design options for the underground Blackstone canal** to address the recurring flooding in the Green Island area as it is located in a vulnerable floodplain and is home to many low-income residents.

*Action B: Investigate a stormwater enterprise fund/stormwater utility fee to support enhanced stormwater management initiatives*

- Establish a credit to **incentivize green infrastructure**, porous pavement.

*Action C: Prioritize green infrastructure projects to mitigate urban heat island and reduce flooding*

- Implement in areas adjacent to public right-of-way for dual benefits.

*Action D: Develop a public outreach and education initiative*

- Continue to educate residents on ways to **mitigate the occurrence of frozen pipes** related to extreme cold.
- Continue to promote **water conservation** amongst residents during droughts for in-home use and for landscaping.
- Promote **adopt a catch basin** program.

*Action E: Implement adaptation/resiliency strategies to harden critical city-owned buildings*

- Identify community schools within neighborhoods to test **micro-pilot programs** and techniques.
- Proceed with an **assessment of Worcester public schools** to address their heating and energy performance and become more resilient to extreme heat and cold. In the process, the buildings will be more efficient and sustainable (work on insulation problems and heat leaks).
- Identify the best location in City-owned buildings for **emergency shelters/resiliency hubs** with generators or other onsite power for emergency resources.
- Create a **resilient building scoring system** to prioritize building improvements and inform capital planning.

*Action F: Advocate and assist in creating a resilient transportation network*

- Advocate that **WRTA and MBTA create and implement reliable contingency plans** for commuters during extreme events.
- Identify **bus routes at risk of flooding** and develop a contingency plan for emergency route plan.
- Design and install **bus shelters** at popular bus stops where riders would be **vulnerable** to extreme heat or extreme cold exposure.

*Action G: Assess the vulnerability of drinking water supply to future drought conditions*

- Study impacts of increased development and increased incidence of **summer droughts** on existing water supply.
- Develop a public **education** program on the **protection of potable water**, “what we drink.”



## Priority Actions for Societal Resiliency

### *Action A: Initiate an education program/campaign about climate change*

- Use **effective communication strategies**, including the City's website and social media, for public information related to **preparedness**.
- Develop a program for education on **awareness of climate change** impact and possible preparedness measures; e.g. talk to your neighbors and help others.

### *Action B: Improve the City's emergency planning to incorporate climate change*

- Determine if designated **shelters** are adequate and not vulnerable to current and future flooding.
- Identify strategies in partnership with kids for **engaging families with limited English** proficiency.
- Reach out to people through **emergency messaging** (opt-in vs all-in) focusing on identified neighborhoods with most **at risk populations**.
- Implement a **flashing light warning system** for snow emergencies.
- **Expand social media use** to communicate before/during/ after weather-related emergencies.
- Create a **resiliency network** to reach isolated populations.
- Create a **sheltering plan** (including heating/cooling) **and communication** plan to inform residents of an emergency and knowing what resources are available and where to go during an emergency, especially for most vulnerable populations.
- Create or confirm an **emergency plan for assisted living and affordable housing residents** (e.g. public health department and first responders).

### *Action C: Empower renters and property owners to prepare for climate change*

- Develop education that is specific to **renters and property owners** to ensure everyone can prepare.
- Create a registration for **landlord license** and checklist to improve resiliency and protect renters.

## Priority Actions for Environmental Resiliency

### *Action A: Protect open space and water resources*

- Develop a detailed study to **assess the possible impact of climate change on the City's natural resources**.
- Study options for implementing **regulatory controls or policy changes addressing climate change** (ex: legal mechanisms to promote green infrastructure, and protect open space areas).
- Continue to **protect water resources** from contamination from industrial properties by providing **education** on best practices.
- Provide education on **upland fertilizer usage** at higher elevations that seeps down to lower neighborhoods and waterways as more frequent extreme precipitations will add stress to the water system and will increase the risk for contamination.
- Require **green infrastructure** as part of all new development to reduce urban heat during extreme heat event and also increase stormwater retention/ filtering on site.

### *Action B: Improve waste collection practices*

- Educate the community about special measures; "what to do" for **waste collection** during flooding/heat.
- Implement a City-wide **food composting** program.

### *Action C: Improve the tree canopy*

- Continue to support the **Right Tree, Right Place** program.
- Create and adopt a **tree replacement policy**, including addressing tree pruning and maintenance.



## 3.2 Other Potential Actions of Lower Priority

The following list captures other potential actions identified by workshop participants in small group discussions, ranked as of lower priority.

### Infrastructure

- Continue to develop a prioritization for the **sewer separation program**.
- Investigate **Cambridge Street low overpass** combined with drainage improvements.
- Continue to **evaluate dams** for assessment/elimination/redundancy.
- Coordinate with National Grid to improve **energy resiliency** by promoting and supporting a **microgrid**.
- Develop an inventory of **retaining walls** and perform a condition assessment.
- Develop a comprehensive “**complete streets**” inventory to identify projects for grant funding.
- Add **splash pads** to community parks.
- Assess the vulnerability of the **Senior Center**.
- Establish a **betterment tax** for properties along **flooding** route.

### Societal

- Provide a training program for municipal staff with a **community advisory board** to increase **access and knowledge of city/local/regional resources available to residents**, especially those new to the city and immigrants, including through marketing/outreach material and website content to reduce language barriers and improve access to informational services.
- Expand and improve **WRTA service** to provide community greater community resilience and equity.
- Lobby the State to improve how the **building code incorporates resiliency**.
- Provide **high water and fast water training and equipment** for emergency responders, including fire/police.
- Provide **multiple language translations** for all public outreach materials.
- Provide **multidisciplinary training** for non-profits, religious organizations, etc.

## Environmental

- Determine if it is feasible to purchase **repetitive loss properties** for stormwater retention/storage.
- Develop a **wetlands migration and improvement plan**.
- Investigate if **zoning ordinances** could accommodate development based on **microclimates**.
- Study the **daylighting of Beaver Brook**.
- Evaluate whether **wind power** is feasible at tops of hills to increase the City's energy resiliency.
- Create an **open space management plan** (if one does not exist).
- Cap **brownfield sites** to prevent infiltration and possibly allow for full redevelopment in a resilient way.

### 3.3 Findings from the Public Listening Session

The City held a Public Listening Session on June 13, 2019 at Worcester City Hall. The presentation and subsequent dialogue with participants were led and facilitated by City staff members:

- Luba Zhaurova (from the City's Energy and Asset Management Division), and
- Stefanie Covino (from the City's Planning and Regulatory Services Division).

Members of the public in attendance to the listening session were engaged by the presentation. The public appeared supportive of the MVP planning process and generally agreed with climate change-related issues presented.

The public provided certain suggestions and recommendations to the City including:

- Ensuring that multilingual strategies for public outreach are implemented and vulnerable populations have access to the critical climate change related information they need.
- Providing maps showing the geographic location of specific vulnerabilities and indicating any hotspots or neighborhoods that impact the types of vulnerabilities experienced.
- Improving interdepartmental communication and understanding between City divisions.
- Focusing on the "Right Tree Right Place" initiative to ensure that trees are not interfering with utility power lines and solar power installations.

## 4.1 Project Team and Workshop Participants

### Project Team

City of Worcester, Energy and Asset Management Division:

- John Odell (Director, Worcester Energy and Asset Management)
- Luba Zhaurova (Sustainability Project Manager, Worcester Energy and Asset Management)

Kleinfelder Team:

- Nathalie Beauvais (Facilitator, Project Manager, MVP Certified Provider)
- Jonnas Jacques (Facilitator, Assistant Project Manager)
- Indrani Ghosh (Facilitator, MVP Certified Provider)
- Robin Seidel (Facilitator, MVP Certified Provider)
- John Rahill (Facilitator)
- Darrin Punchard (Punchard Consulting, Facilitator)

Core Group:

- Luba Zhaurova (Worcester Energy and Asset Management)
- John Odell (Worcester Energy and Asset Management)
- Meghan Gomes (Worcester Emergency Communications & Management)
- Michael Shanley (Worcester Emergency Communications & Management)
- James Brooks (Worcester Housing Development)
- Stefanie Covino (Worcester Planning & Regulatory Services)
- Michelle Smith (Worcester Planning & Regulatory Services)
- James Bedard (Worcester Public Schools)
- Matthew Labovites (Worcester Public Works & Parks – Operations)

## Workshop Participants and Affiliation

<u>Participant Name</u>	<u>Affiliation (Role)</u>
Robert Antonelli	Parks Division Assistant Commissioner, DPW&P City of Worcester
Bruce Augusti	MEMA
Steven Bandarra	Sustainability Coordinator Worcester State University
James Bedard	Director of Environmental Management & Capital ProjeWorcester Public Schools
James Brooks	Director City of Worcester, EOED - Housing Development Division
Susan Buchan	Director of Energy Projects E4TheFuture
John Cannon	Director of Facilities Operations Holy Cross
Michael Carroll	Director of Sustainability Worcester Academy
Deborah Cary	Executive Director Mass Audubon
Matilde Castiel	Commissioner of Health & Social Services Department City of Worcester
Peter Coffin	Blackstone River Coalition
Dante Comparetto	Member of the Worcester School Committee; MPA student (Scribe)
Stefanie Covino	Conservation Planner, City of Worcester, EOED - Planning & Regulatory Services Division (Facilitator)
Jill C. Dagilis	Executive Director of Worcester Community Action Council
Kevin Dandrade	Vice President TEC, Inc.
Jeuji Diamondstone	Community organizer and writer
Kristin Divris	Water Utility Resilience Program MassDEP
Martin Dyer	City of Worcester Fire Department
Mike Freeman	Assistant Director of Transportation Worcester Public Schools
Jonathan Gervais	Environmental Manager City of Worcester, DPW&P
Karin Valentine Goins	WalkBike Worcester
Meghan Gomes	Preparedness Coordinator City of Worcester, Emergency Communications & Management
Isabel Gonzalez-Webster	Director Worcester Interfaith
Andrea Gossage	Community & Customer Manager, MA Jurisdiction National Grid
Mary Beth Harrity	Tatnuck Brook Watershed Association
Etel Haxhijaj	Massachusetts Community Organizer and Worcester Resident, Mothers Out Front
Carolyn Howe	Friends of Patch Reservoir
Jenny Isler	Director of Sustainability at Clark University
Lorraine Laurie	Green Island Neighborhood Group
Andrew Loew	Project Manager CMRPC
Sean M. Lovely	City of Worcester, Police Department
Samuel Martin	Worcester Youth Center
Paul P. Mathise	Director of Sustainability Worcester Polytechnic Institute
Timothy J. McGourthy	Executive Director of Worcester Research Bureau

<b>Participant Name</b>	<b>Affiliation (Role)</b>
Ed McKeon	Coes Zone Task Force
Gaylen Moore	Worcester Resident Mothers Out Front
John Odell	Director City of Worcester, Energy and Asset Management Division
Peter Peloquin	Planning Assistant CMRPC
Rob Pezella	Director of School Safety Worcester Public Schools
Stephen Rolle	Assistant Chief Development Officer – Division of PlannCity of Worcester
Joe Sancoucy	Department of Inspectional Services
Jacob Sanders	Intergovernmental and Municipal Initiatives City of Worcester, Office of the City Manager
Errica Saunders	350 Central Mass
Michael E. Shanley	Acting Director of Emergency Communications & Management
Michelle Smith	Chief Planner City of Worcester, EOED - Planning & Regulatory Services Division
Vincent Sullivan-Jacques	Director of Volunteer Outreach and Community Engage Assumption College
Liz Tomaszewski	Associate Director of Sustainability Worcester Polytechnic Institute
Jeanette Tozer	Senior Project Manager EOED - Special Projects
Joe Wanat	City of Worcester Zoning Board Member (Vice-Chair)/Engineer at VHB
Ari Winograd	Planning and Operations Coordinator, City of Worcester, Division of Public Health/Central MA Regional Public Health Alliance

## 4.2 Citations and References

### Citation

City of Worcester (2019), Municipal Vulnerability Preparedness Plan: Community Resilience Building Workshop Summary of Findings & Recommendations. City of Worcester and Kleinfelder. Worcester, Massachusetts.

### References

*Massachusetts Integrated State Hazard Mitigation and Climate Adaptation Plan*, Massachusetts Emergency Management Agency (MEMA), September 2018.

<https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf>

*Worcester Hazard Mitigation Plan Update* [Last Revised – March 2019], Prepared by the Central Massachusetts Regional Planning Commission. <http://www.cmrpc.org/worcester-hazard-mitigation-plan>

*Resilient MA Climate Clearinghouse* (data as of January 2019). <http://resilientma.org/>

# Appendix A

Presentation from the Community Resilience Building  
Workshop (1/25/2019)



# WORCESTER COMMUNITY RESILIENCE BUILDING WORKSHOP

JANUARY 25, 2019



# I. WORKSHOP AGENDA

<b>I.</b>	<b>Arrival / Light breakfast</b>	8:00 am
<b>II.</b>	<b>Welcome and agenda overview</b> Luba Zhaurova, Sustainability Project Manager, City of Worcester	8:30 am
<b>III.</b>	<b>Opening remarks</b> Edward M. Augustus Jr., Worcester City Manager	8:45 am
<b>IV.</b>	<b>Kick-off / Participants Introductions</b> Led by the Kleinfelder team	9:00 am
<b>V.</b>	<b>Hazards</b> <ul style="list-style-type: none"><li>○ Presentation (by Kleinfelder)</li><li>○ Large group discussion – determine the highest priority hazards</li></ul>	9:30 am
<b>VI.</b>	<i>Break</i>	10:30 am
<b>VII.</b>	<b>Community Strengths and Vulnerabilities</b> <ul style="list-style-type: none"><li>○ Presentation (by Kleinfelder)</li><li>○ Small groups’ exercise (infrastructural, societal, environmental)</li><li>○ Small groups present findings</li></ul>	10:45 am
<b>VIII.</b>	<i>Lunch</i>	12:00 pm
<b>IX.</b>	<b>Community Actions</b> <ul style="list-style-type: none"><li>○ Presentation (by Kleinfelder)</li><li>○ Small groups’ exercise</li></ul>	1:00 pm
<b>X.</b>	<i>Break</i>	2:00 pm
<b>XI.</b>	<b>Priority Actions</b> <ul style="list-style-type: none"><li>○ Small groups’ exercise (identifying overall priority actions using a risk matrix)</li><li>○ Small groups present findings</li><li>○ Large group identifies highest priority actions; defines 6 locations for further risk &amp; vulnerability assessments</li></ul>	2:15 pm 3:00 pm 3:30 pm
<b>XII.</b>	<b>Summary and Closing</b>	3:50 pm-4pm

# WHAT IS CLIMATE CHANGE?

Visit [www.resilientma.org](http://www.resilientma.org) to learn more!



resilient MA

Climate Change Clearinghouse for the Commonwealth

Explore Sectors

Identify Changes

Take Action

Maps Data Documents

Search for resources...

Search

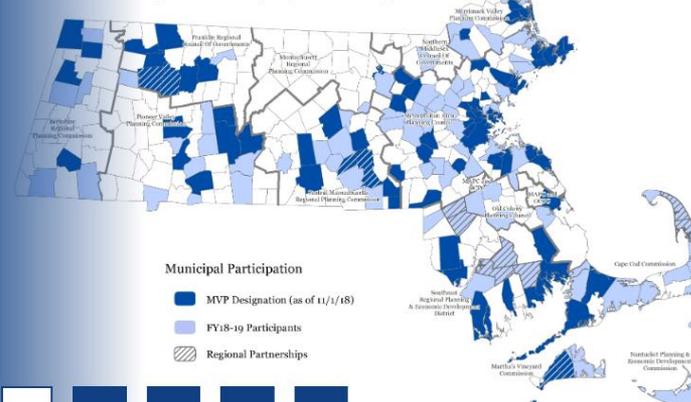
Providing the most up-to-date climate change science and decision-support tools for the Commonwealth. [More »](#)

## Municipal Vulnerability Preparedness

Our cities and towns are on the front lines of climate change. The new MVP program from the Executive Office of Energy and Environmental Affairs works with communities across the state to decrease risk, build resiliency, and identify strengths and opportunities through targeted planning and action.

[More »](#)

Municipal Vulnerability Preparedness Program



# WHAT IS CLIMATE CHANGE?

Visit [www.resilientma.org](http://www.resilientma.org) to learn more!

## Climate Change Projections for Massachusetts

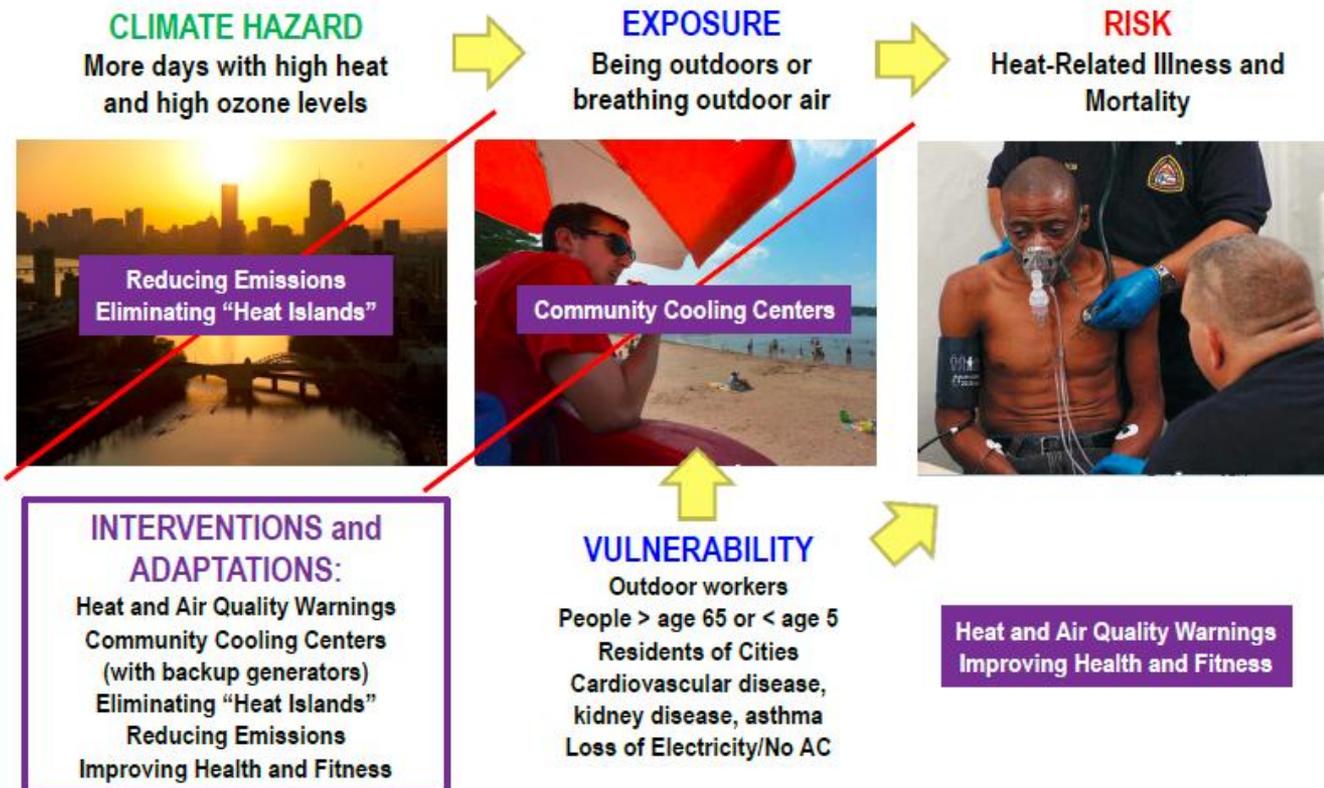
CLIMATE CHANGES	RELATED NATURAL HAZARDS	PROJECTIONS BY THE END OF THIS CENTURY
<b>Changes in precipitation</b> 	<ul style="list-style-type: none"> <li>- Inland flooding</li> <li>- Drought</li> <li>- Landslide</li> </ul>	<ul style="list-style-type: none"> <li>- Annual precipitation: Increase up to 16% (+7.3 inches)</li> <li>- Days with rainfall accumulation 1+ inch: Increase up to 57% (+4 days)</li> <li>- Consecutive dry days: Increase 18% (+3 days)</li> <li>- Summer precipitation: Decrease</li> </ul>
<b>Sea level rise</b> 	<ul style="list-style-type: none"> <li>- Coastal flooding</li> <li>- Coastal erosion</li> <li>- Tsunami</li> </ul>	<ul style="list-style-type: none"> <li>- Sea level: Increase 4.0 to 10.5 feet along the Massachusetts coast</li> </ul>
<b>Rising temperatures</b> 	<ul style="list-style-type: none"> <li>- Average/extreme temperatures</li> <li>- Wildfires</li> <li>- Invasive species</li> </ul>	<ul style="list-style-type: none"> <li>- Average annual temperature: Increase up to 23% (+10.8 degrees Fahrenheit)</li> <li>- Days/year with daily minimum temperatures below freezing: Decrease up to 42% (-62 days)</li> <li>- Winter temperatures: Increase at a greater rate than spring, summer, or fall</li> <li>- Long-term average minimum winter temperature: Increase up to 66% (+11.4 degrees Fahrenheit)</li> <li>- Days/year with daily maximum temperatures over 90 degrees Fahrenheit: Increase by up to 1,280% (+64 days)</li> <li>- Growing degree days: Increase by 23% to 52%</li> </ul>
<b>Extreme weather</b> 	<ul style="list-style-type: none"> <li>- Hurricanes/tropical storms</li> <li>- Severe winter storms/nor'easters</li> <li>- Tornadoes</li> <li>- Other severe weather</li> </ul>	<ul style="list-style-type: none"> <li>- Frequency and magnitude: Increase</li> </ul>

Note: This plan also assesses earthquakes, but there is no established correlation between climate change and earthquakes.  
 Source of Climate Change Projections: Northeast Climate Adaptation Science Center at the University of Massachusetts, Amherst.

# HOW WE ARE ADAPTING?

Visit [www.resilientma.org](http://www.resilientma.org) to learn more!

## How Adaptations and Interventions Work



# INTRODUCE YOURSELVES!

- Name
- Affiliation
  - *(department, organization, business, resident, etc.)*

# GROUND RULES

1. Everyone must participate (and listen)
2. Everyone's input is equally valued
3. Disagree without being disagreeable
4. No side conversations
5. Stay on topic

# NATURAL HAZARDS

## Community Resilience Building Risk Matrix



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

www.CommunityResilienceBuilding.org

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

# 1

Features					Actions					Priority		Time	
Location	Ownership	V or S	Hazard		Actions					H - M - L	Short Long	Ongoing	
Keep in mind that the prioritized features will be used in the <b>Task 2 – Risk and Vulnerability Assessments</b>													
<b>COMMUNITY STRENGTHS AND VULNERABILITIES</b>					<b>COMMUNITY ACTIONS</b>					<b>PRIORITY ACTIONS</b>			
<div style="display: flex; justify-content: space-between; width: 100%;"> <span>Part 1</span> <span>Part 2</span> <span>Part 3</span> </div>													

# II. HAZARDS AND THEIR IMPACTS

What are Worcester's past, current, and future hazards?



Heavy  
Rainfall



Ice/Snow  
Storms



Wind



Brush Fires



Extreme  
Heat



Drought

# IDENTIFIED HAZARD 1:



# HEAVY RAINFALL



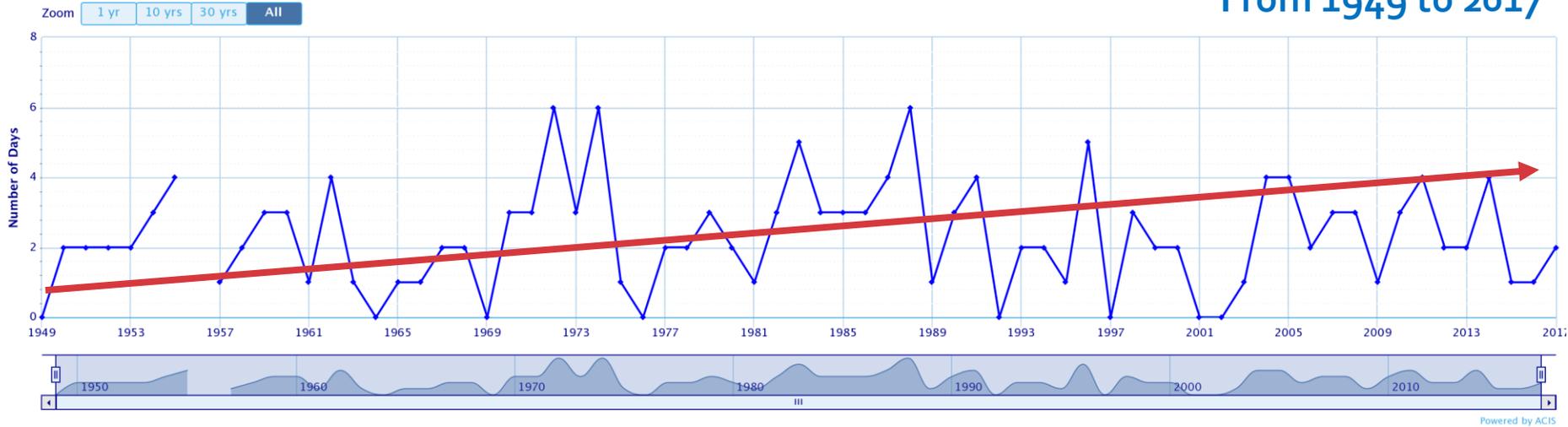


# HEAVY RAINFALL – HISTORICAL DATA

Number of Days Precipitation  $\geq$  2 in – Jan through Dec – WORCESTER, MA

Use navigation tools above and below chart to change displayed range

From 1949 to 2017

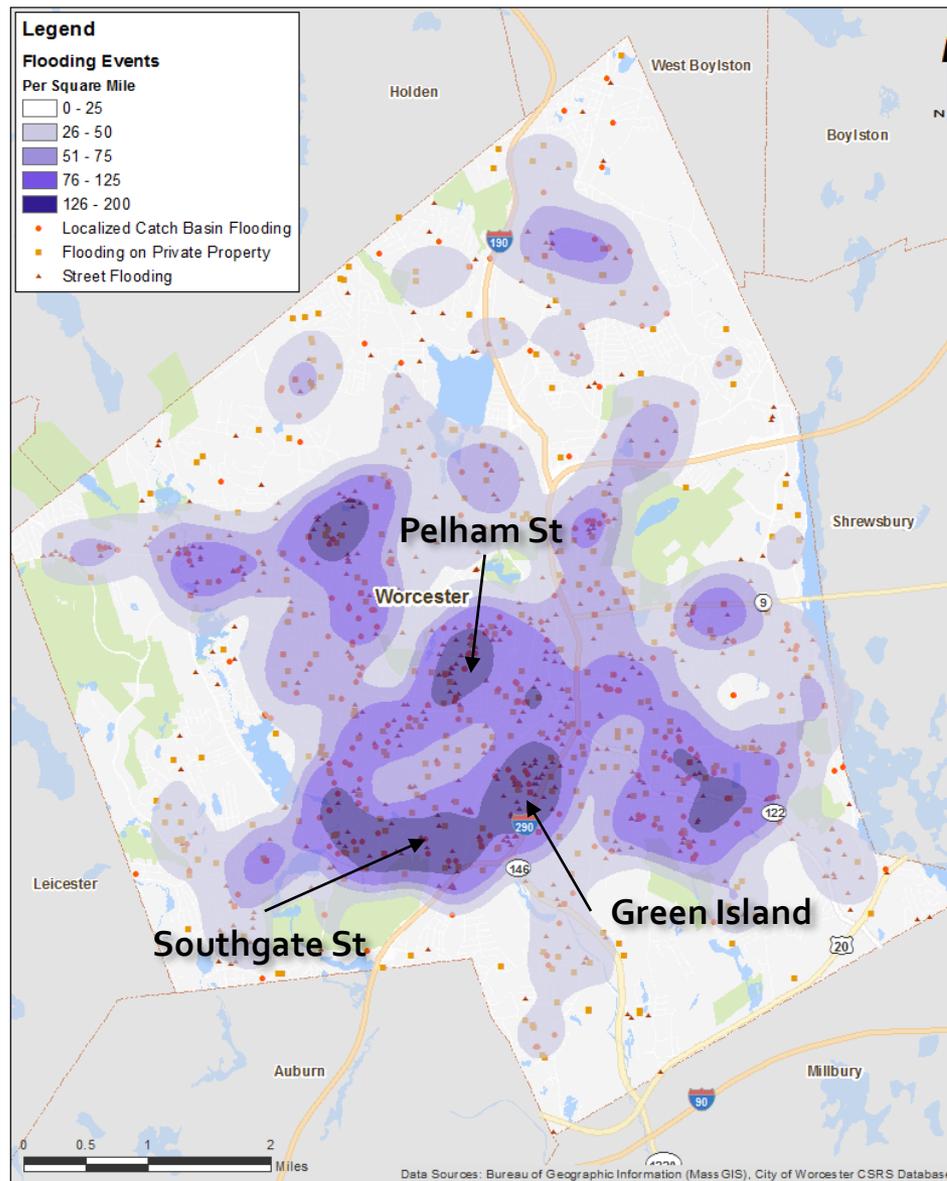


Two types of rainfall flooding:

- Overbank flooding from rainfall / snowmelt
- Piped Infrastructure backup / failure (Culverts, CSO, SSO)



# HEAVY RAINFALL – HISTORIC FLOODING EVENTS



Concentration of Reported Flooding Events

- Heavy rainfall already causes flooding in Worcester.
  - Green Island (Elsworth St, Quinsigamond Ave)
  - Pelham St (small area, localized flooding)
  - Southgate St (near Green Island, failing infrastructure and erosion issues)
- Impacts: infrastructure, property damage, loss of life/injury, natural resources.

*Note: Map based on the Worcester's Customer Service Request System (CSRS) data for flooding events 2006-2016.*

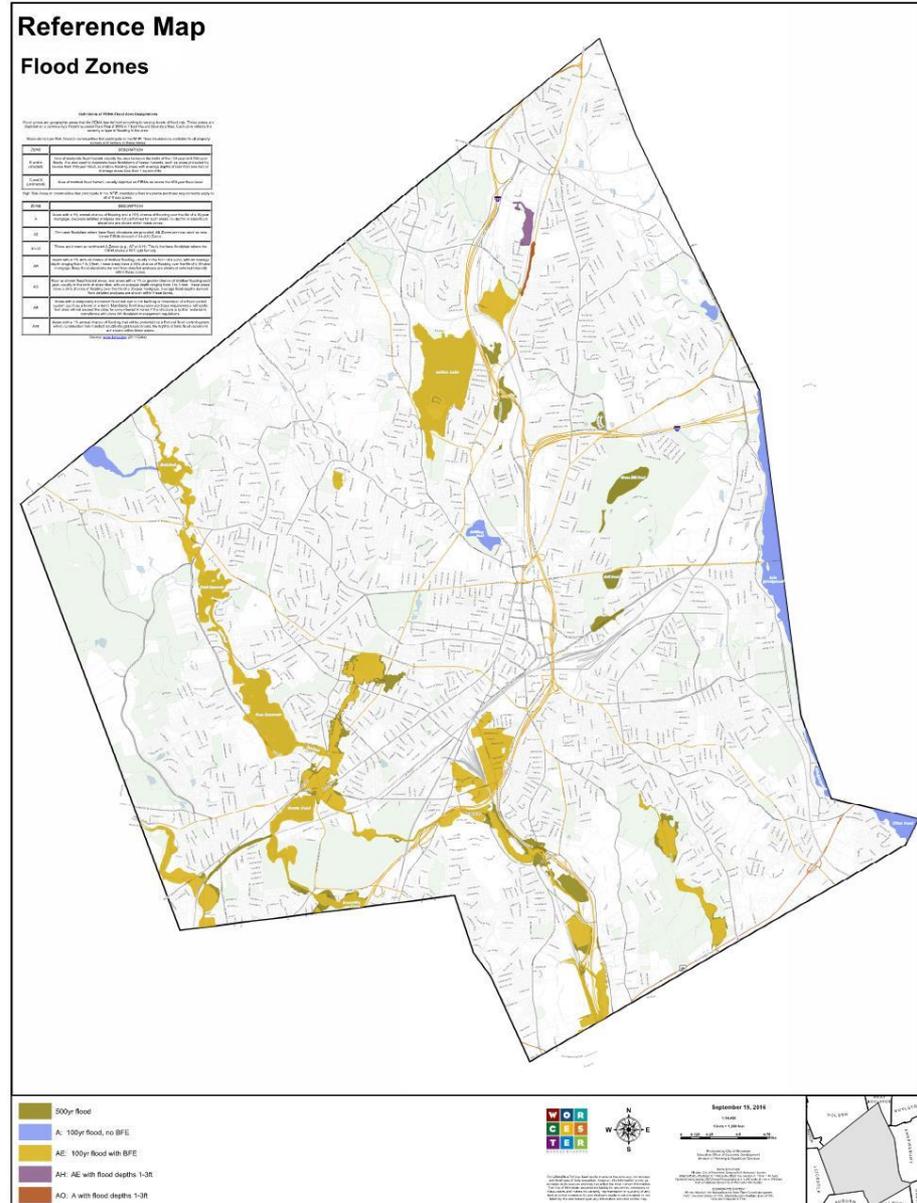
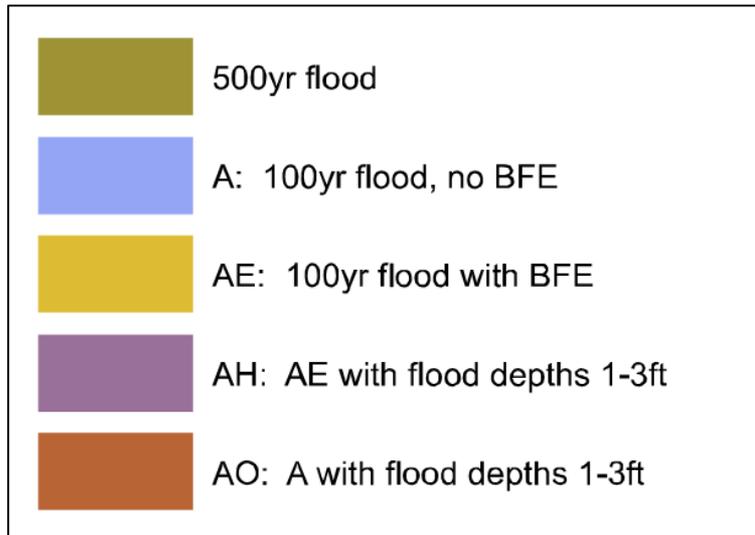


# HEAVY RAINFALL – FEMA FLOOD ZONES

FEMA flood zones are based on probabilities of future flooding events.

- Example: A 100-year flood is an event that has a 1% probability of occurring in any given year (500-year flood has 0.2% probability).
- These zones are used by communities to set building and flood insurance requirements.

Source: [https://www.fema.gov/disaster/updates/fema-flood-zones-explained](https://www.fema.gov/disaster/updates/fema-flood-maps-and-zones-explained)



Source: <http://www.worcesterma.gov/planning-regulatory/boards/conservation-commission>



# HEAVY RAINFALL – PIPED INFRASTRUCTURE FLOODING

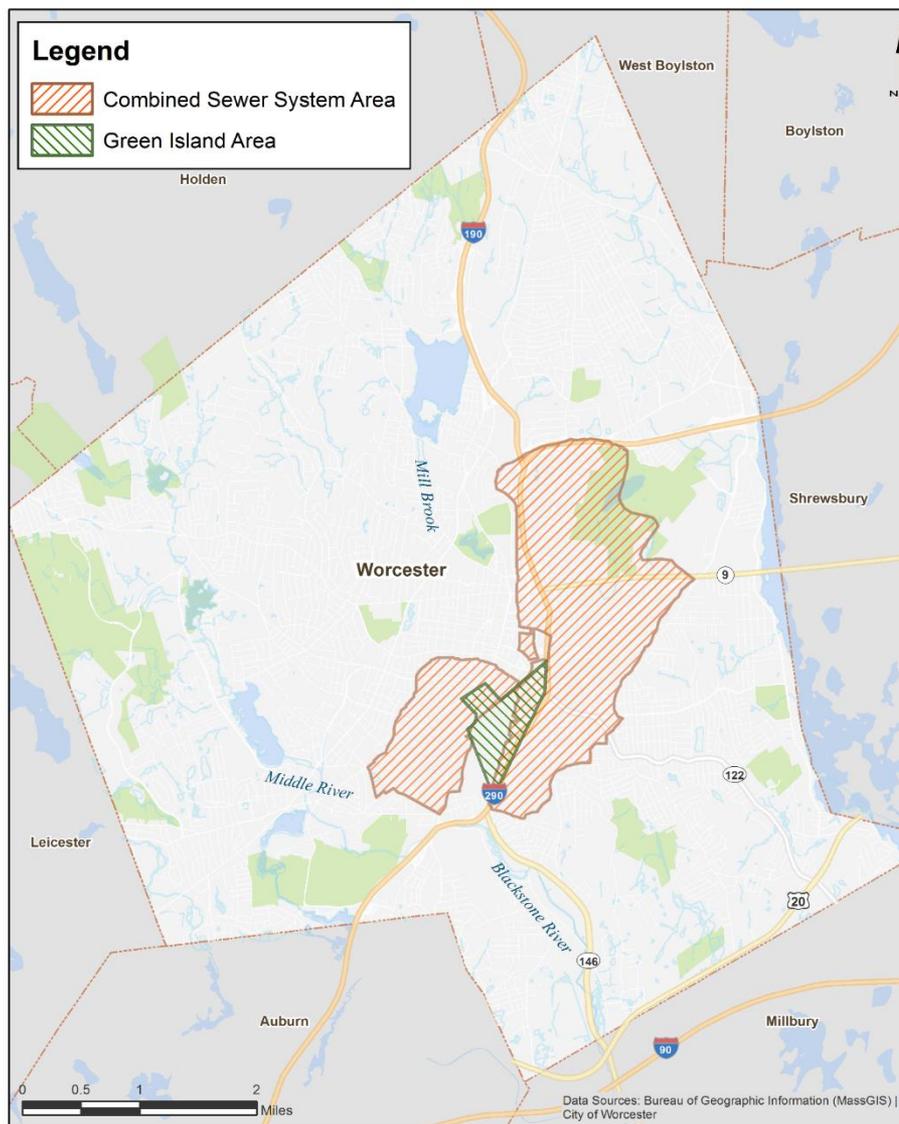
## Sewer backups are an issue in Worcester

- ~400 miles of sewer pipeline in the city
- ~60 miles of combined sewer pipes in the city
- Old pipe infrastructure: combined sewer and drain (CSO) makes up about 15 % of wastewater collection system area (about 4 mi sq), but 60% of the total system flow is generated in the combined system.
- CSO piping increases chance of backup during wet weather because of increased stormwater runoff.





# HEAVY RAINFALL – COMBINED SEWER INFRASTRUCTURE



- Combined sewer areas (in brown) are located near populated areas of the city.
- Locations are vulnerable to Combined Sewer Overflows (CSOs).
- Green Island (in green) area is particularly susceptible given its topography.

Combined sewer infrastructure map



# HEAVY RAINFALL – GREEN ISLAND



Projected Locations of Flooding in the Green Island Area

Source: CDM Smith Green Island Area Flooding Study, May 2016

The Green Island area is highly susceptible to flooding events.

- Lowest elevation in the city.
- Situated at the confluence of Mill Brook and Middle River.
- Large portion lies within FEMA flood zone.
- Combined sewer infrastructure.
- Area is densely populated.

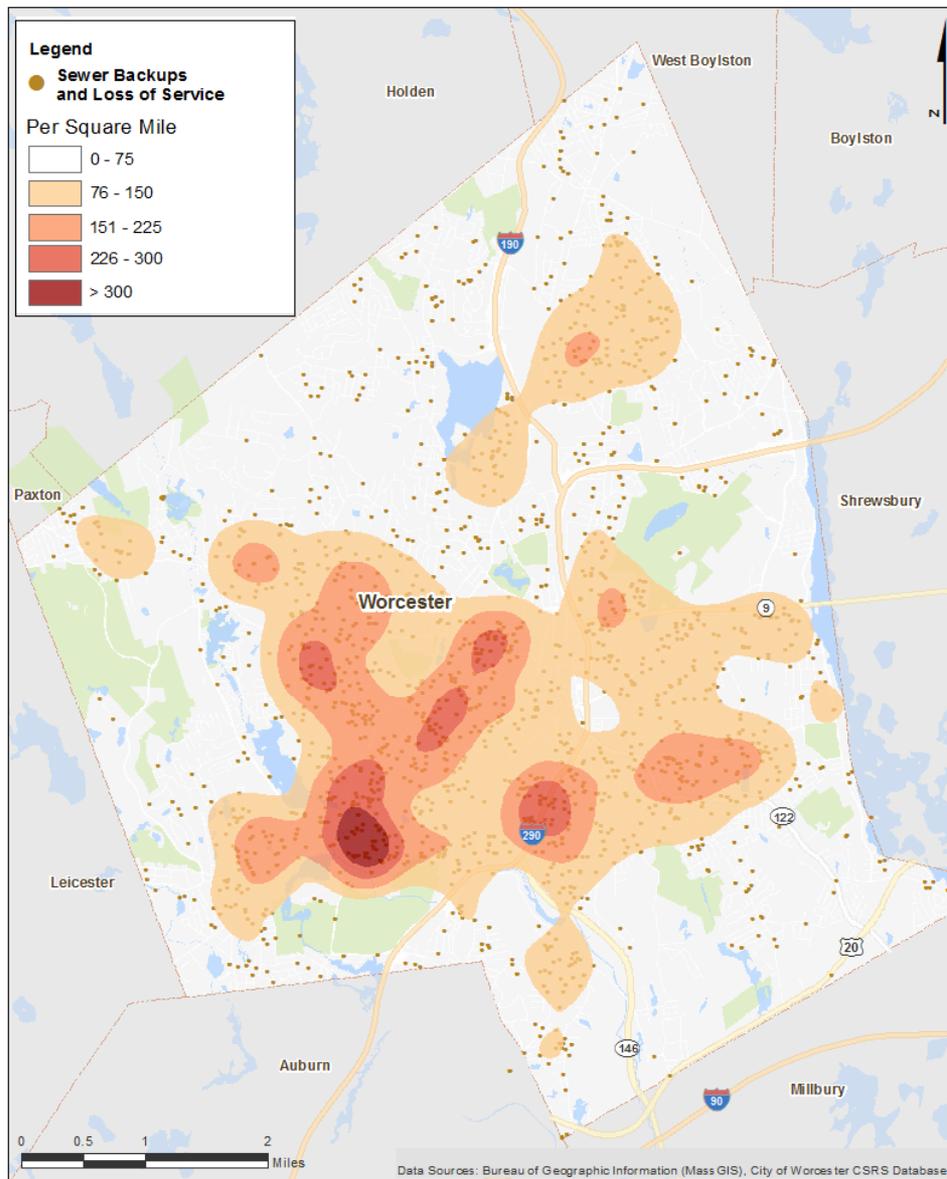
Source: Worcester Integrated Plan [DRAFT], Kleinfelder 2018



Flooding on Southgate Street – June 2010



# HEAVY RAINFALL – HISTORIC PIPED INFRASTRUCTURE FLOODING



Density of Reported Sewer Backups and Loss of Service

Data based on reported sewer backups and service losses from Worcester residents between 2006 and 2016.

*Note: Map based on Customer Service Request System (CSRS) data for sewer backups and loss of service 2006-2016*



## HEAVY RAINFALL – BANK EROSION

Erosion a concern for Worcester:

- Caused by a combination of factors (intense rainfall, flooding events, soft sediments, farming activity, land topography, etc).
- A danger for properties, ecosystems and other infrastructure along the river.



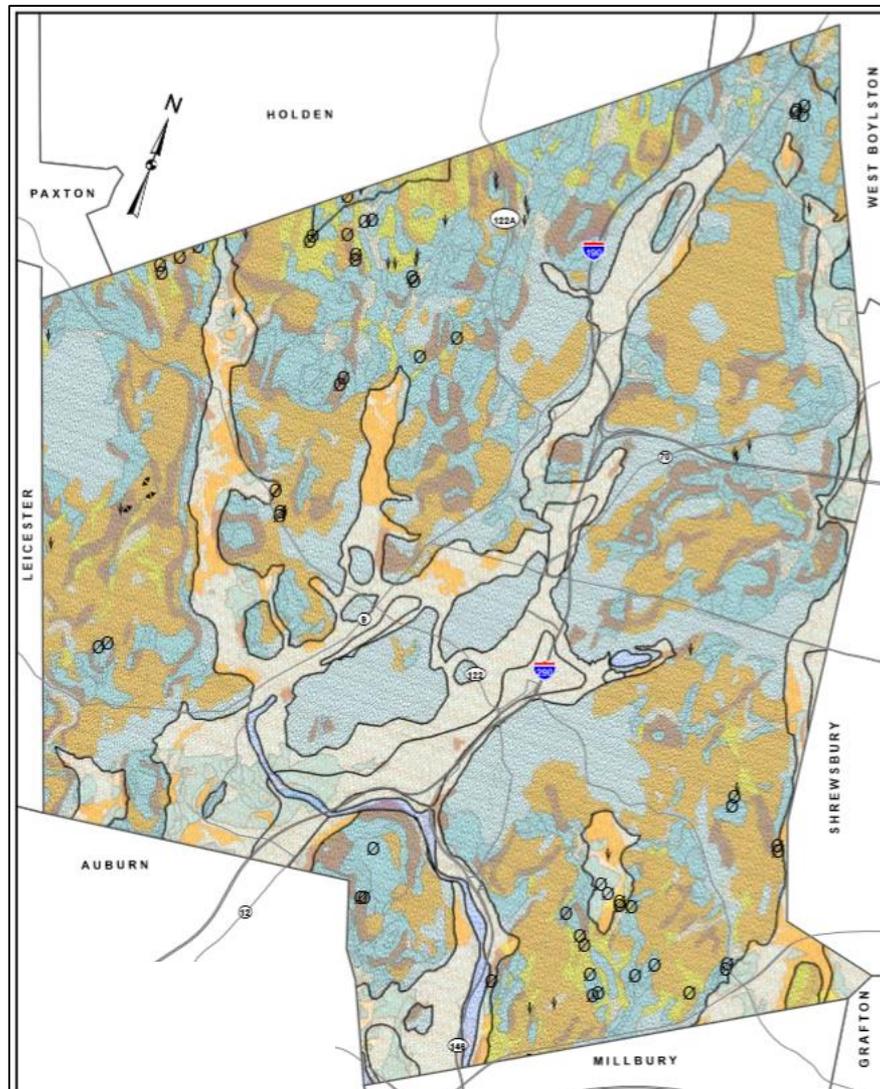
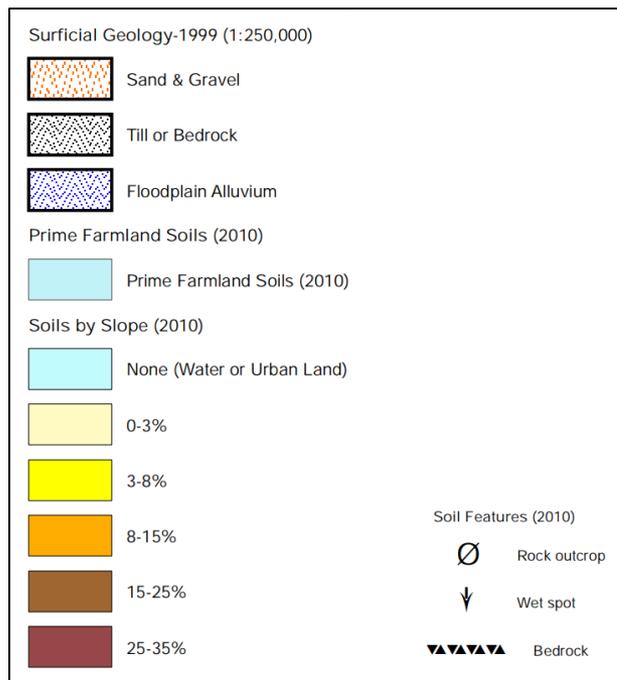


# HEAVY RAINFALL – RIVERBANK EROSION

From the map:

- Soft sediments like sand and gravel are common.
- Topography is hilly - a large portion of the city has sloped land.

## Soils and Geologic Features Map

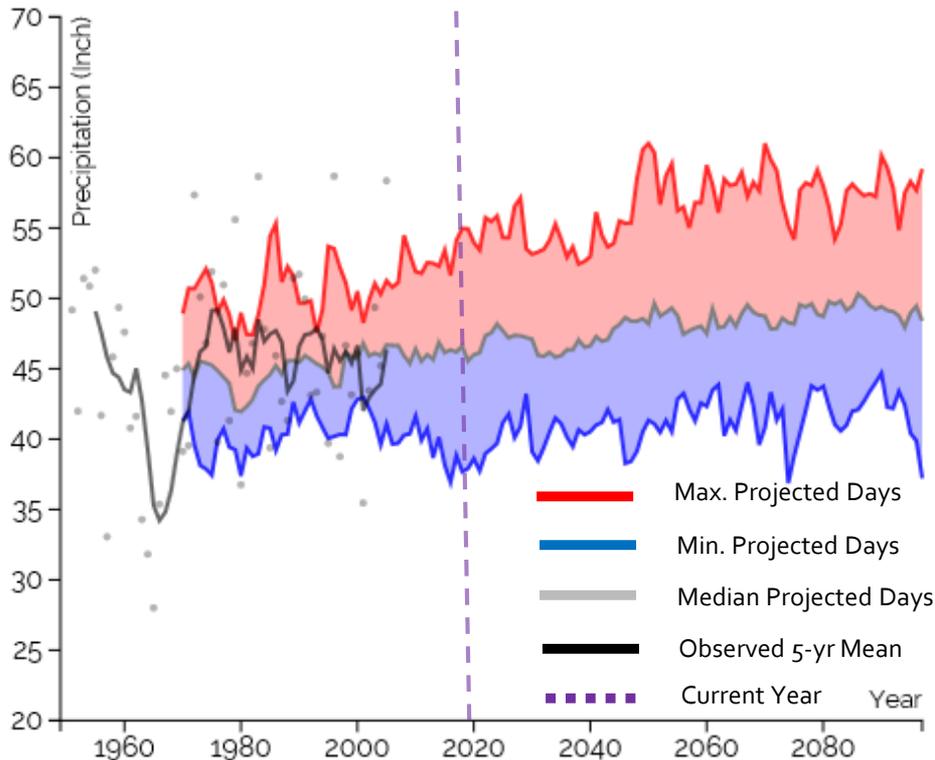




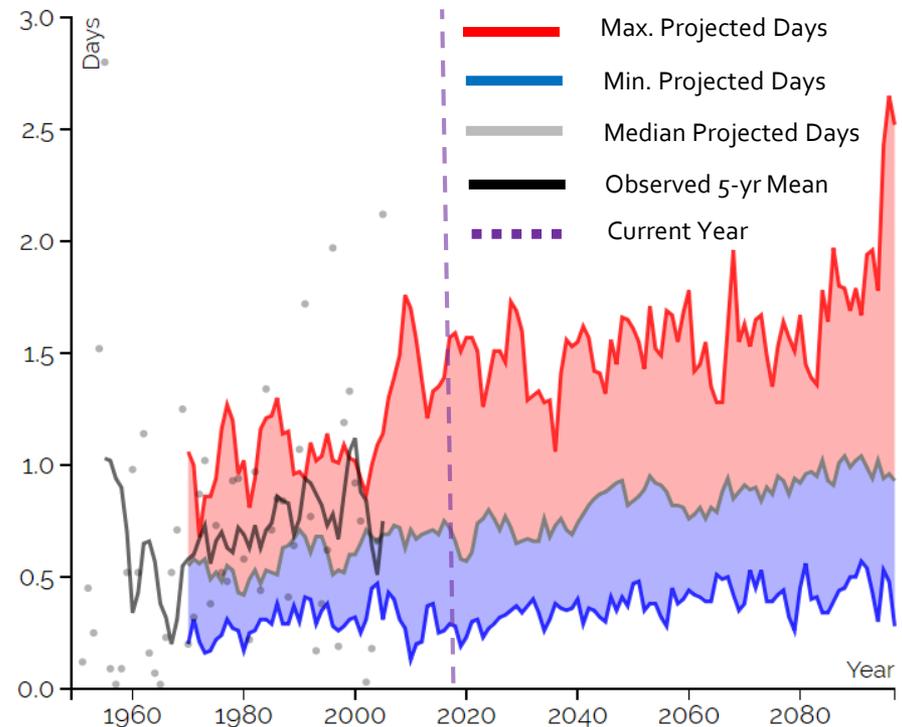
# HEAVY RAINFALL – FUTURE PROJECTIONS

- Total annual rainfall will increase
- Heavy rainfall events will become more frequent

**Annual Total Precipitation**  
Worcester County, MA

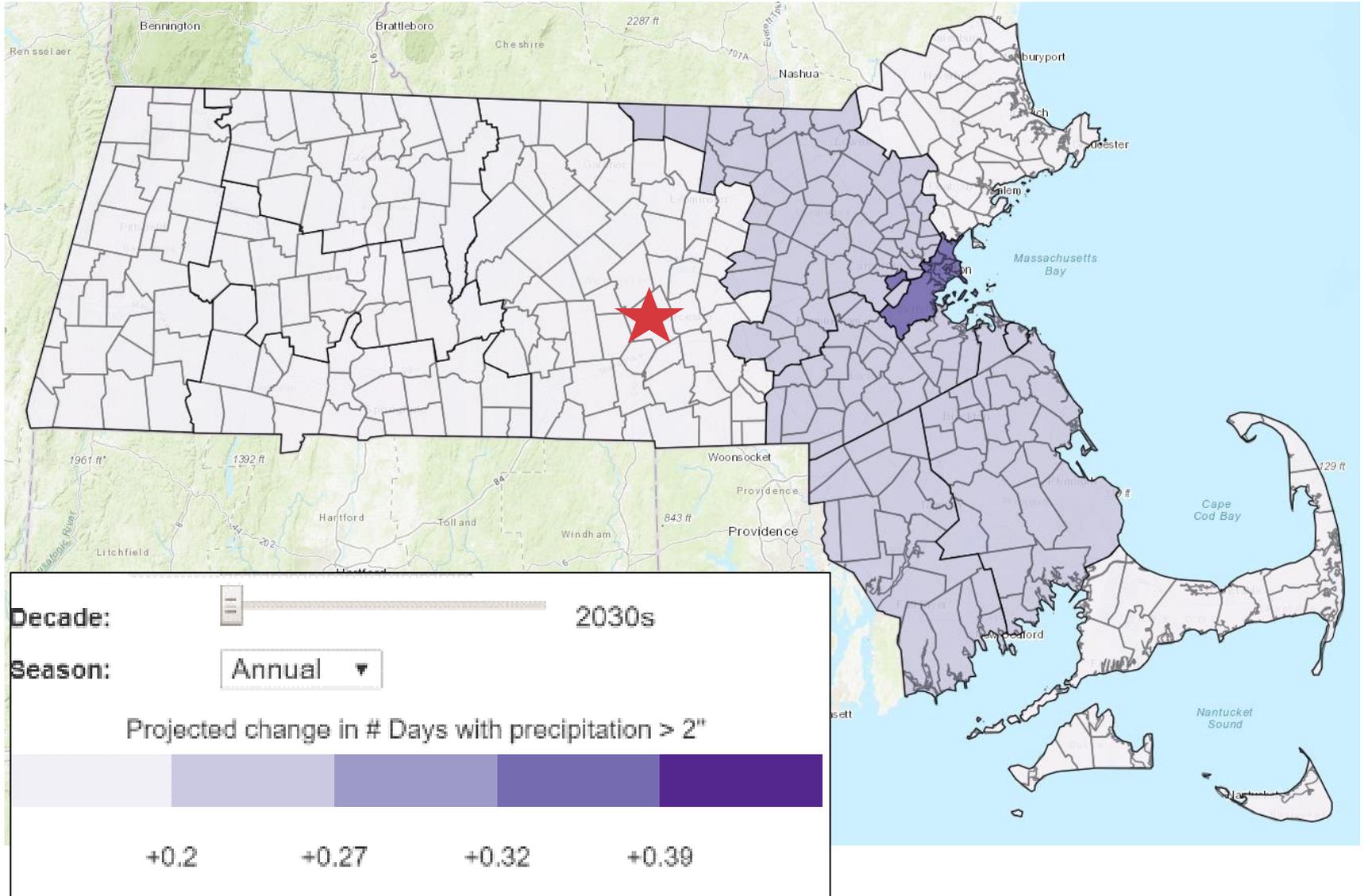


**Annual Days with Precipitation > 2"**  
Massachusetts



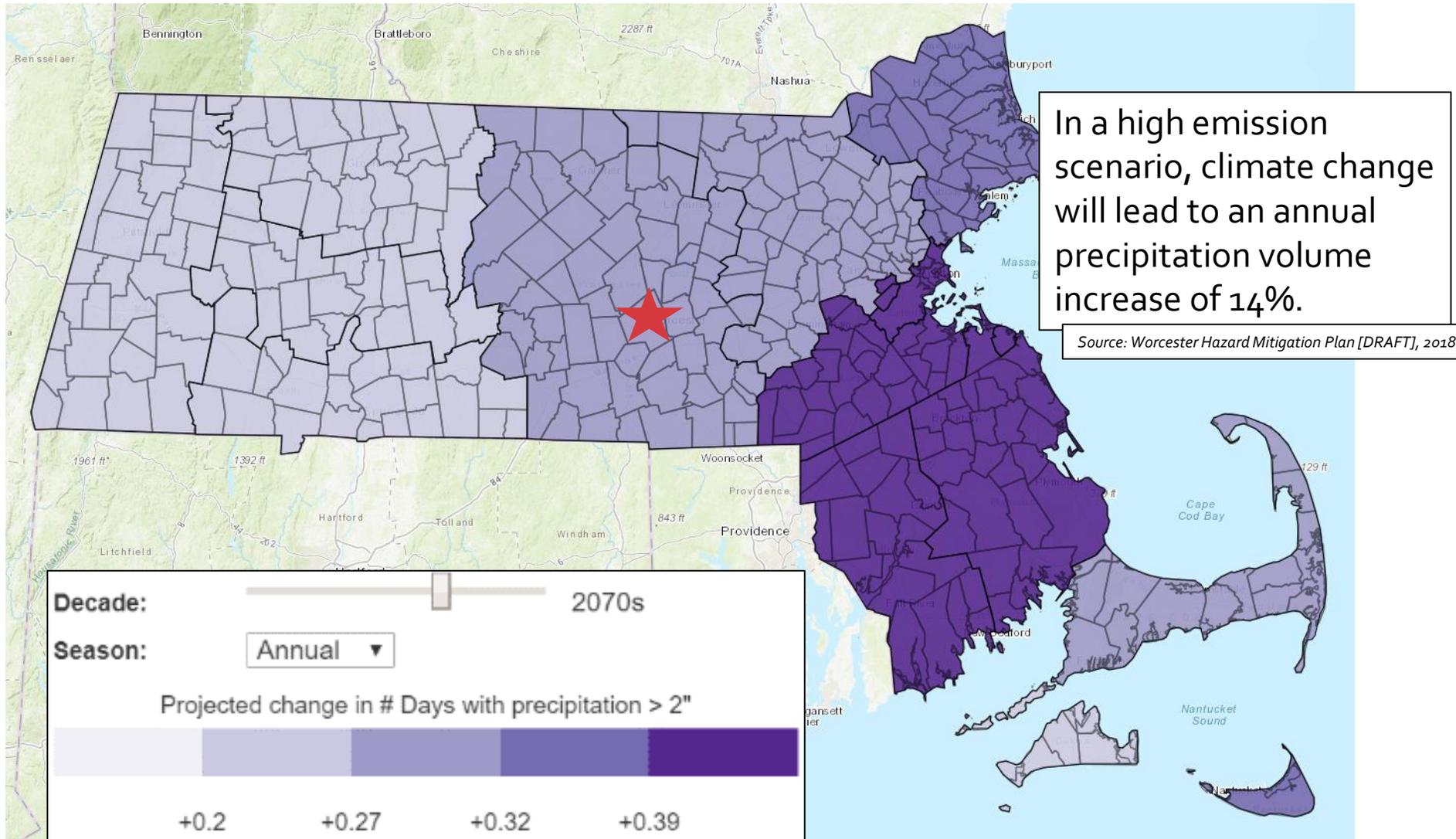


# HEAVY RAINFALL – 2030



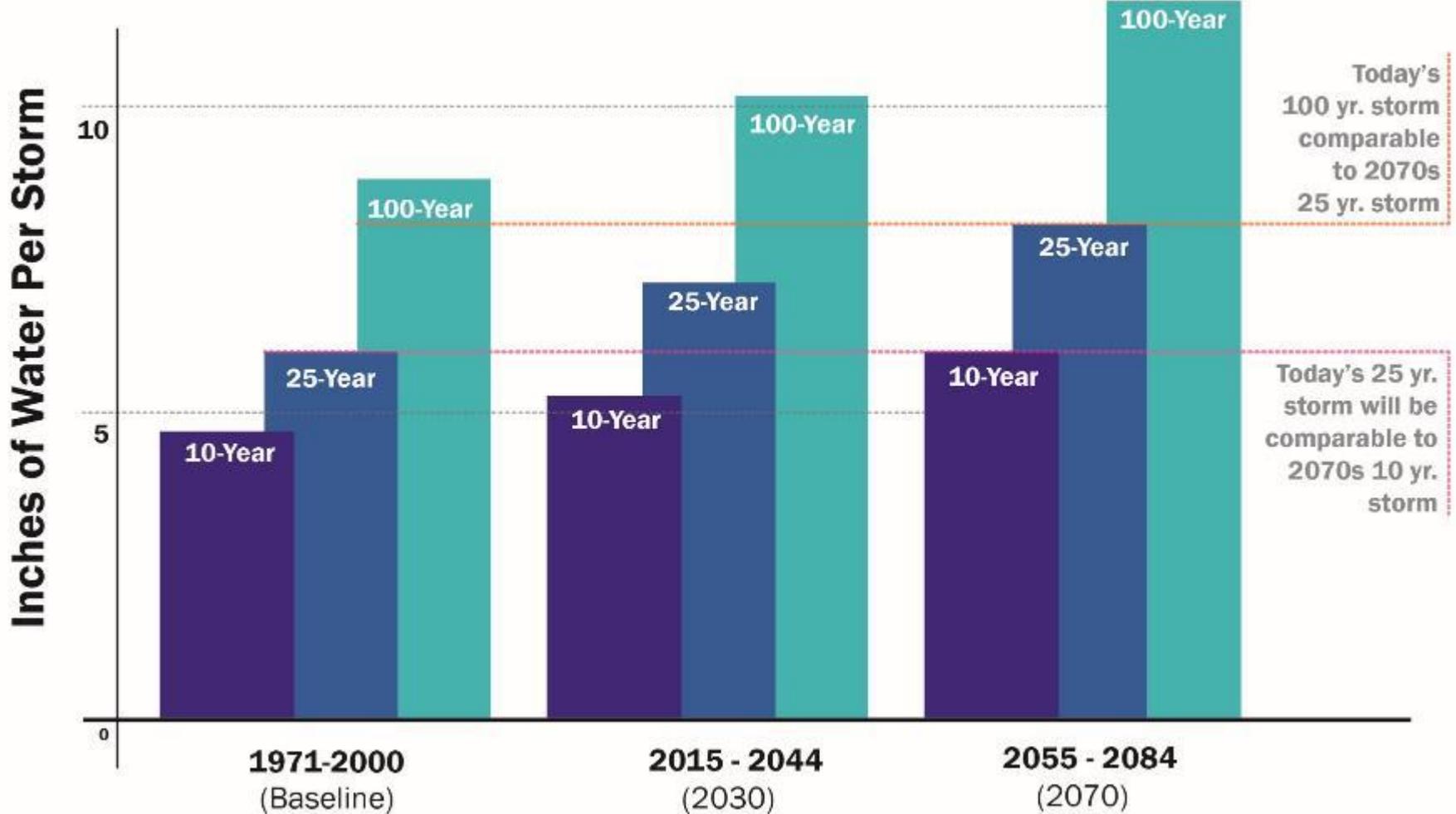


# HEAVY RAINFALL – 2070





# HEAVY RAINFALL



Source: Design storm projections for the Boston metro area based on Kleinfelder/ATMOS projections, Nov. 2015, Kleinfelder for City of Cambridge.

# IDENTIFIED HAZARD 2:



# SNOW/ICE STORMS



# SNOW/ICE STORMS

## Worcester is susceptible to large snow and ice storm events:

- The local geography plus the way eastern MA protrudes towards the Atlantic Ocean makes Worcester particularly susceptible to nor'easters and other severe winter storms.
- 62 high impact storms since 1968 (> 10 in).
- **Named snowiest city (of population 100,000 or more) in U.S. in 2015 with 90.1 inches (by GoldenSnowGlobe.com).**



## Potential Impacts:

- Power outages, school closings, internet and phone outages, utility damage, tree damage, roadway blockage, property damage, unsafe roads.



# SNOW/ICE STORMS

Ice storm (December 11-12, 2008):

- ½ inch of ice blanketed the region.
- Millions of dollars worth of damage.
- Extended power outages and school closings.
- Vivid reminder of how damaging ice storms can be.



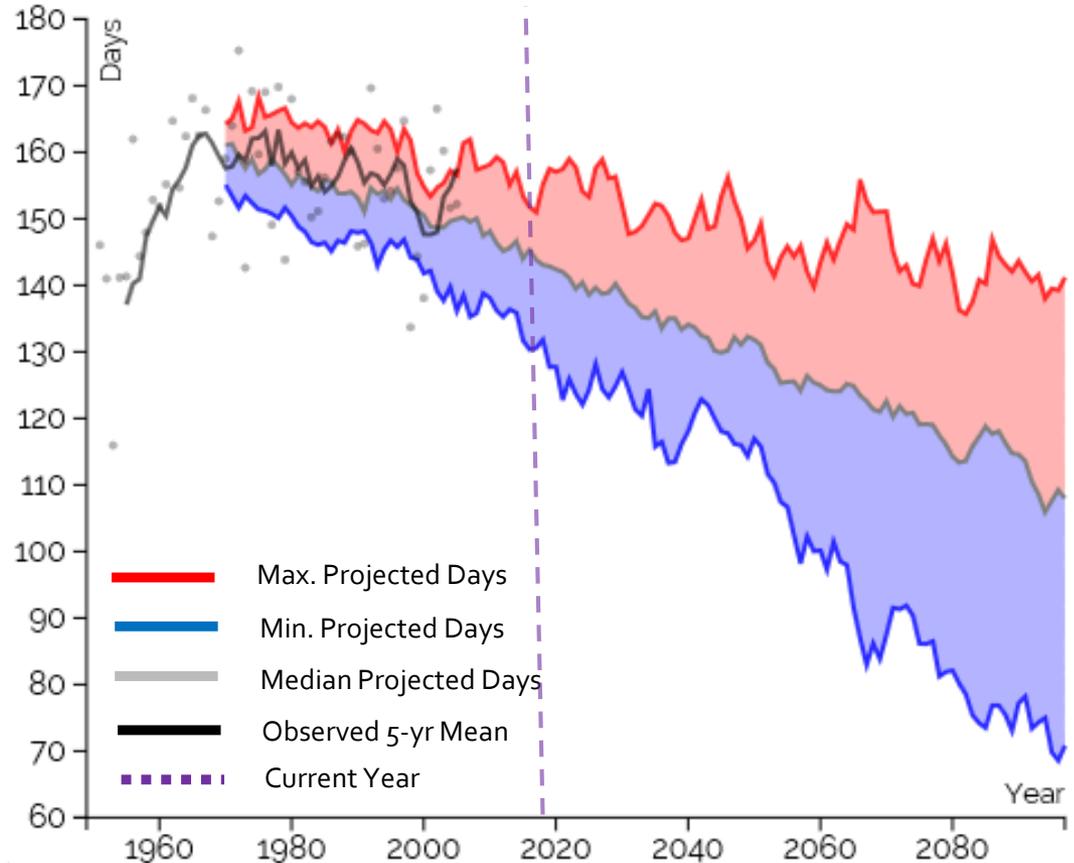


# SNOW/ICE STORMS

- Annual precipitation volume in winter is projected to **increase** 30% due to climate change.
- Annual days below freezing is projected to **decrease** over the next 80 years due to climate change.
- Projected rising temperatures will cause more winter precipitation to fall as rain or freezing rain instead of snow.
- Higher chance of ice and freezing rain storms

Source: Worcester Hazard Mitigation Plan [DRAFT], 2018

Annual Days with Minimum Temperature Below 32°F  
Worcester County, MA

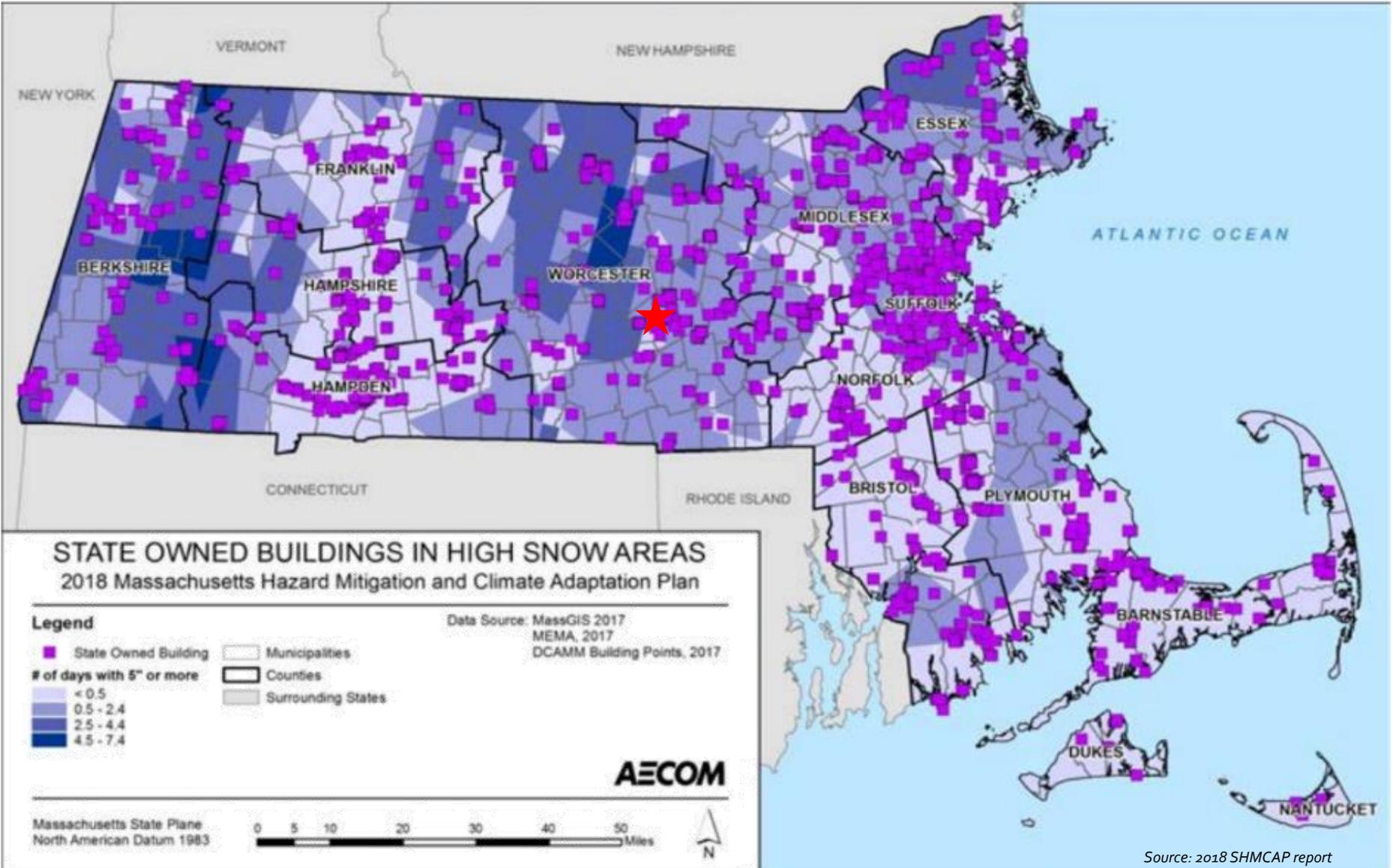


Source: resilientma.org 2018



# SNOW/ICE STORMS – HISTORIC DATA

Figure 4-64: Number of Days with 5 Inches of Snow or More



Source: 2018 SHMCAP report

# IDENTIFY A THIRD HAZARD:



EXTREME HEAT



DROUGHT



WIND



BRUSH FIRES



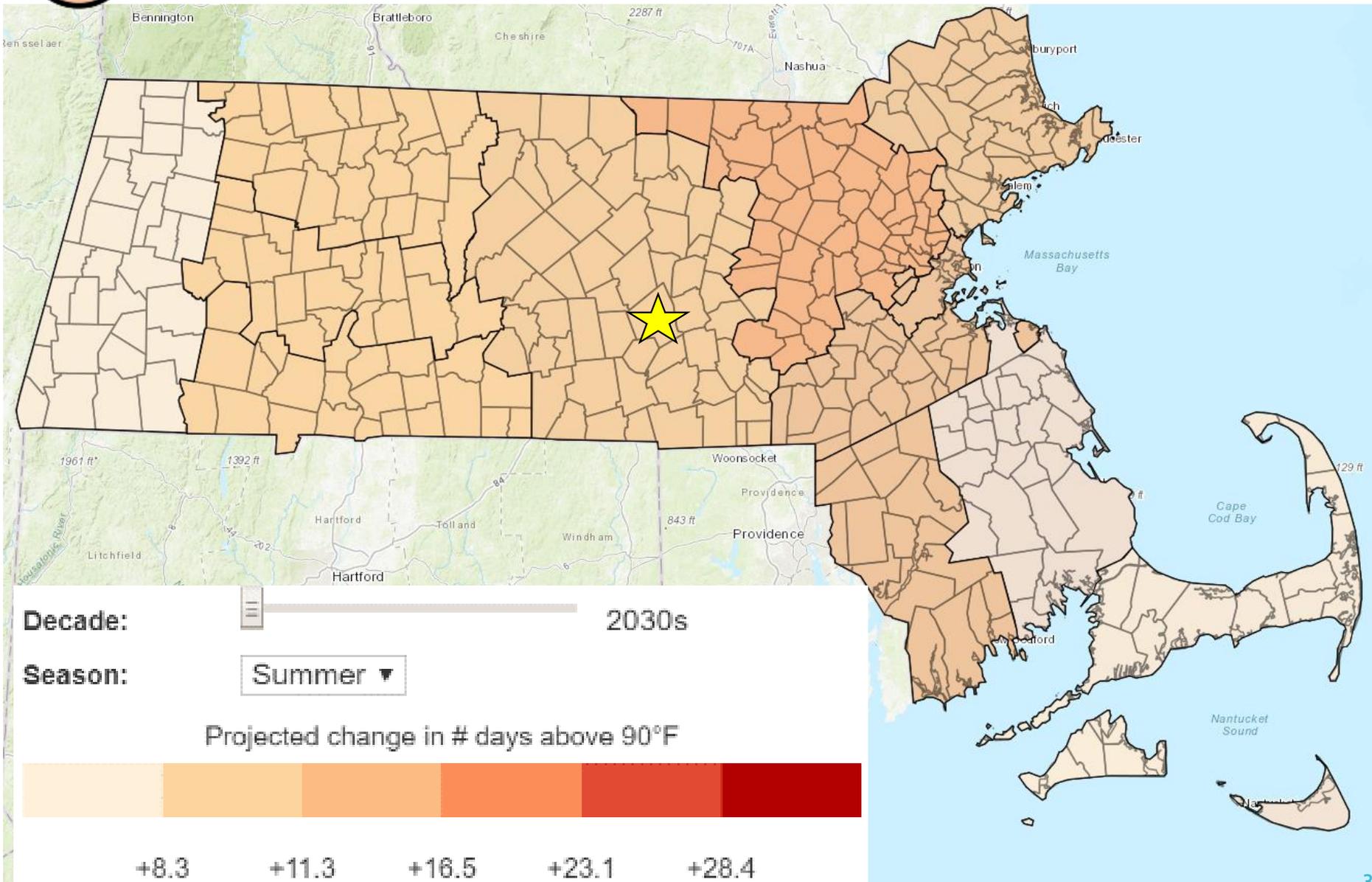
# EXTREME HEAT – PRESENT HOT SPOTS

- Heat effect exacerbated in impervious surface areas in the city known as “heat islands”.
- Often located in business districts or downtown areas.



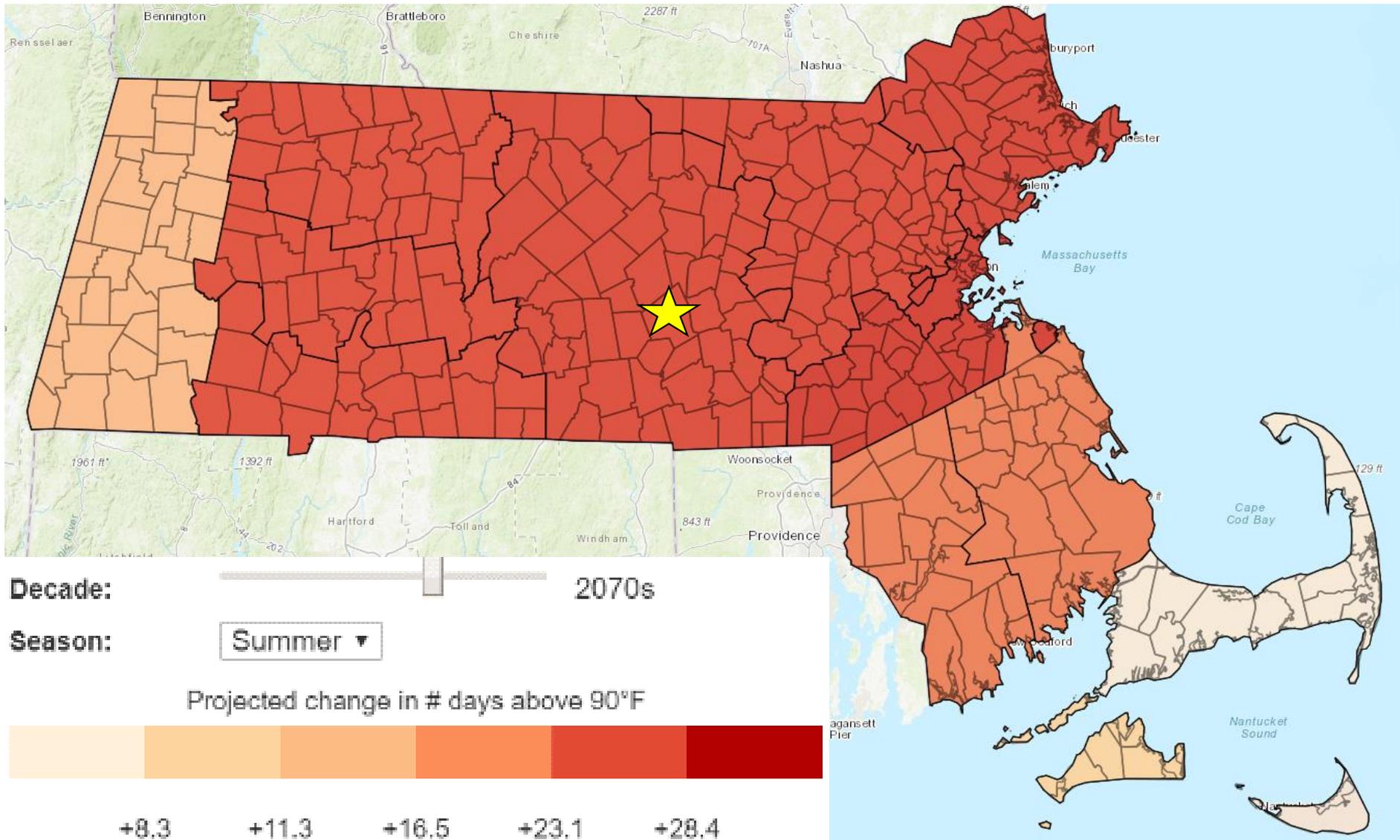


# EXTREME HEAT - 2030





# EXTREME HEAT - 2070

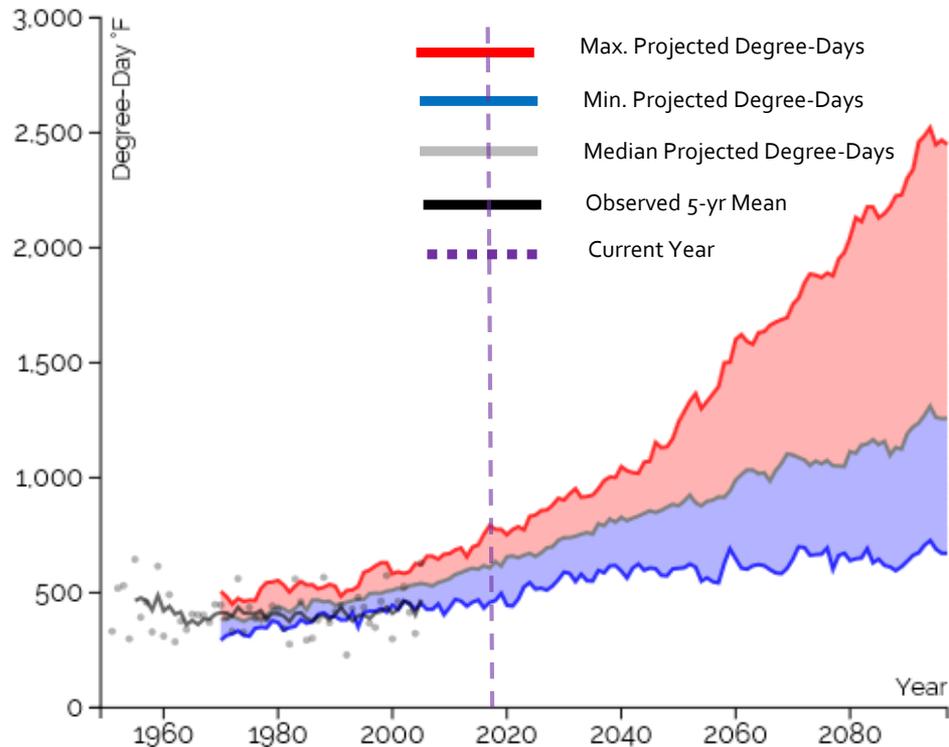




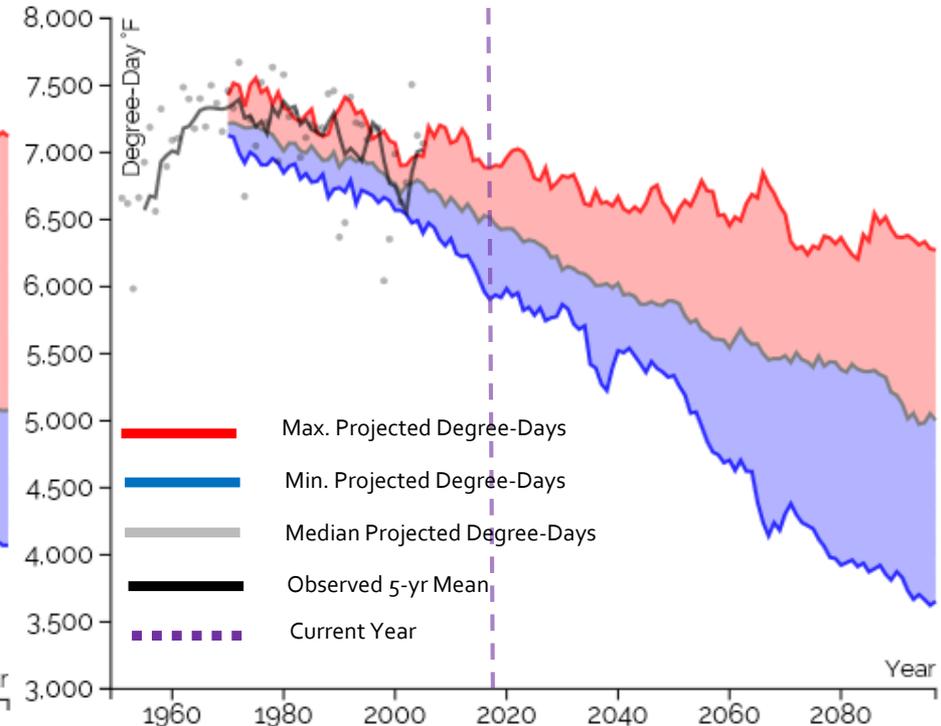
# EXTREME HEAT – ENERGY DEMAND

- There will be more cooling degree-days than heating degree-days by 2070!
- Degree-days are a sum of the year's high or low temperatures relative to the mean. HDD apply to temps lower than the mean, CDD apply to temps higher than the mean.

**Annual Cooling Degree-Day Accumulation (CDD)**  
Worcester County, MA



**Annual Heating Degree-Day Accumulation (HDD)**  
Worcester County, MA





# EXTREME HEAT – PUBLIC HEALTH

## Human health issues:

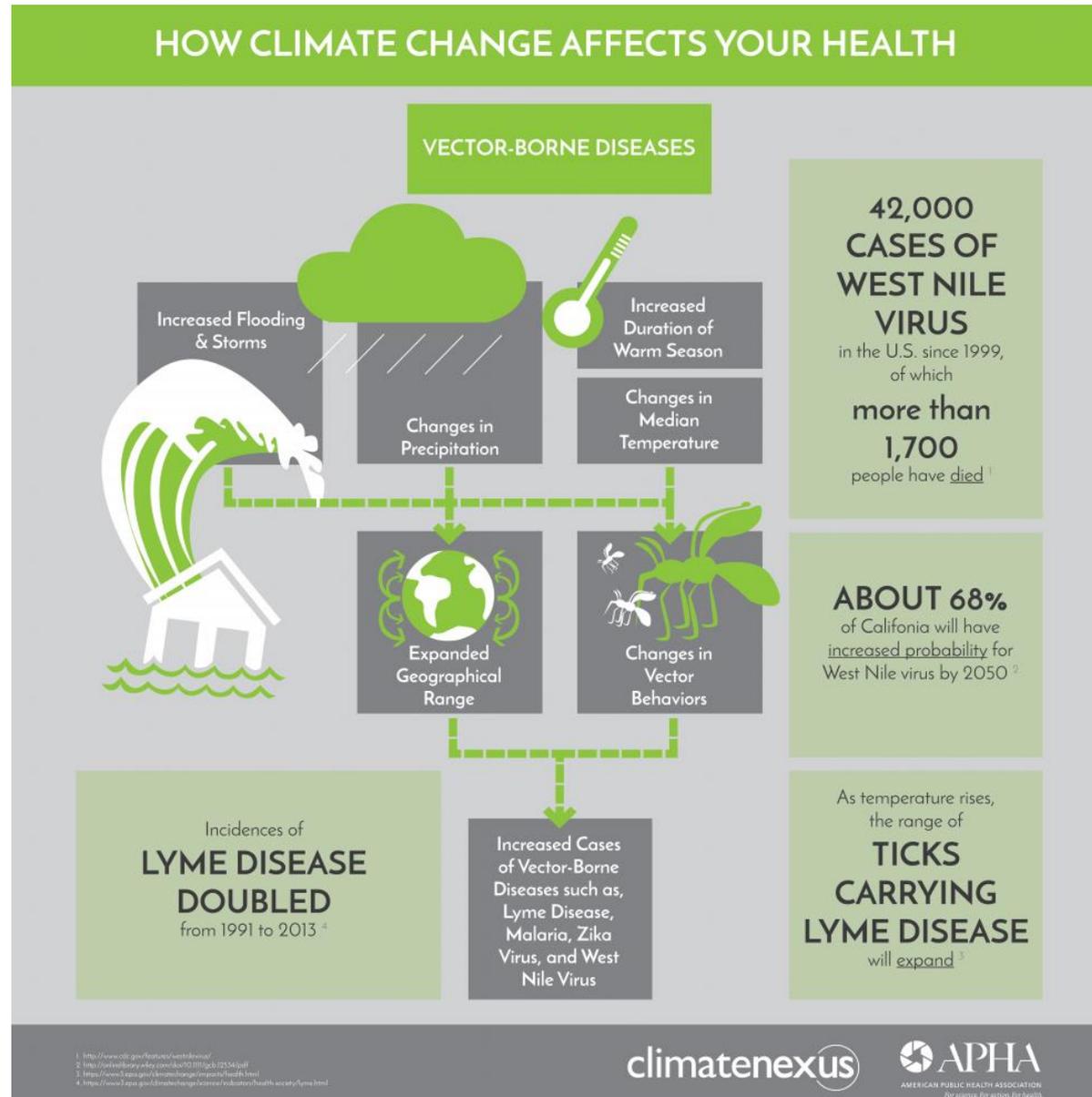
- Heat-related illness and mortality
  - Study shows deaths during heat waves in NYC are more common in neighborhoods with higher relative daytime surface temperature

Source: Madrigano, Jaime & Ito, Kazuhiko & Johnson, Sarah & Kinney, Patrick & Matte, Thomas. (2015). A Case-Only Study of Vulnerability to Heat Wave-Related Mortality in New York City (2000–2011). *Environmental health perspectives*. 123. 10.1289/ehp.1408178.

- Air quality, asthma
  - Emissions of pollutants like ozone and PM2.5 increase at high temperatures. Especially an issue in the north-eastern US, leading to concerns about related illness and mortality.

Source: Kinney, Patrick. (2018). Interactions of Climate Change, Air Pollution, and Human Health. *Current Environmental Health Reports*. 5. 10.1007/s40572-018-0188-x.

- Vector-borne diseases

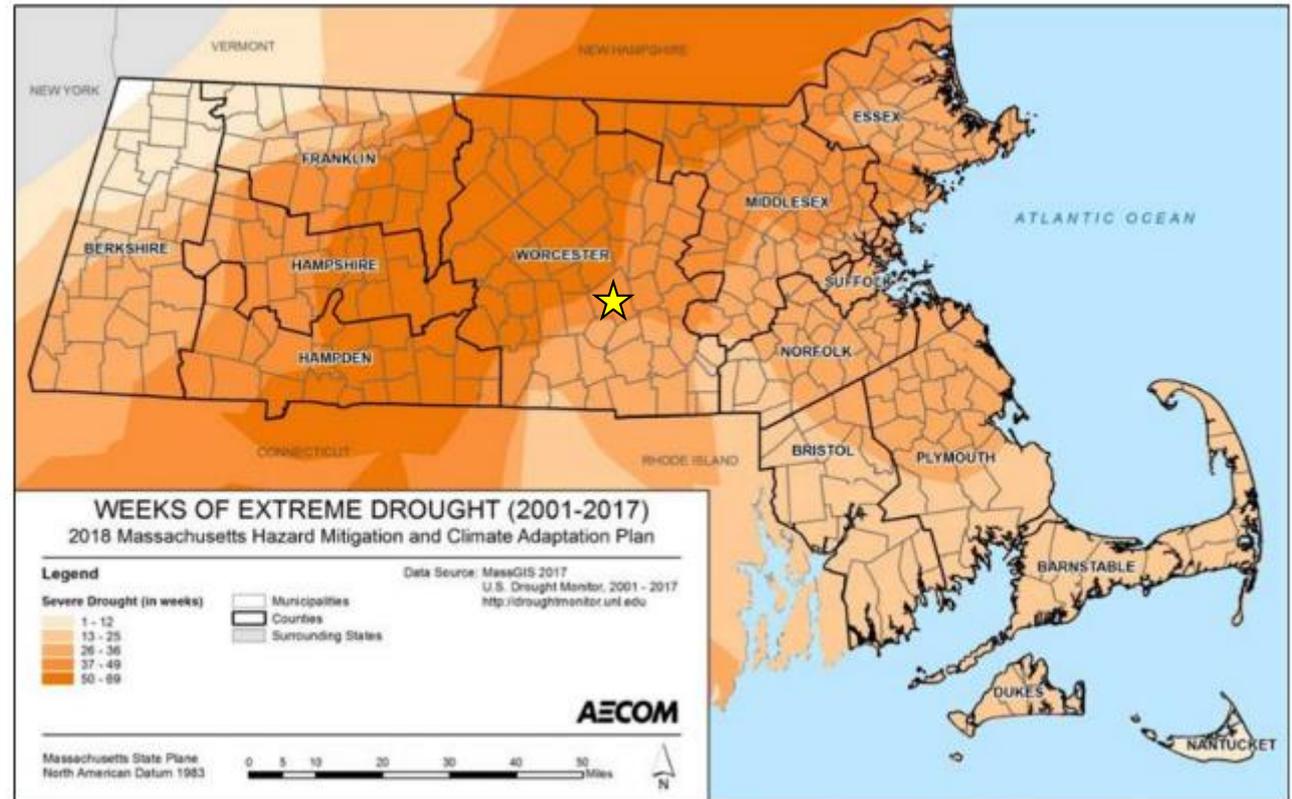




# DROUGHT – HISTORIC DATA

- More rainfall in large events could mean longer gaps with no rainfall locally.
- Could impact natural resources:
  - Trees
  - Water quality
  - Aquatic organisms
  - Aquifers / Reservoirs

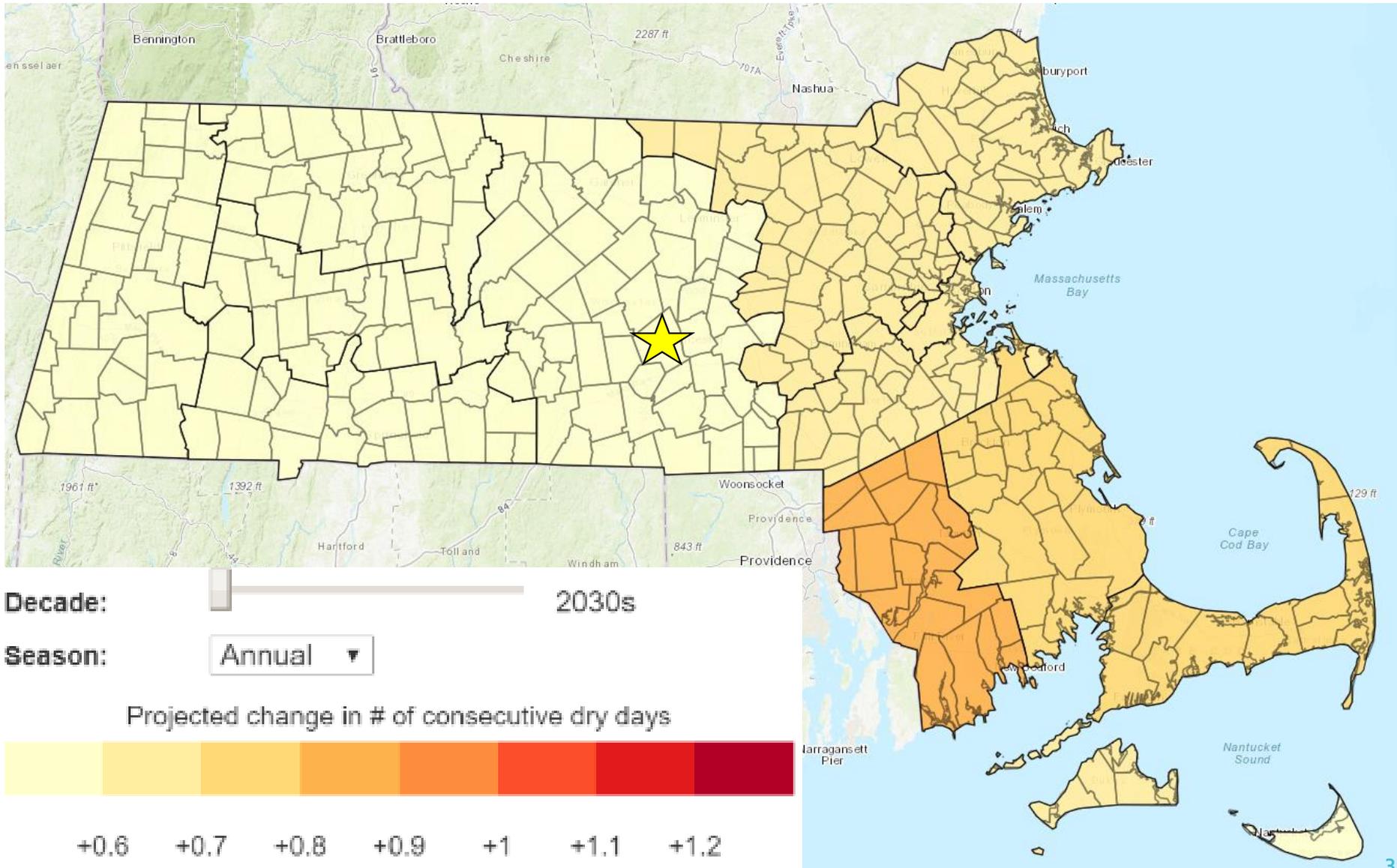
Figure 4-8: Weeks of Severe Drought (2001-2017)



- In Worcester, there have been 7 major droughts since 1930 (3-8 years each)

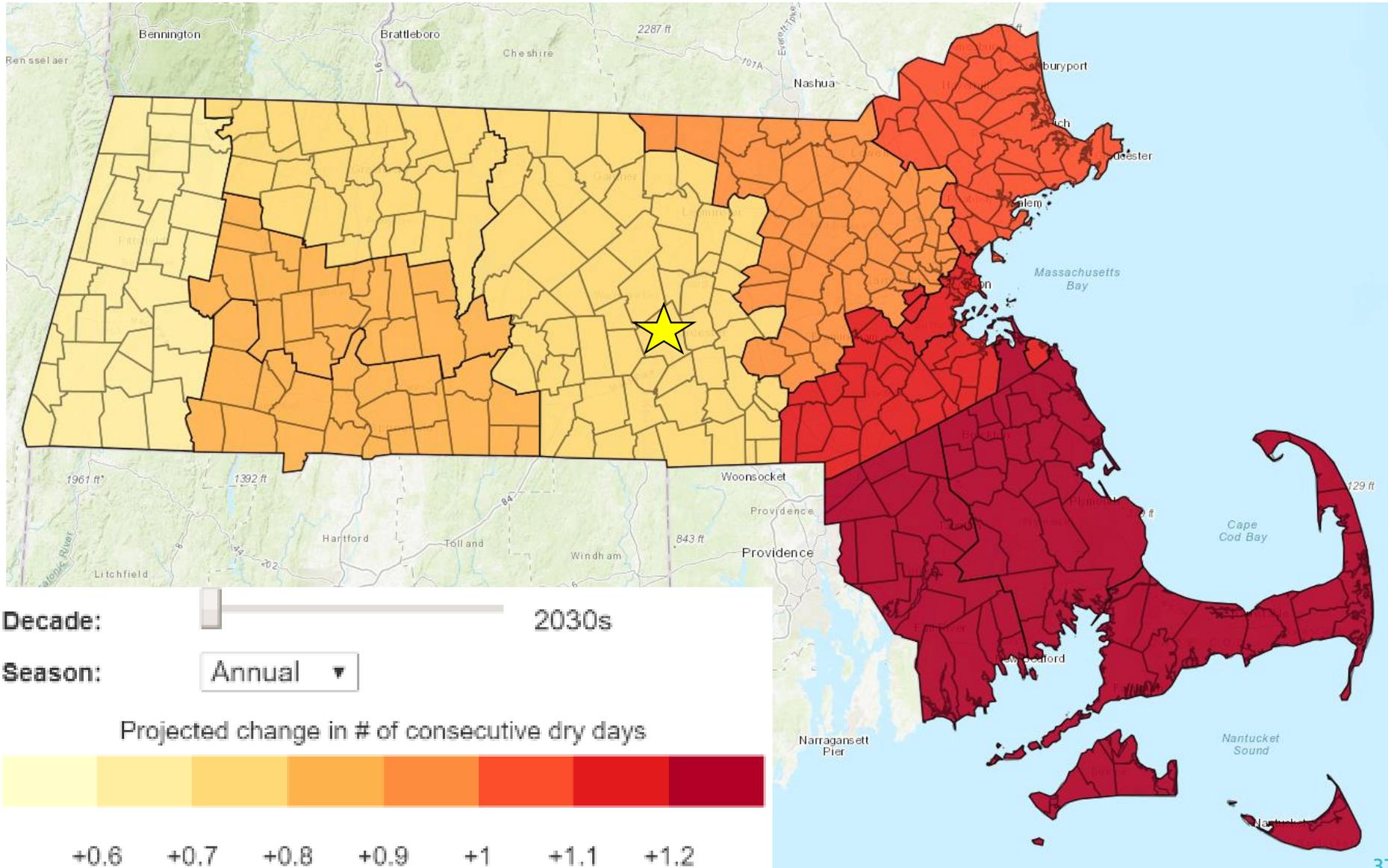


# DROUGHT – CONSECUTIVE DRY DAYS 2030





# DROUGHT – CONSECUTIVE DRY DAYS 2070



# WIND

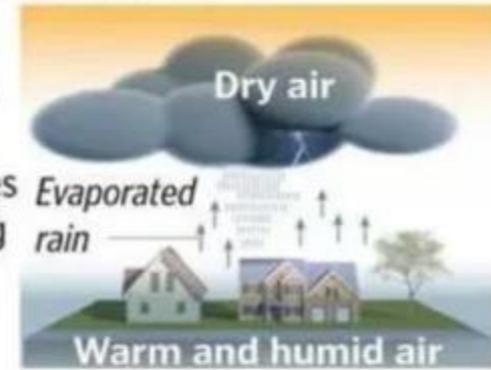
- Typically, damaging winds are classified as those exceeding 50-60 mph.
- Damaging winds can result from microbursts, thunderstorms, blizzards, tropical storms, tornados, etc.
- Impacts: town resources, infrastructure, private and public property.



Source: Joanne Rathe/Globe Staff

## HOW A MICROBURST HAPPENS

- 1 Under certain conditions during a thunderstorm, the rain evaporates quickly, ascending to the drier air above.



SOURCE: NOAA

- 2 The upper dry air is cooled suddenly and sinks to the ground, spreading in strong, damaging winds

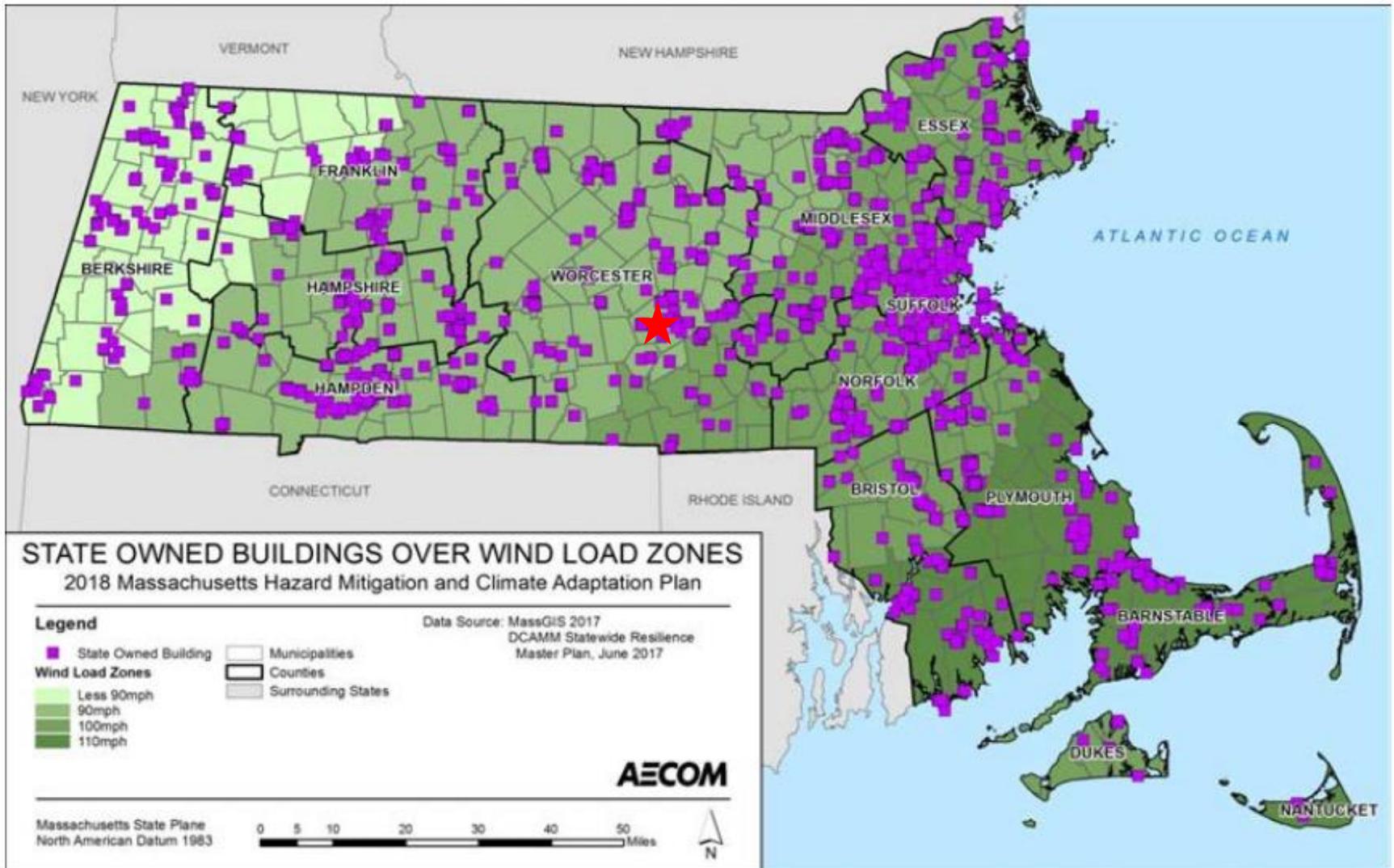


JAVIER ZARRACINA/THE BOSTON GLOBE



# WIND – HISTORIC DATA

Figure 4-76: Wind Load Zones in the Commonwealth of Massachusetts



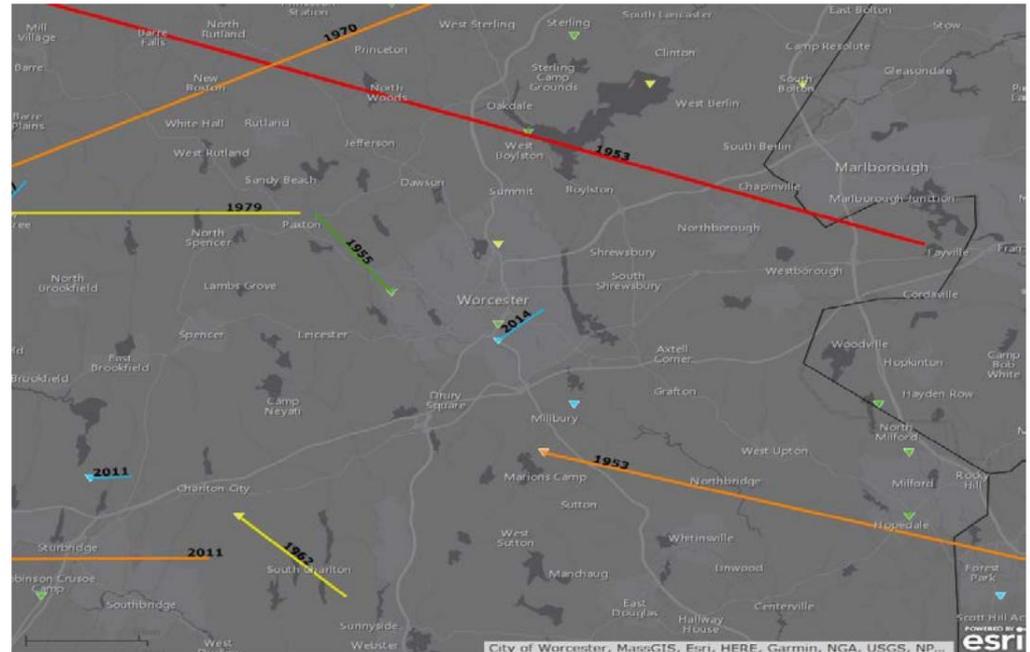
Source: DCAMM, 2017 (facility inventory)

Source: Worcester Hazard Mitigation Plan [DRAFT], 2018

# TORNADOES

## Tornado tracks in Worcester area 1950 - 2016

- Destructive swirling columns of air, often formed during severe thunderstorm events.
- Rotational wind speeds can reach 250 mph.
- Path can be difficult to predict because they often stall or change direction abruptly.
- In MA, tornado events have occurred most frequently in the Connecticut River Valley and in western Worcester County.



### Tornado Magnitude Scale



Impacts from tornadoes can be devastating: Loss of life, tree and power line damage, personal property loss.



# BRUSH FIRES

- Like wind, brush fires are typically a result of dry ground conditions and drought.
- Approximately 90% of wildfires in Massachusetts are caused by humans, the other 10% by lightning.
- Impacts: natural resources, infrastructure, private and public property.



*Source: CBS Boston c/o Dustin Fitch)*



# II. VOTE FOR YOUR 3<sup>RD</sup> HAZARD

## AND PROVIDE A REASON

- What hazards have impacted your community in the past/present?
  - Where, how often, and in what ways?
- What is exposed to climate threats now and in the future?
- What have been the impacts to operations and budgets, planning and mitigation efforts?

Community Resilience Building Workshop Risk Matrix

Fill in Top 3 or 4 Hazards on Risk Matrix

Features	Location	Ownership	V or S	Thunderstorm	Wildfire, hurricanes, drought	Heat	Sea level rise
Infrastructural							
Societal							
Environmental							

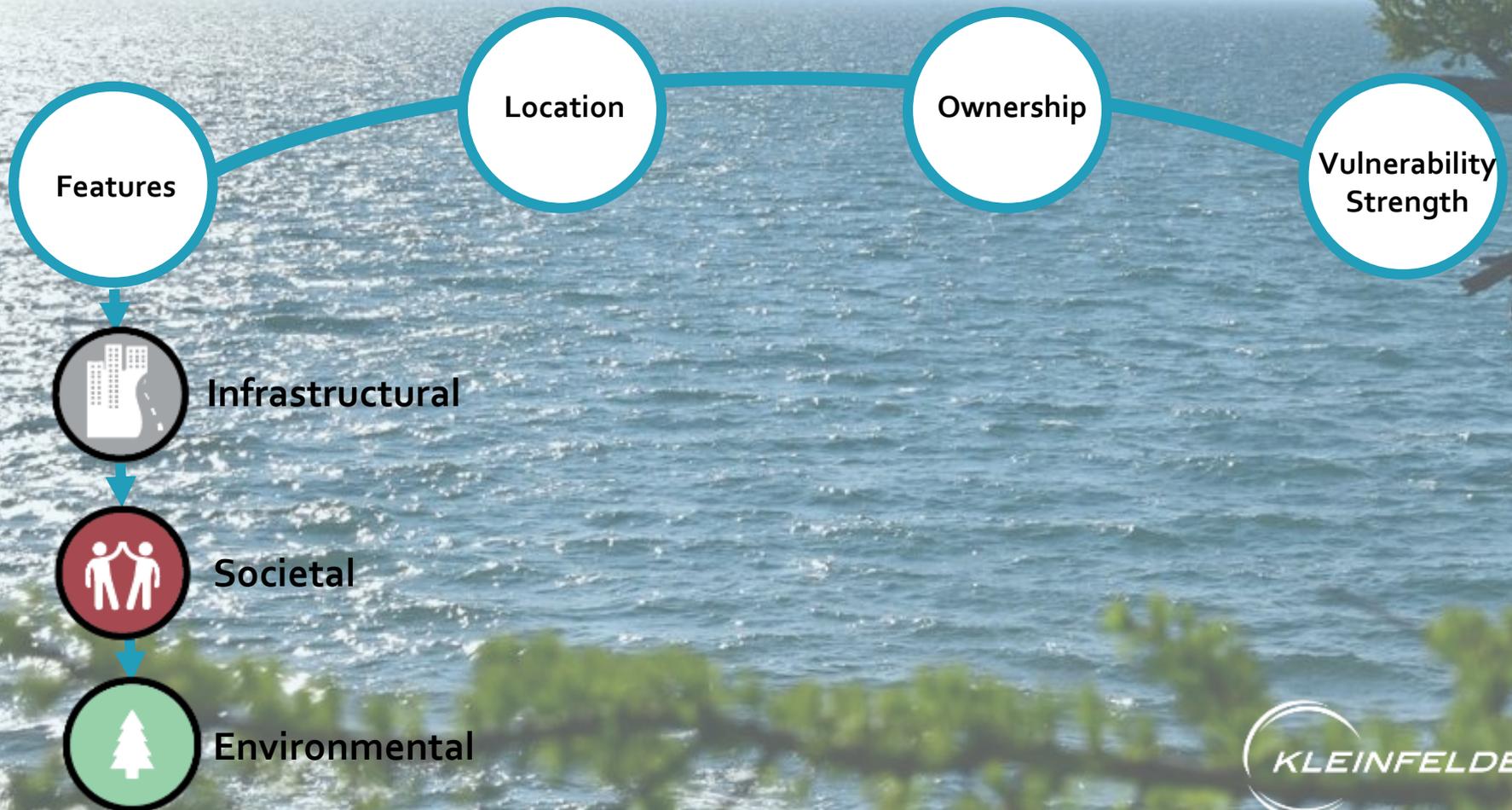
# III. BREAK – 15 MINS

## WORCESTER COMMUNITY RESILIENCE BUILDING WORKSHOP



# IV. STRENGTHS & VULNERABILITIES

What are Worcester's infrastructural, societal, and environmental strengths and vulnerabilities?





# INFRASTRUCTURE

**Critical Infrastructure** – provides essential services and serves as the backbone of the city's security and health.

- Vital to the hazard response effort.
- Maintains existing level of protection from hazards for the community.
- Would create a secondary disaster if a hazard were to impact it.
- Facilities and populations to especially protect from a hazard.

*Examples Include:*

- Bridges, Roads
- Dams, Reservoirs
- Emergency Operations
- Municipal Buildings, Schools, Hospitals
- Utilities, Water and Sewer System
- Commercial Buildings and Businesses
- Historic Sites





# INFRASTRUCTURE



Nelson Elementary School



Water Filtration Plant



# INFRASTRUCTURE



Pine Hills Dam



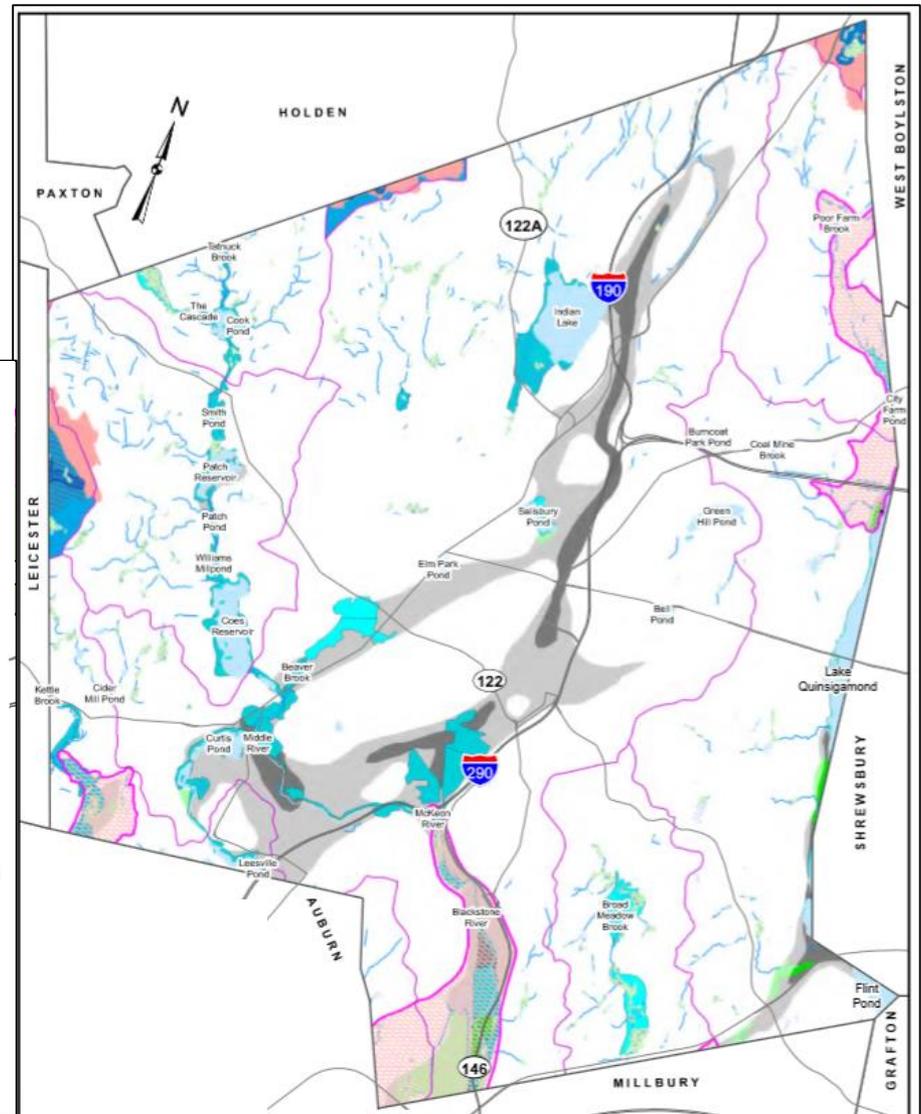


# INFRASTRUCTURE

## Water Resources Map

### Public Water Infrastructure:

- Essential for city function and survival.





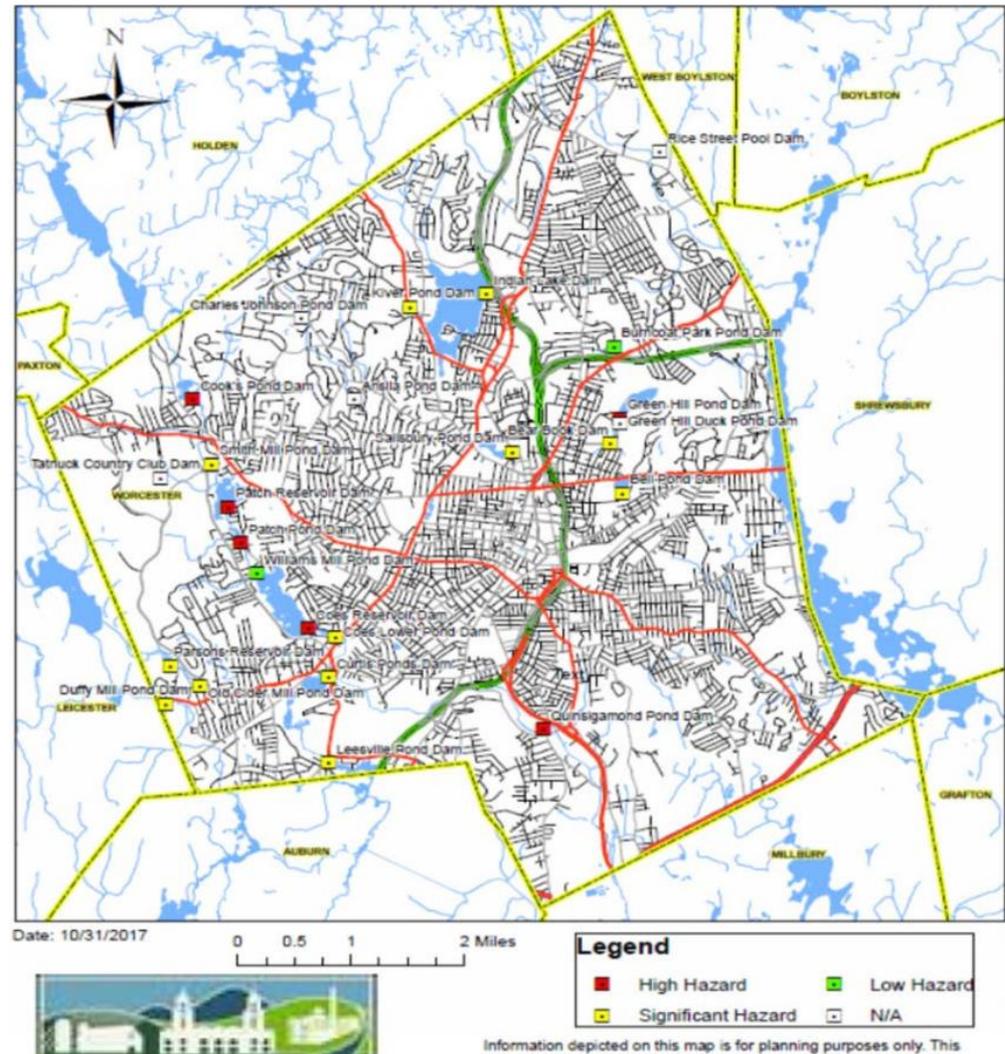
# INFRASTRUCTURE

## Dam Locations and Hazards Map

25 dams in Worcester

- 6 High Hazard
- 12 Significant Hazard

Dam failure is not common but many present a disastrous hazard to lives and property. The hazard level classification reflects the potential impact of a specific dam failure. Extensive flooding would occur in downstream areas.



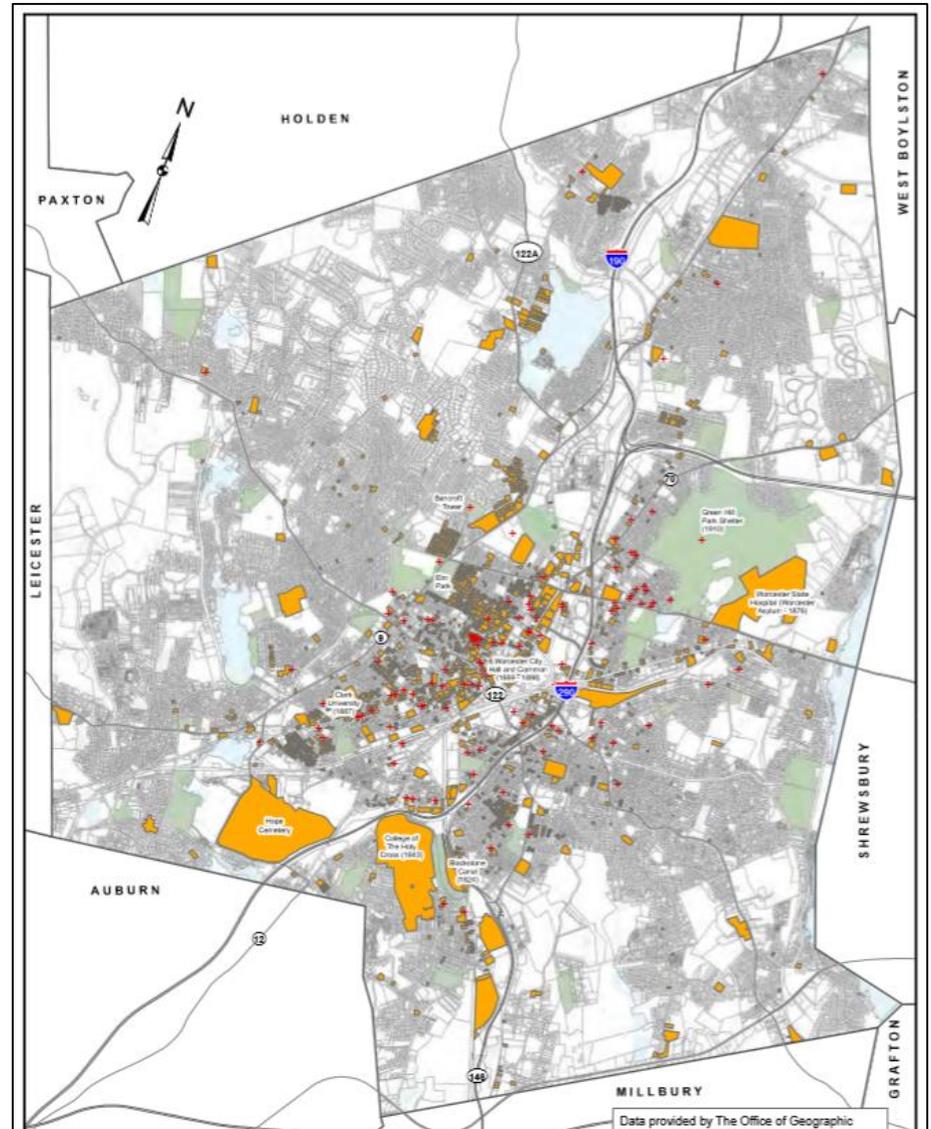
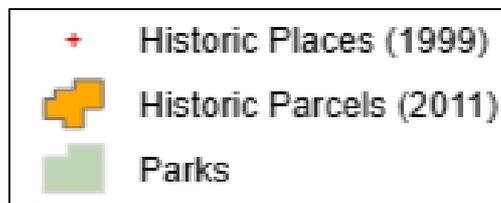


# INFRASTRUCTURE

## Unique Features Map

Other important city infrastructure:

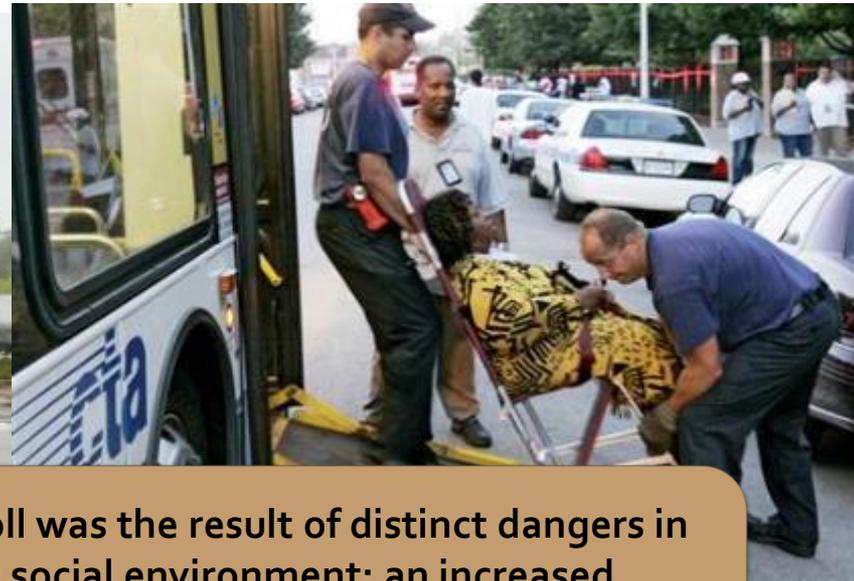
- Historic locations.
- Public parks.





# SOCIETY

- Combination of factors and forces that affect the susceptibility of various groups within a community to harm, as well as their ability to respond positively after extreme events.



**“The death toll was the result of distinct dangers in Chicago’s social environment: an increased population of isolated seniors who live and die alone”– Eric Klinenberg**



# SOCIETY

## 2016 Data:

- City Population: 184,509
- Males: 91,316 (49.5%)
- Females: 93,193 (50.5%)

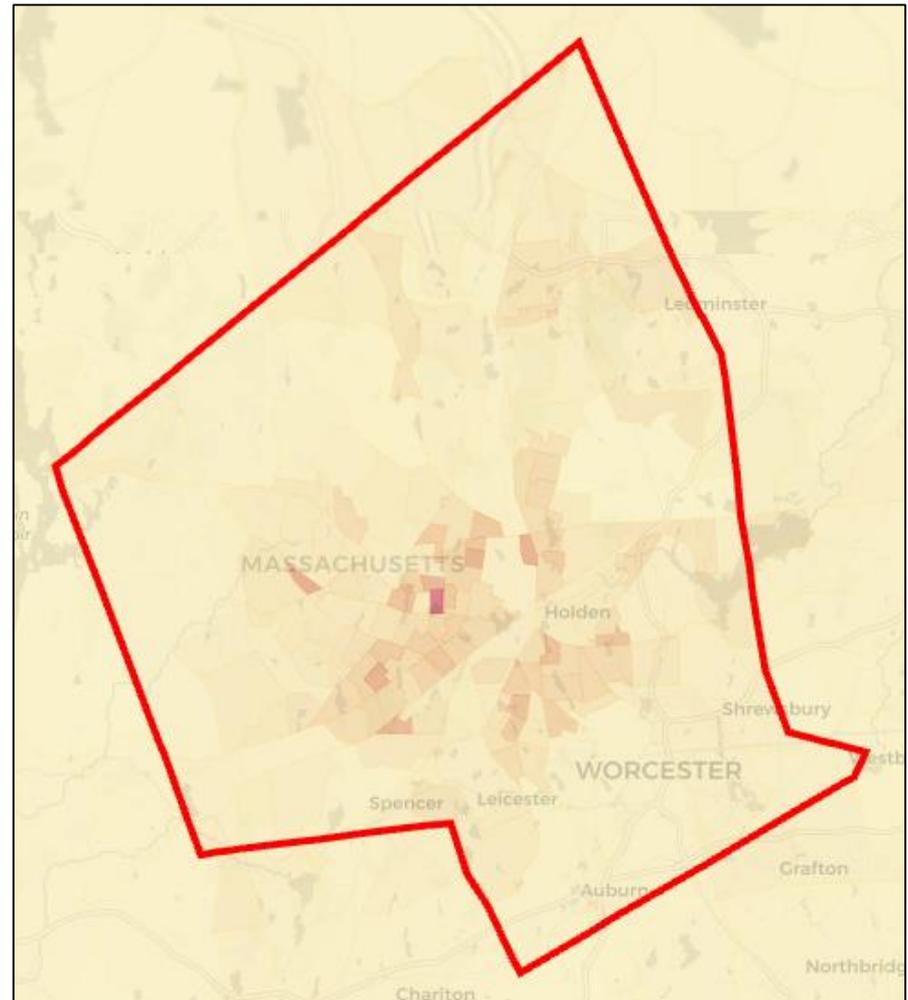
Source: [www.city-data.com](http://www.city-data.com)

## Age Stats for Worcester

- 25.5% under 19
- 12.5% over 65
- Median age 33.8
- MA median age 39.3

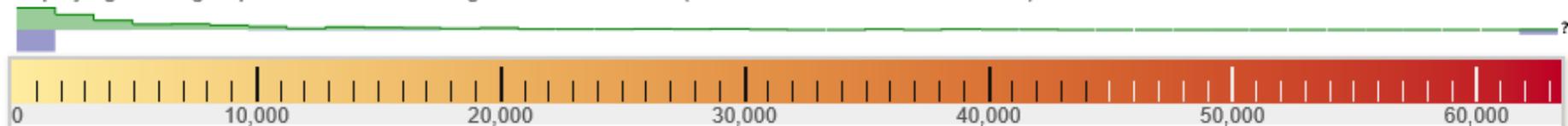
Source: Worcester Hazard Mitigation Plan [DRAFT], 2018

## Worcester Population Density Graphic



Displaying: block groups. Zoom in to view higher resolution data (available down to the block level)

Based on 2000-2016 data



Source: [www.city-data.com](http://www.city-data.com)

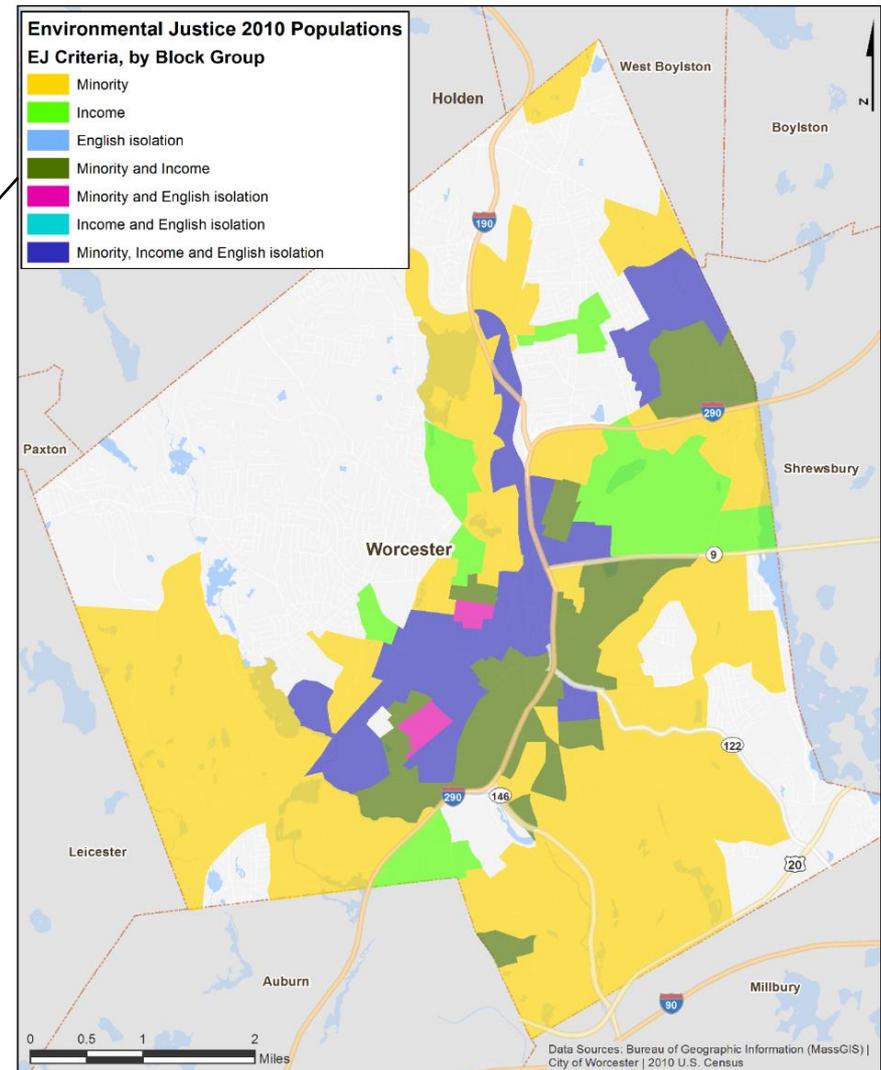
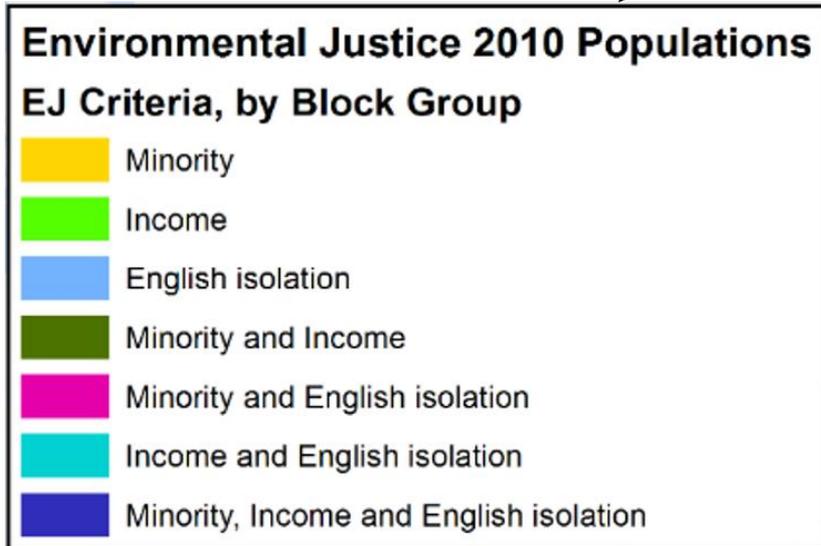


# SOCIETY

The location of vulnerable populations throughout the city.

- Downtown areas have the highest concentration.

## Environmental Justice Populations Map





# SOCIETY

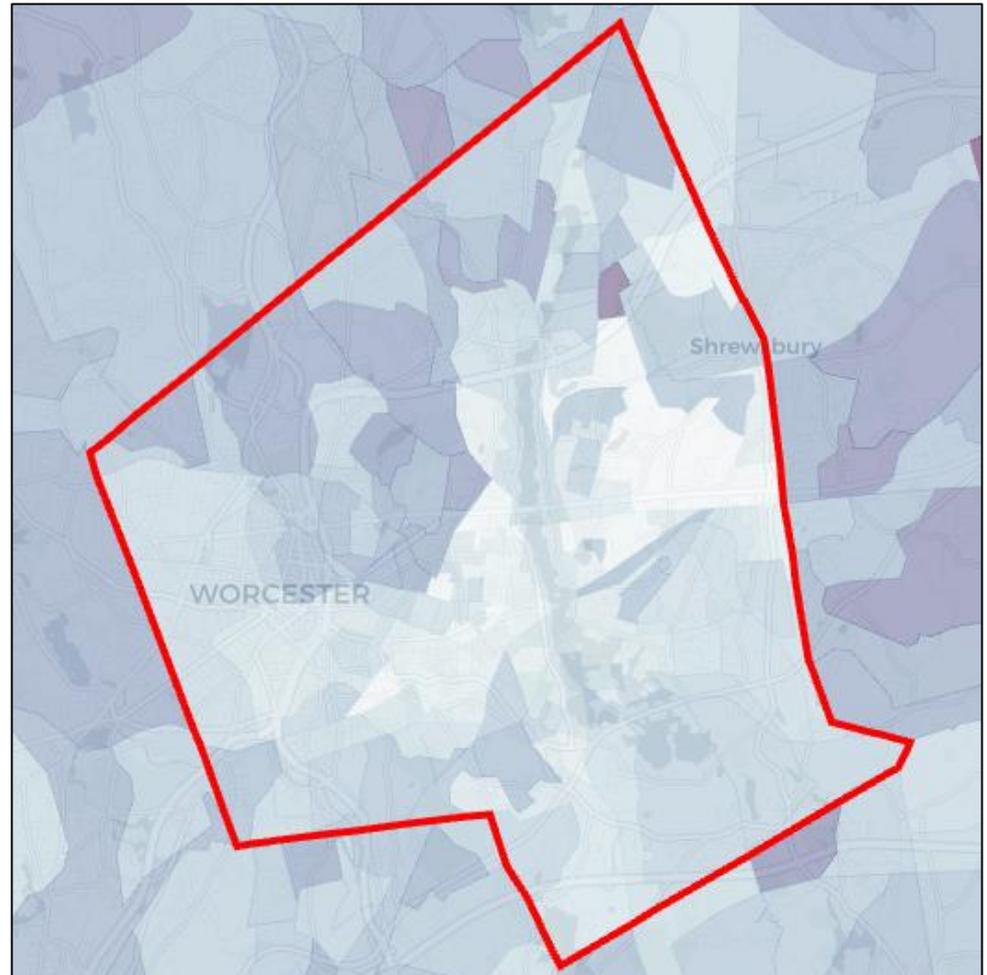
Vulnerable populations, post-incident are most likely to be effected by lack of access to recovery services, displacement, injury, illness, loss of employment, and property damage.

## Worcester Stats : Income

- Median Income: \$56,221
  - MA median income: \$68,563.
  - County median income: \$65,313
- Poverty: 22.4%
  - MA poverty: 11.6%
  - County poverty: 11.8%

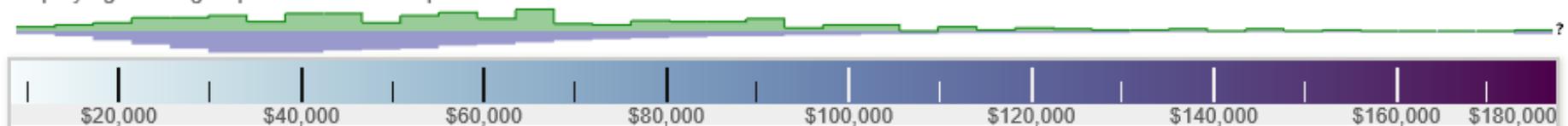
Source: Worcester Hazard Mitigation Plan [DRAFT], 2018

## Median Household Income Graphic



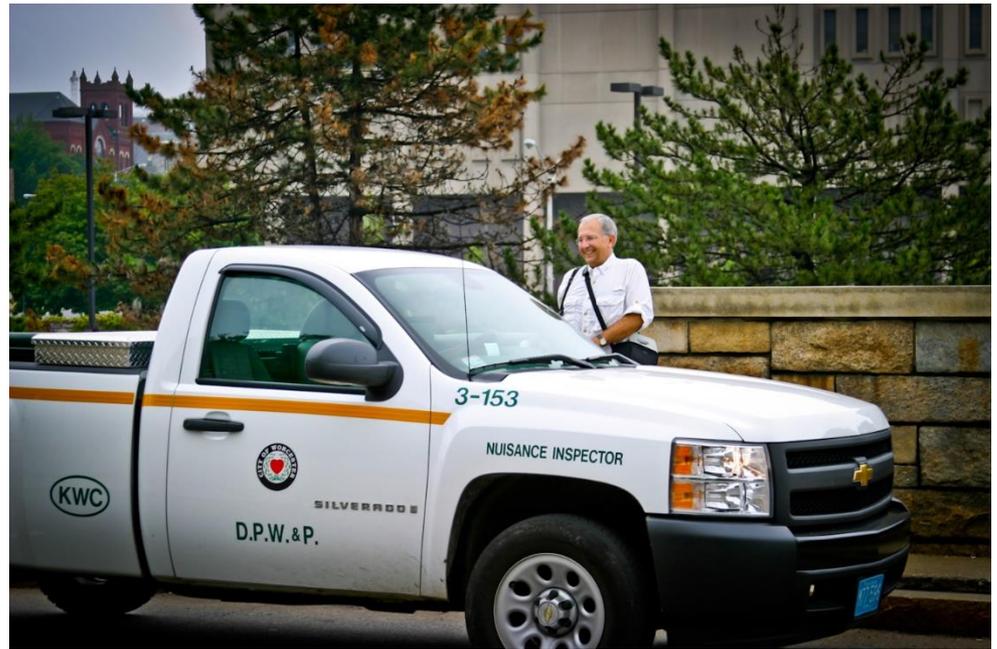
Displaying: block groups. Zoom out and pan to view other areas

Based on 2000-2016 data





# SOCIETY



© 2011 Scott Erb - Erb Photography

# ENVIRONMENT

Benefits of natural systems include:

- Flood storage
- Recreation and tourism
- Cooling during heat waves
- Biodiversity conservation
- Water filtration
- Mobility Vulnerabilities
- Water quality and quantity
- Air Quality

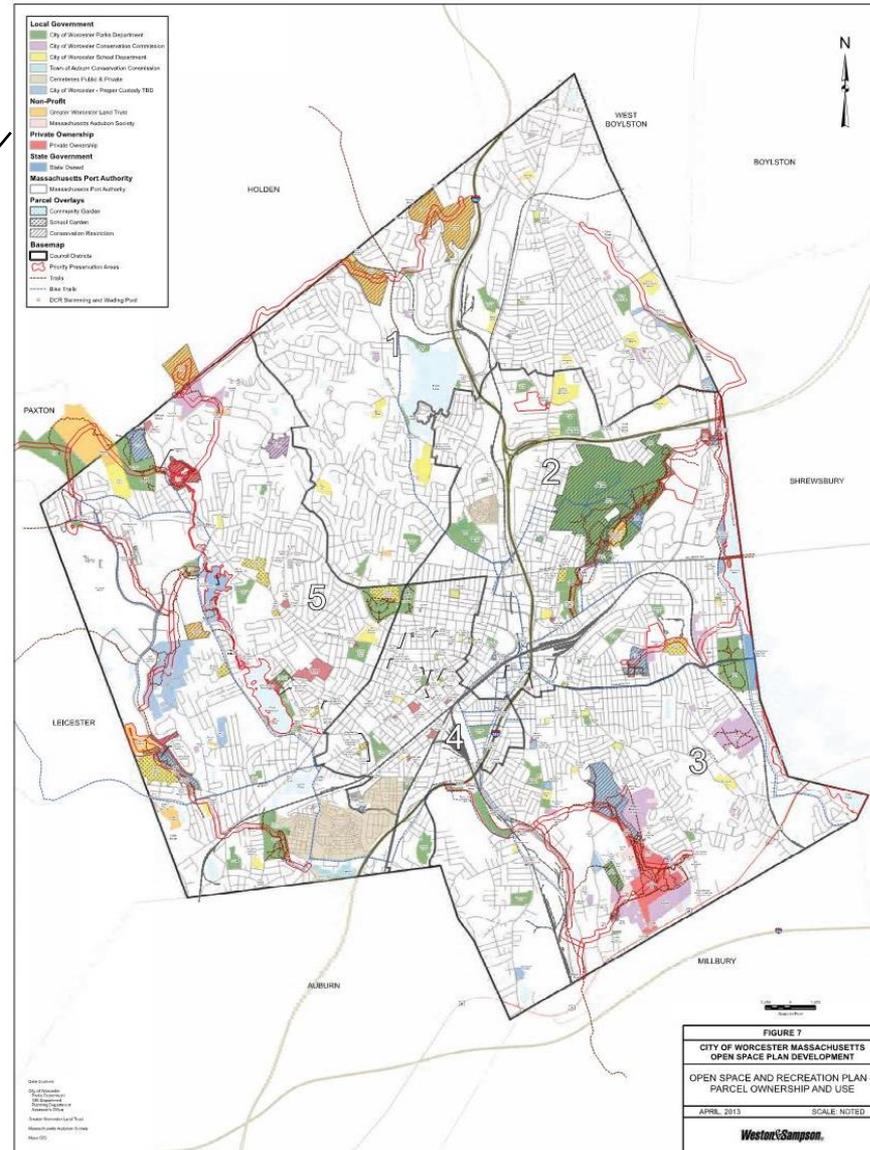
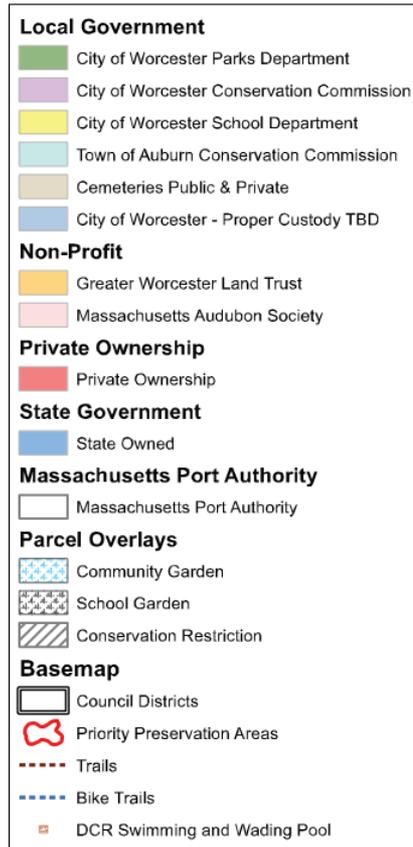




# ENVIRONMENT – PARKS AND OPEN SPACE

## Open Space and Recreation Map

- Parks and open space are essential for cooling and air quality in the city.
- Encourage outdoor activity for residents.



Source: Weston & Sampson OSRP Report, 2013



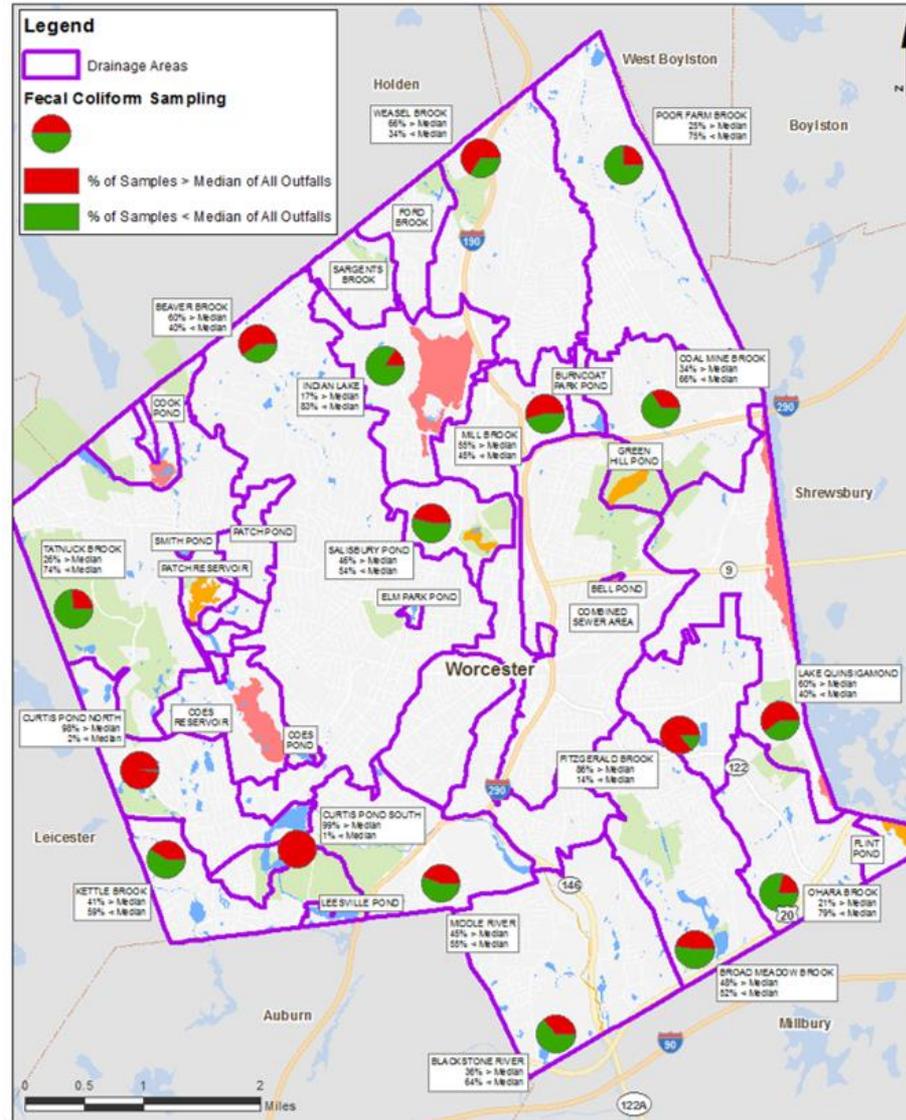
# ENVIRONMENT – POLLUTED WATERWAYS

## Drainage Areas and Fecal Coliform Sampling Locations (1999-2016)

Nutrient loads in Worcester waterways can cause dangerous cyanobacterial (blue-green algal) blooms:

- Some pollution comes from storm water and sewer management.
- Other pollution comes from nutrient release from sediment (difficult to pinpoint and address).
- Cyanobacteria in high levels is dangerous to humans and pets and is difficult to detect.

Source: Worcester watershed advocacy group





# ENVIRONMENT

## Environmental Challenges:

- Erosion
- Invasive plant material
- Chronic flooding
- Sedimentation
- Ground and Surface Water Pollution
- Impaired Water Bodies





# ENVIRONMENT – URBAN FOREST

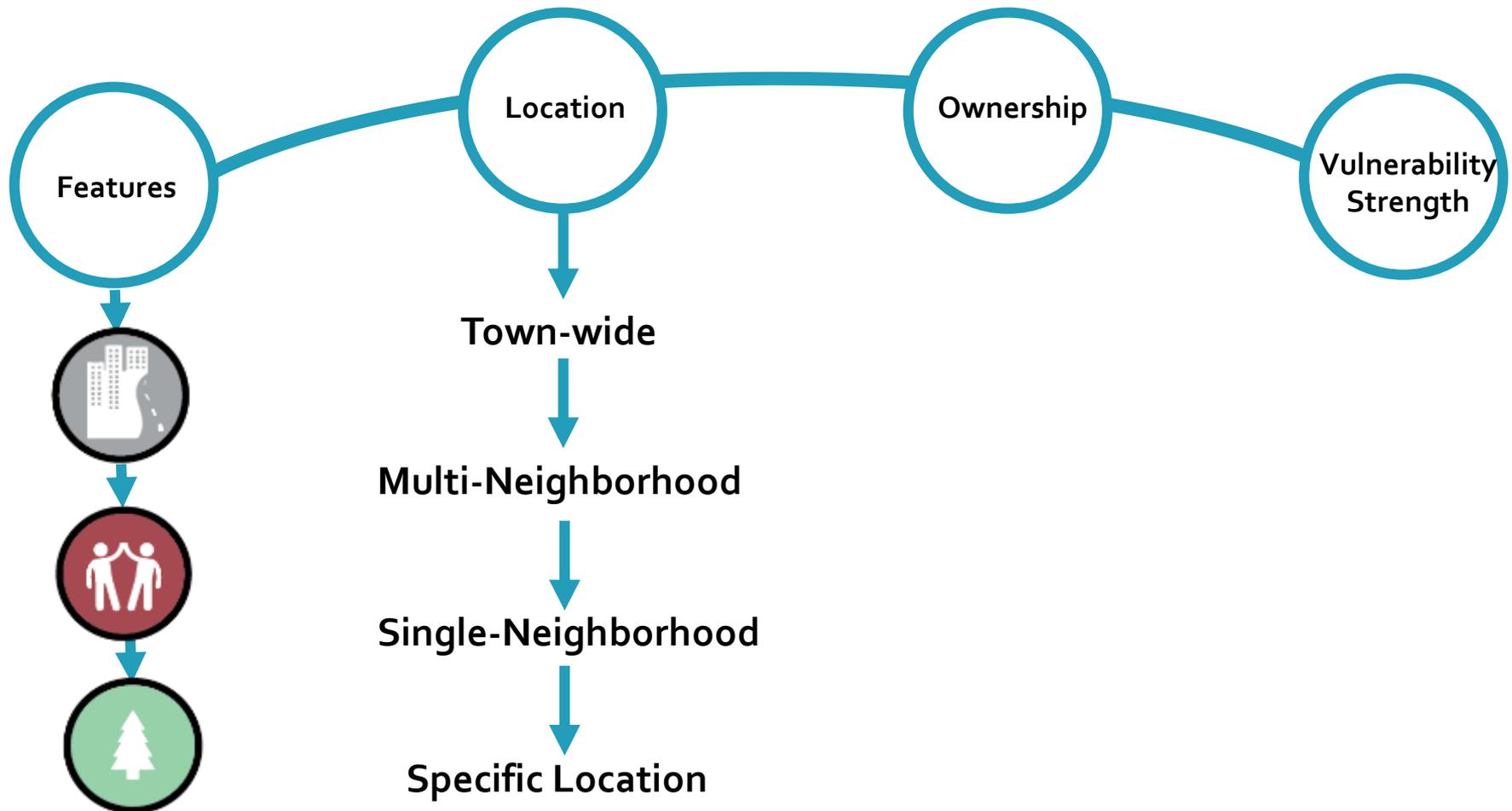
The urban forest is essential for cooling the city. “The average percentage increase in kWh/CDD is 1.17 due to an average one-percentage decrease in canopy cover”.

Block (N = 6)	Percentage Decrease in Canopy Cover (2008-2009)	Percentage Increase (kWh/CDD Usage) after tree removal
1	92	87
2	82	79
3	82	99.6
4	78	116
5	83	140
6	88	67

Table 3: Percent Canopy Cover Difference and Percent kWh Difference between 2008 and 2009.

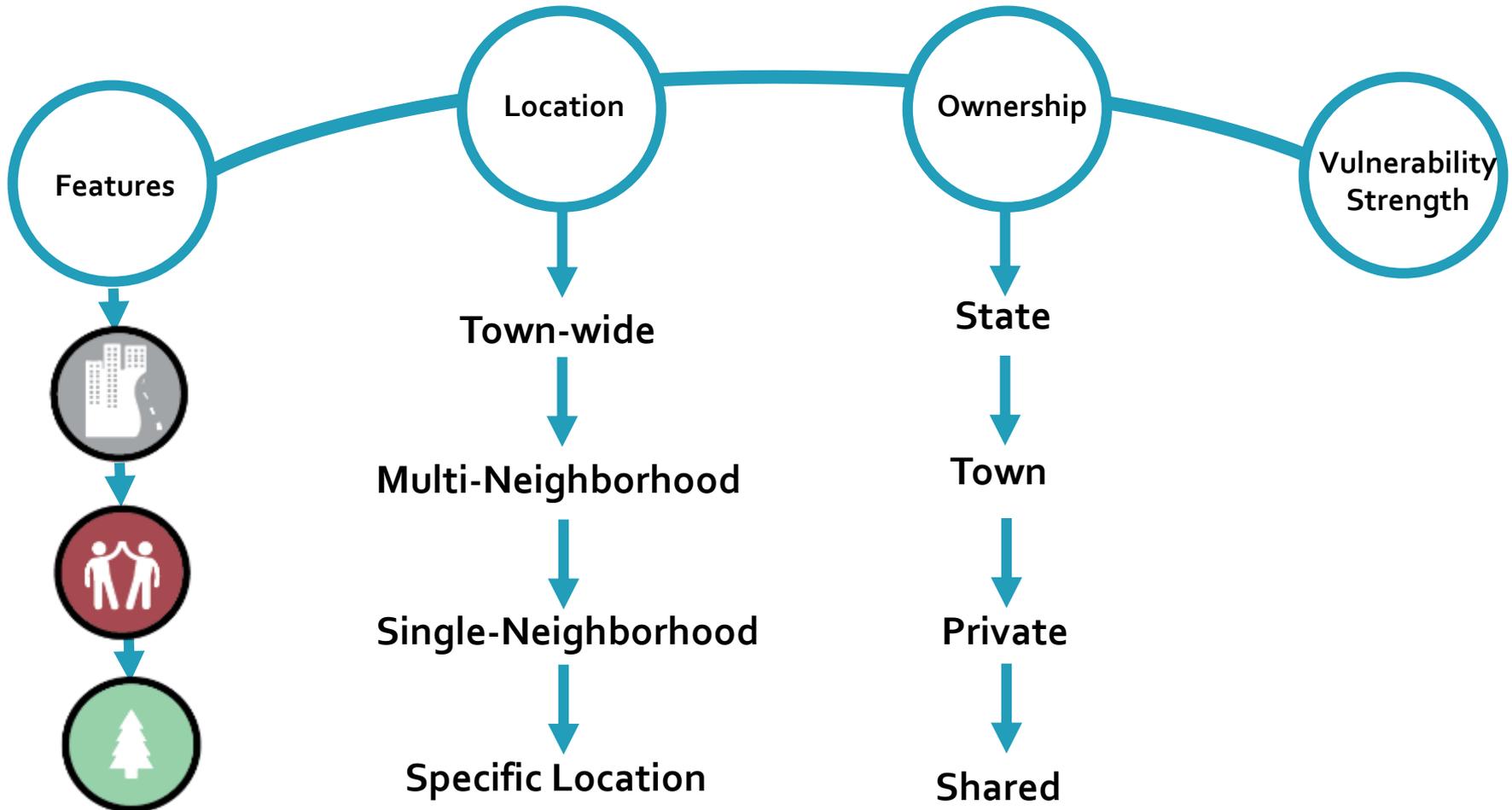
# IV. RESILIENCE & VULNERABILITIES

What are Worcester's infrastructural, societal, and environmental strengths and vulnerabilities?



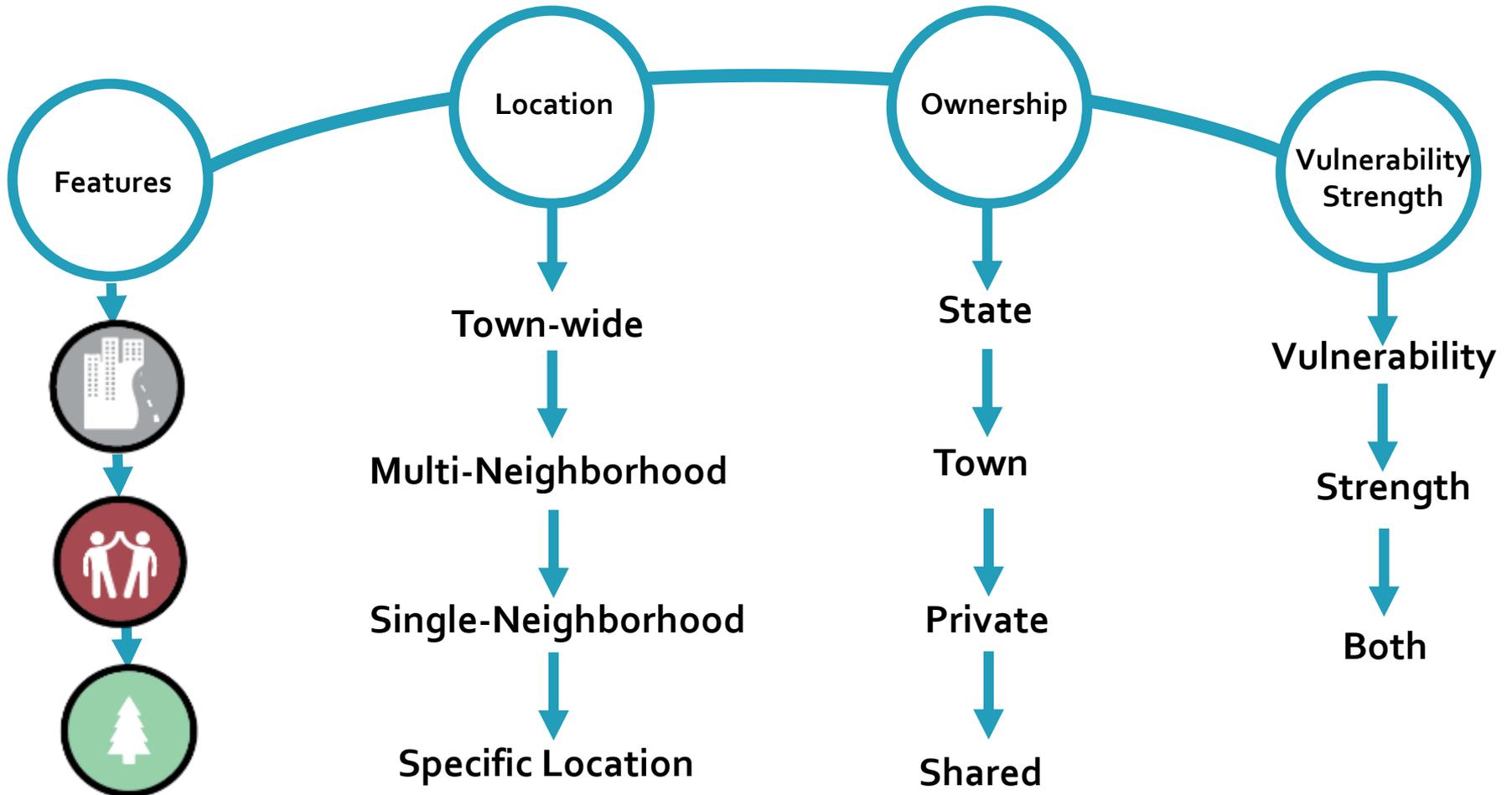
# IV. RESILIENCE & VULNERABILITIES

What are Worcester's infrastructural, societal, and environmental strengths and vulnerabilities?



# IV. RESILIENCE & VULNERABILITIES

What are Worcester's infrastructural, societal, and environmental strengths and vulnerabilities?



# IV. RESILIENCE & VULNERABILITIES

## Small Group Exercise

- What infrastructure, societal features, or important natural resources are exposed to current and future hazards?
- What makes them vulnerable?
- What makes them resilient?
- What are the consequences if the existing vulnerabilities are not addressed?
- *Note: We are working off of provided HMP maps - supplementing work already completed, not starting from scratch.*

The image shows two versions of a 'Community Resilience Building Workshop Risk Matrix'. The left version is a blank template with three main categories: Infrastructure (represented by a building icon), Society (represented by a family icon), and Environment (represented by a tree icon). The right version is a filled-out example with the following data:

Features	Location	Ownership	V or S
<b>Infrastructural</b>			
Town Campus	Specific	Town	V
Evacuation Routes - Roads	Town-wide	Town/State	V
Electrical Distribution System	Multiple	CI&P/Town	V
Dams (inland and coastal)	Multiple	Private	V
Railway and State Bridges	Multiple	Amtrak/State	V
State Roads/Intersections	Town-wide	State/Town	V
Wharves and Shore Infrastructure	Shore	Town-State-Private	V
Waste Water Treatment Facility	Specific	Town	V
New Ambulance Center	Specific	Town	S
Zoning Regulations (maintain large lot size)	Multiple	Town	S

# V. LUNCH – 1 HOUR

## WORCESTER COMMUNITY RESILIENCE BUILDING WORKSHOP



# VI. COMMUNITY ACTIONS

Case Studies

HAZARDS



FEATURES

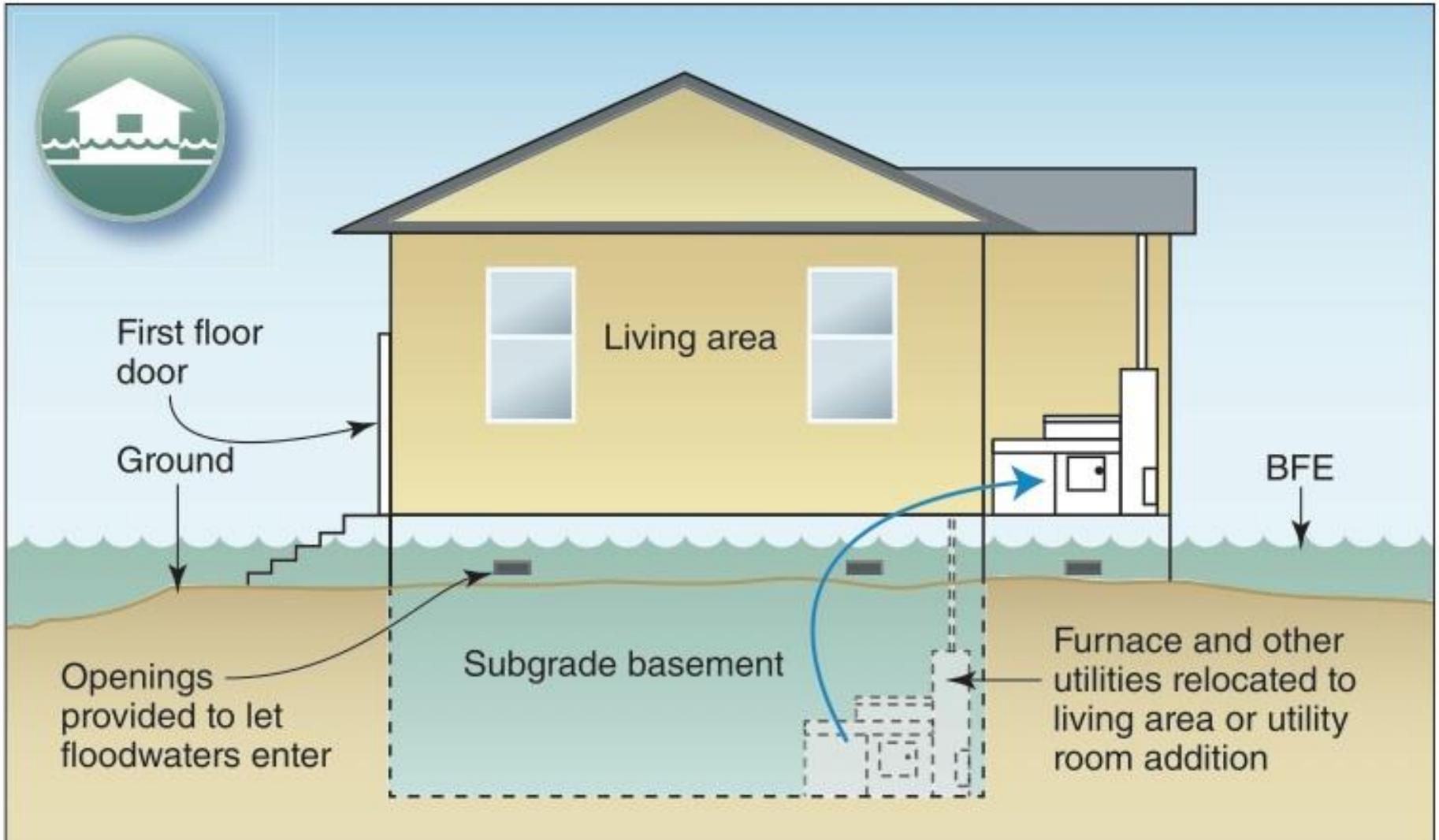


Strategies



# WET FLOODPROOFING

Community Action





# RAISED BUILDINGS

Community Action

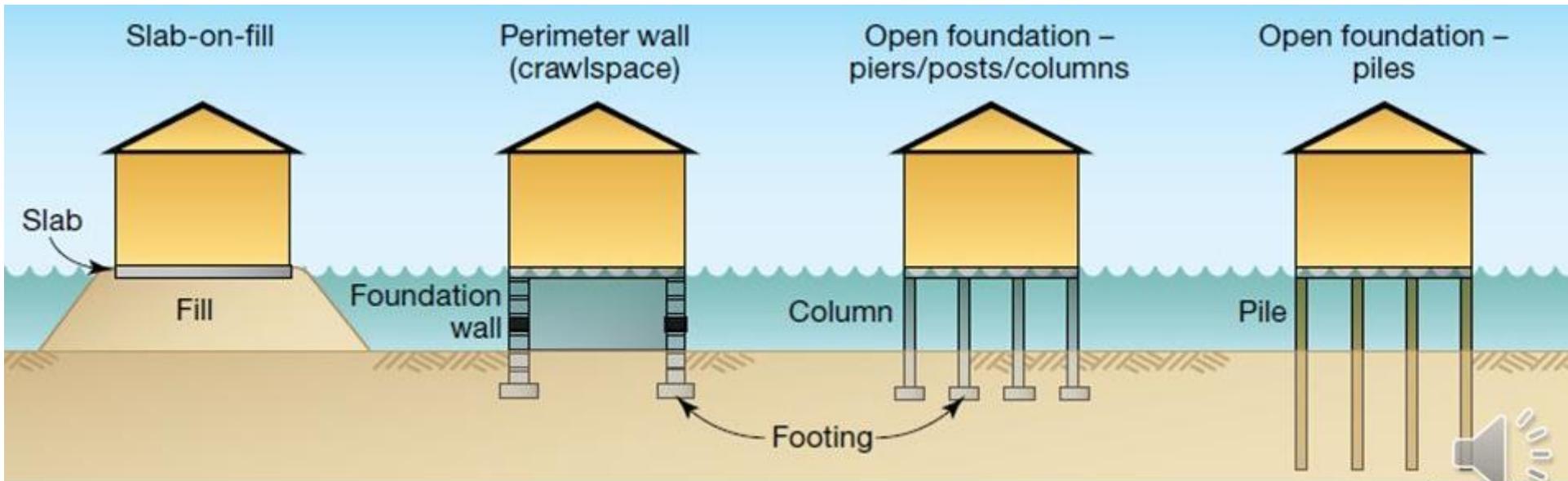


Image source:

FEMA Quick Reference Guide: Comparison of Select NFIP & Building Code Requirements



# ZONING ORDINANCE

Community Action

City of Worcester



## Zoning Ordinance

**Ordained in City Council April 2, 1991**

**As amended through June 26, 2018**

Current Zoning Ordinance, amended June 2018 as an ARTICLE VI – FLOODPLAIN OVERLAY DISTRICT

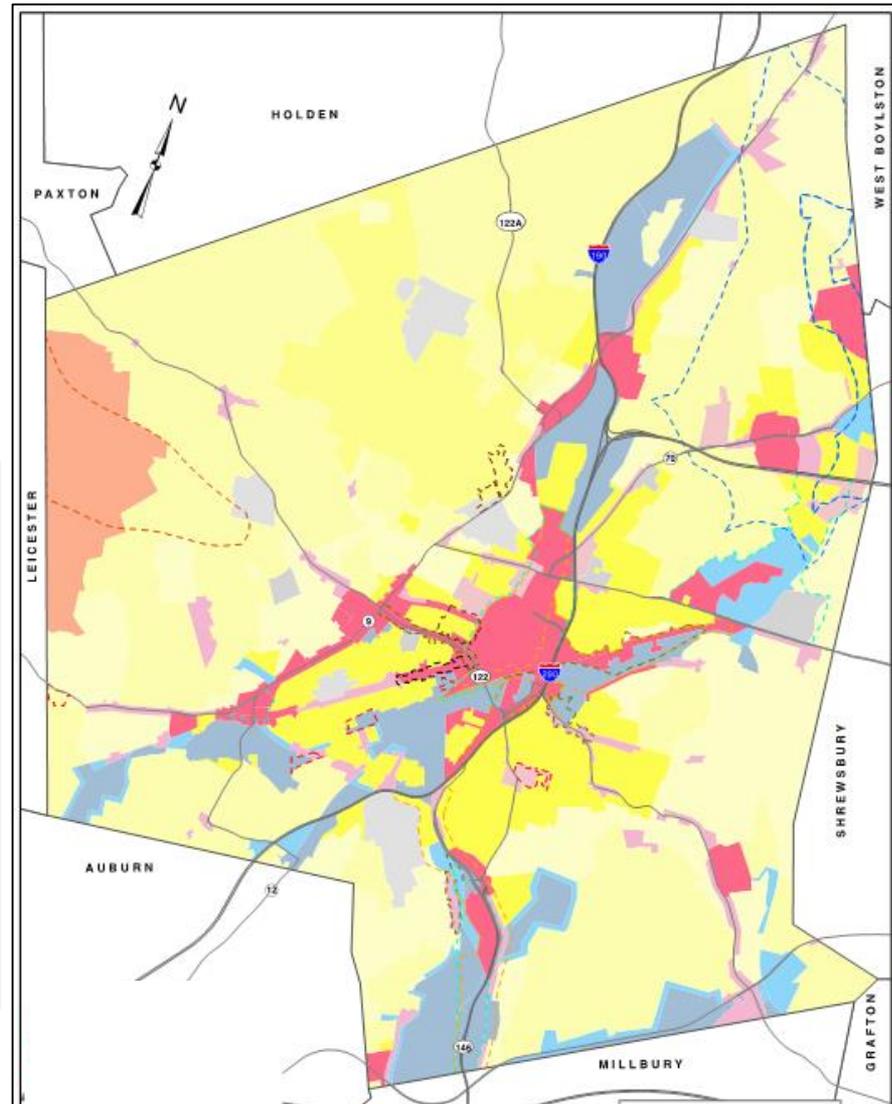
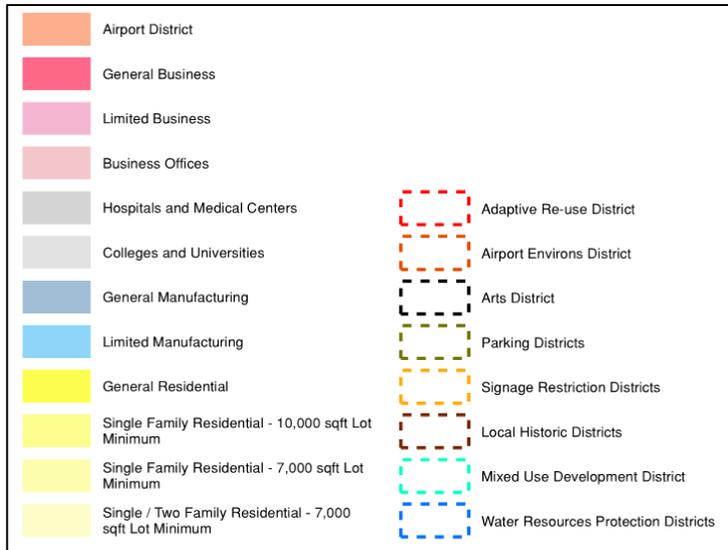
Source: <http://www.worcesterma.gov/uploads/9a/bc/9abccoac3b139cc162db2867ae374da8/zoning-ord.pdf>



# ZONING

## Zoning and Overlay Map

Land use breakdown for the city of Worcester



Source: Weston & Sampson OSRP Report, 2013



# DECORATIVE FLOOD WALLS

Community Action



Source: ABC News, KAAL TV



Source: FloodBreak



Source: Terrascapes Landscape Design



# DEMOUNTABLE FLOOD PANELS

Community Action

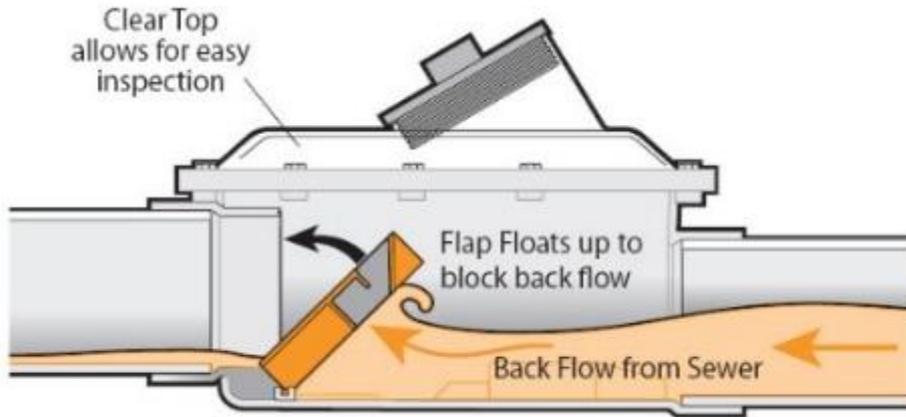




# PREVENTING SEWER BACKFLOW

Community Action

## Backflow Preventer Valve



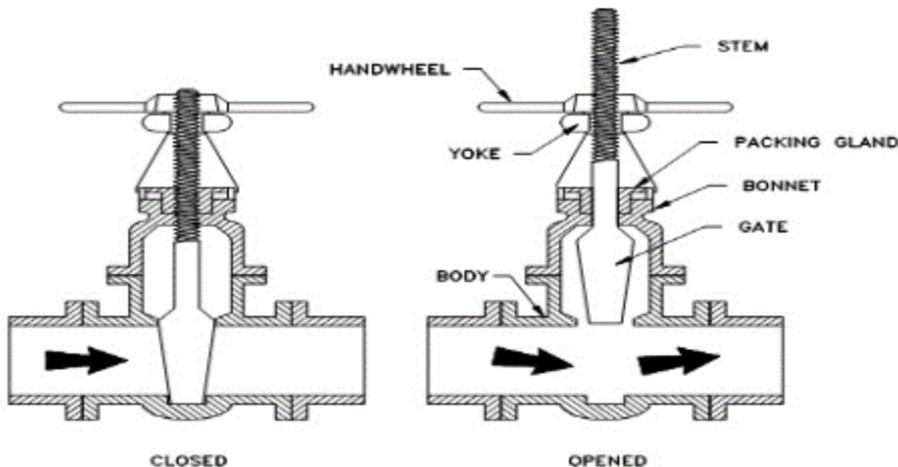
### Pros:

- Closes automatically

### Cons:

- Flap can get stuck (fail)
- Requires maintenance

## Sewer Shutoff Valve



### Pros:

- Reliable

### Cons:

- Someone has to close it



# BERMS WITH BENEFITS

Community Action

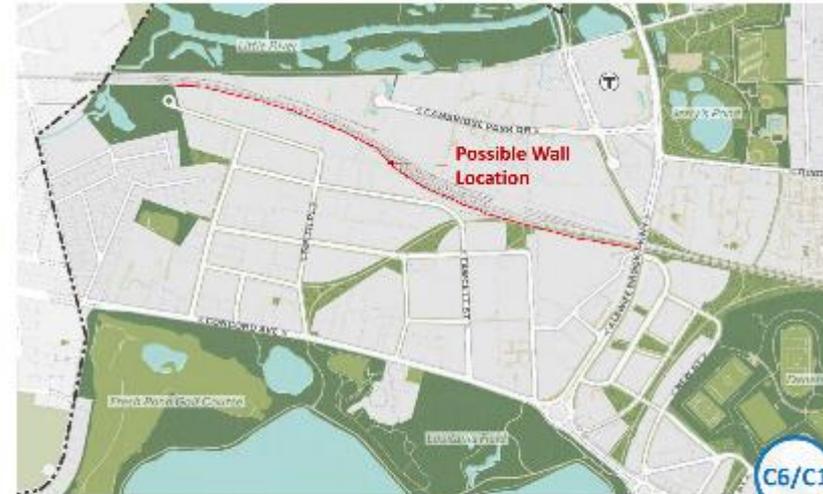
## PROTECTING FRESH POND



[SOURCE: CCPR, 2017]

Evaluate building a vegetated berm at elevation 23.15 feet CCB\* along the Fresh Pond Golf Course. This strategy could effectively protect the Fresh Pond Reservoir for up to the 2070 100-year sea level rise / storm surge flooding.

\*Cambridge city-base datum



[SOURCE: CCPR, 2017]

Evaluate building a flood wall at elevation 22.5 feet CCB South of the railroad track along the Alewife Quadrangle. Building a flood wall at this location can protect the Fresh Pond Reservoir, as well as the Alewife Quadrangle neighborhood.

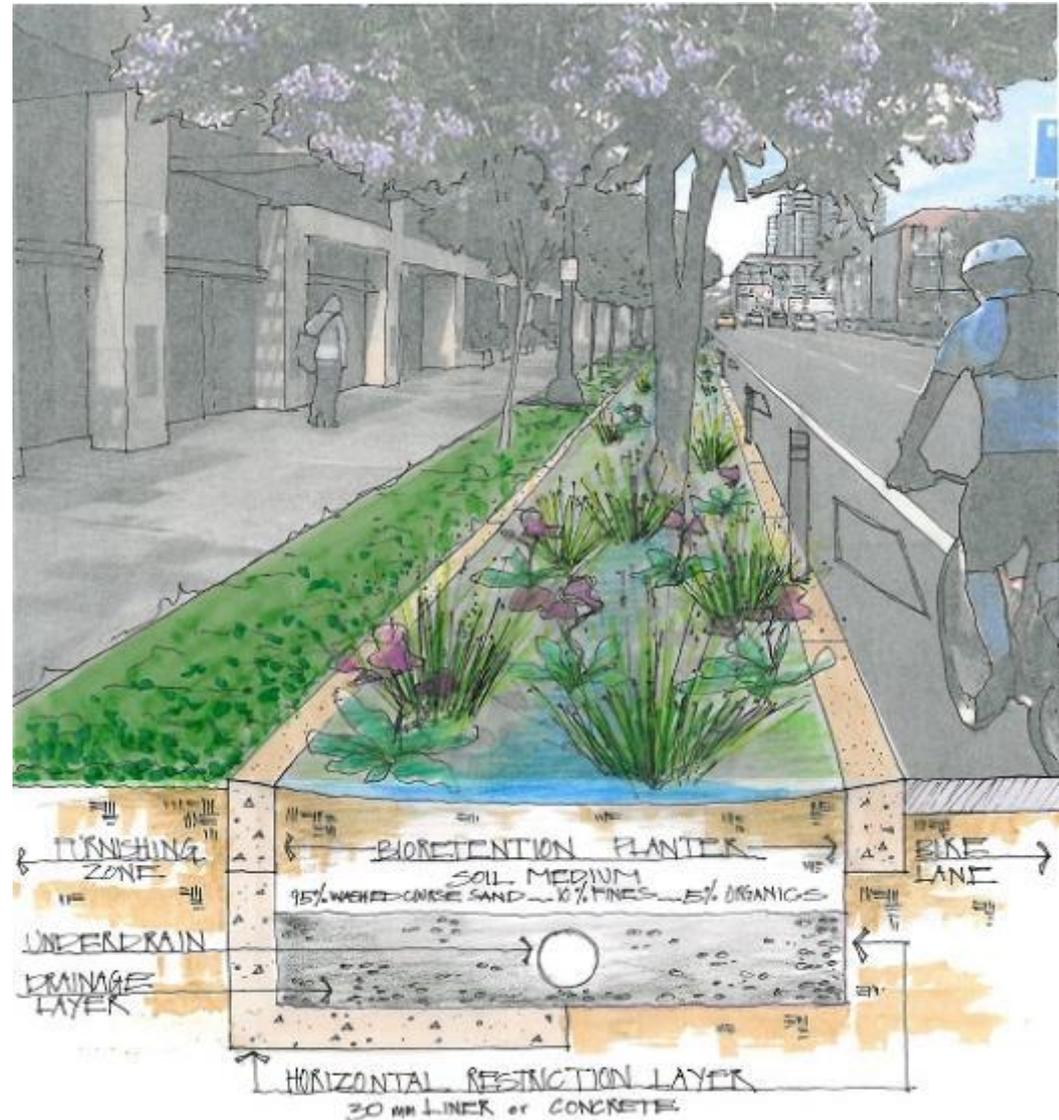


# GREEN INFRASTRUCTURE

Community Action

## Benefits of Low Impact Development (LID)

- Flow Control
- Detention
- Retention
- Filtration
- Infiltration
- Treatment



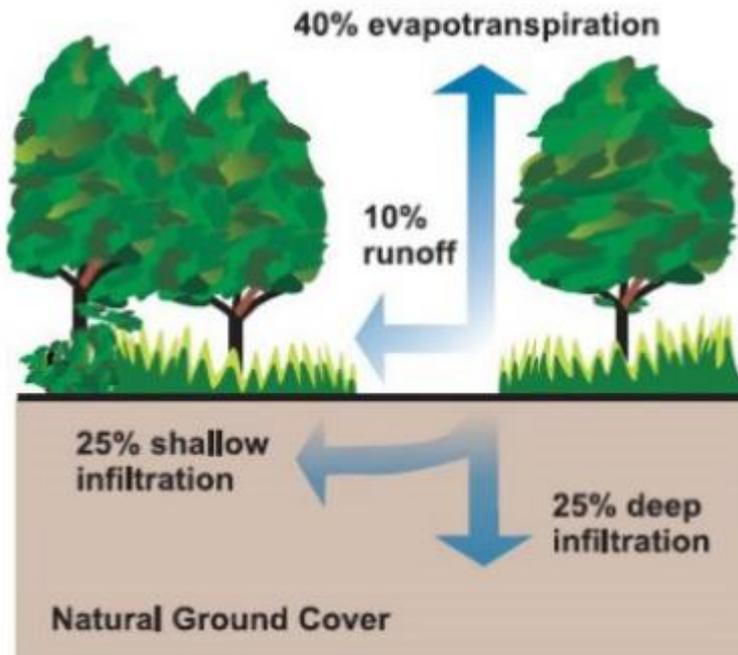


# GREEN INFRASTRUCTURE

## Community Action

Local example: Broad Meadow Brook

- Rainfall runoff from impervious surfaces, such as roads, rooftops and parking lots pick up harmful pollutants and flow into local waterways like Broad Meadow Brook.





# GREEN INFRASTRUCTURE

Community Action

Broad Meadow Brook: LID strategies implemented



Stormwater  
Capture



Rain Gardens



Rain Barrels



No-Mow  
Open Space

Source: <https://www.massaudubon.org/get-outdoors/wildlife-sanctuaries/broad-meadow-brook/about/green-features/water-conservation>



# PERMEABLE PAVEMENT

Community Action



Permeable

Impermeable

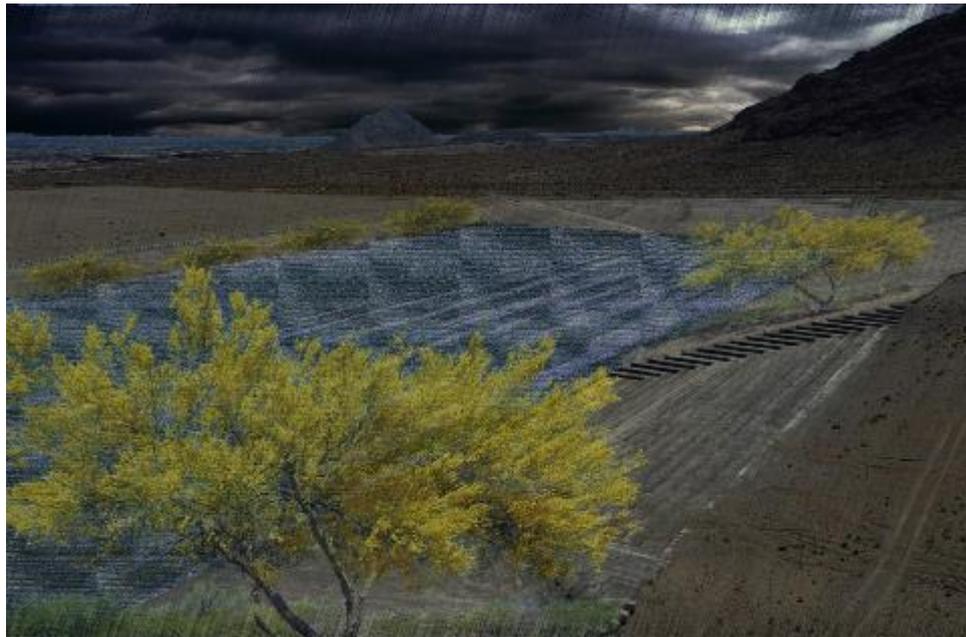


# DUAL-USE FLOOD STORAGE

Community Action



Athletic Field



Flood Storage



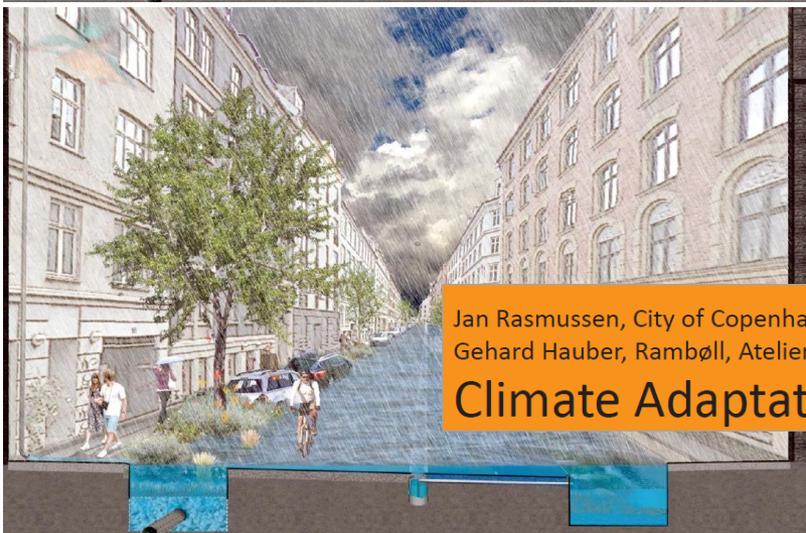
# DUAL-USE FLOOD STORAGE

Community Action

Explore innovative options for managing stormwater

Canal Streets

Open Spaces



Jan Rasmussen, City of Copenhagen  
Gehard Hauber, Rambøll, Atelier Dreiseitl  
**Climate Adaptation**



**North Point Park**



# MULTI-BENEFIT WATER INFRASTRUCTURE

Community Action



Single Purpose



Multi-Benefit



# MULTI-USE LEVEES

Community Action



Flood Protection



Mobility



# PREPARE

Community Action

Equipment



Contracts



Storage





# CLEAR COMMUNICATION

Community Action

Emergency Notification System

Keeping our citizens informed

Sign up for **CODE RED**

## WINTER IS COMING

AND SO IS THE WORCESTER WINTER PARKING BAN

**EMERGENCY SNOW ROUTE**

**NO PARKING TOW ZONE  
DEC 1-APR 30  
2AM-6AM  
AND WHEN DECLARED**

WORCESTERMA.GOV

**WINTER BAN**

**NO PARKING TOW ZONE  
WHEN DECLARED**

WORCESTERMA.GOV

**STAY IN THE KNOW AND BE BETTER PREPARED FOR EMERGENCIES:**

- @WorcesterDPW, @SnowParkingBan, @TweetWorcester
- [www.facebook.com/WorcesterDPW/](http://www.facebook.com/WorcesterDPW/)  
[www.facebook.com/WorcesterMassachusettsOfficial/](http://www.facebook.com/WorcesterMassachusettsOfficial/)
- [worcesterma.gov/e-services/winter-parking-ban/](http://worcesterma.gov/e-services/winter-parking-ban/)
- (508) 929-1300 City Government Channel 192

SIGN UP TODAY FOR FREE PUSH NOTIFICATIONS & CREATE YOUR FREE SMART911 SAFETY PROFILE



# DEICING ROADS

Community Action

## Equipment



15 million tons of deicing salt are used each year in the United States



# ALTERNATIVE OPTIONS

Community Action

Other options?





**SNOW & ICE**  
Community Action

What would Dwight Schrute do?

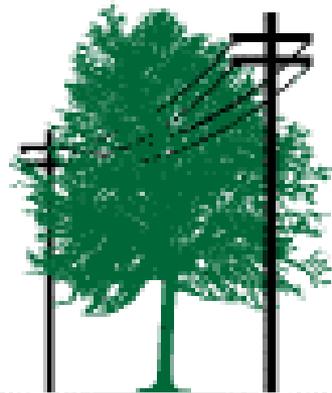


Source: NBC The Office

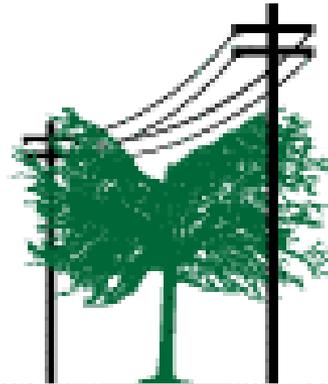


# STAY ON TOP OF MAINTENANCE

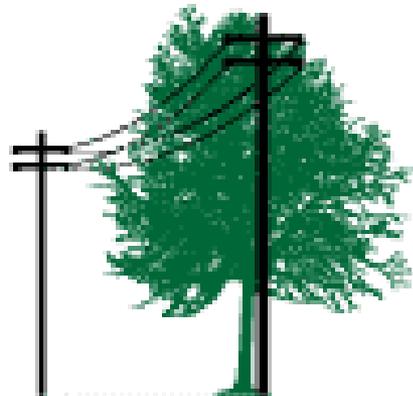
Community Action



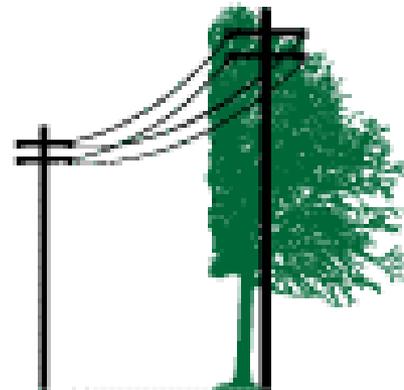
**BEFORE "V"  
PRUNING**



**AFTER "V"  
PRUNING**



**BEFORE SIDE  
PRUNING**



**AFTER SIDE  
PRUNING**



# STREET TREES/ URBAN FOREST

Community Action



Source: Conservation Magazine

In Worcester – A study in the Burncoat Neighborhood showed that urban tree removal resulted in 98% increase in mean energy use during the summer of 2009.

Source: University of Massachusetts, Amherst



# REDUCE PAVEMENT

Community Action

Reduce Asphalt with:

- Infill development
- Native Landscaping
- Solar power canopy devices





# COOLING CENTERS

Community Action

Cooling centers are:  
Air-conditioned public facilities where people may go for relief during periods of extreme heat.





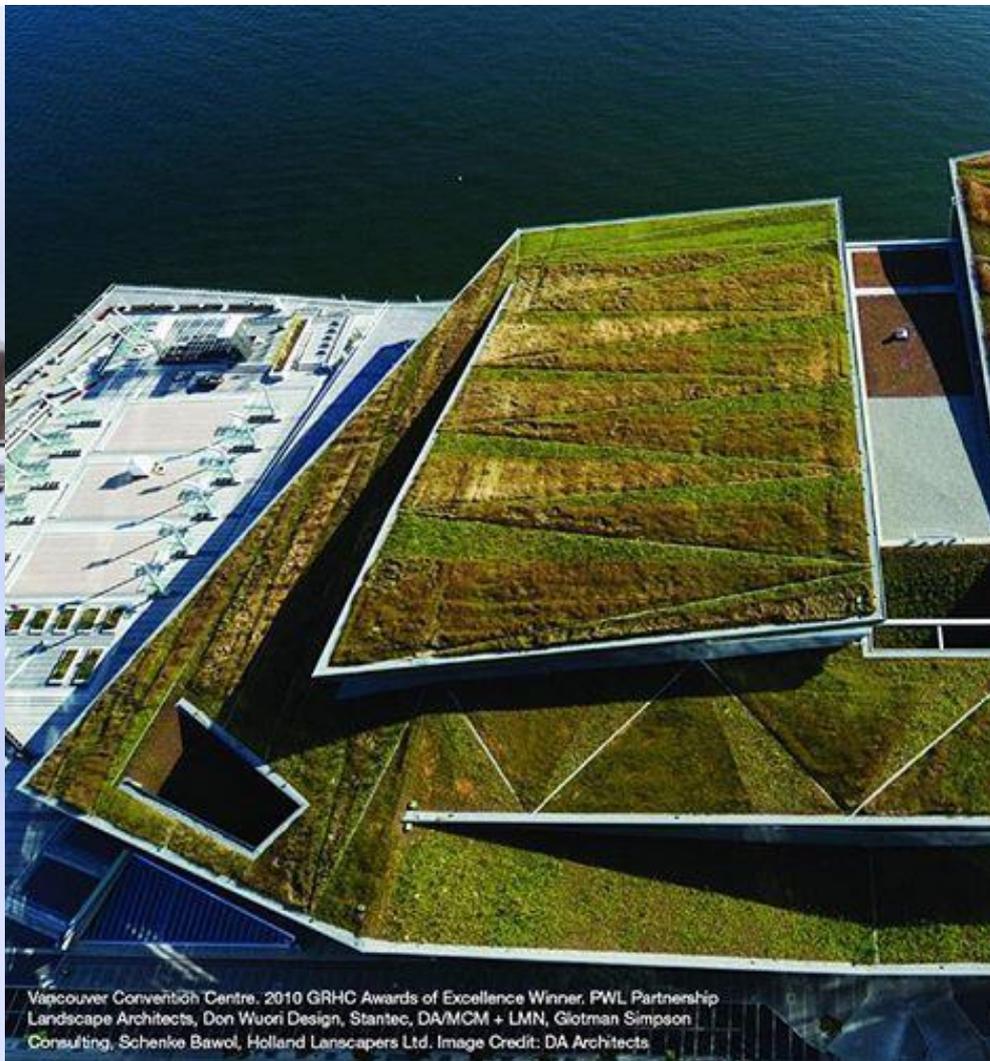
# ALTERNATIVE ROOFS

Community Action

White Roofs



Green Roofs

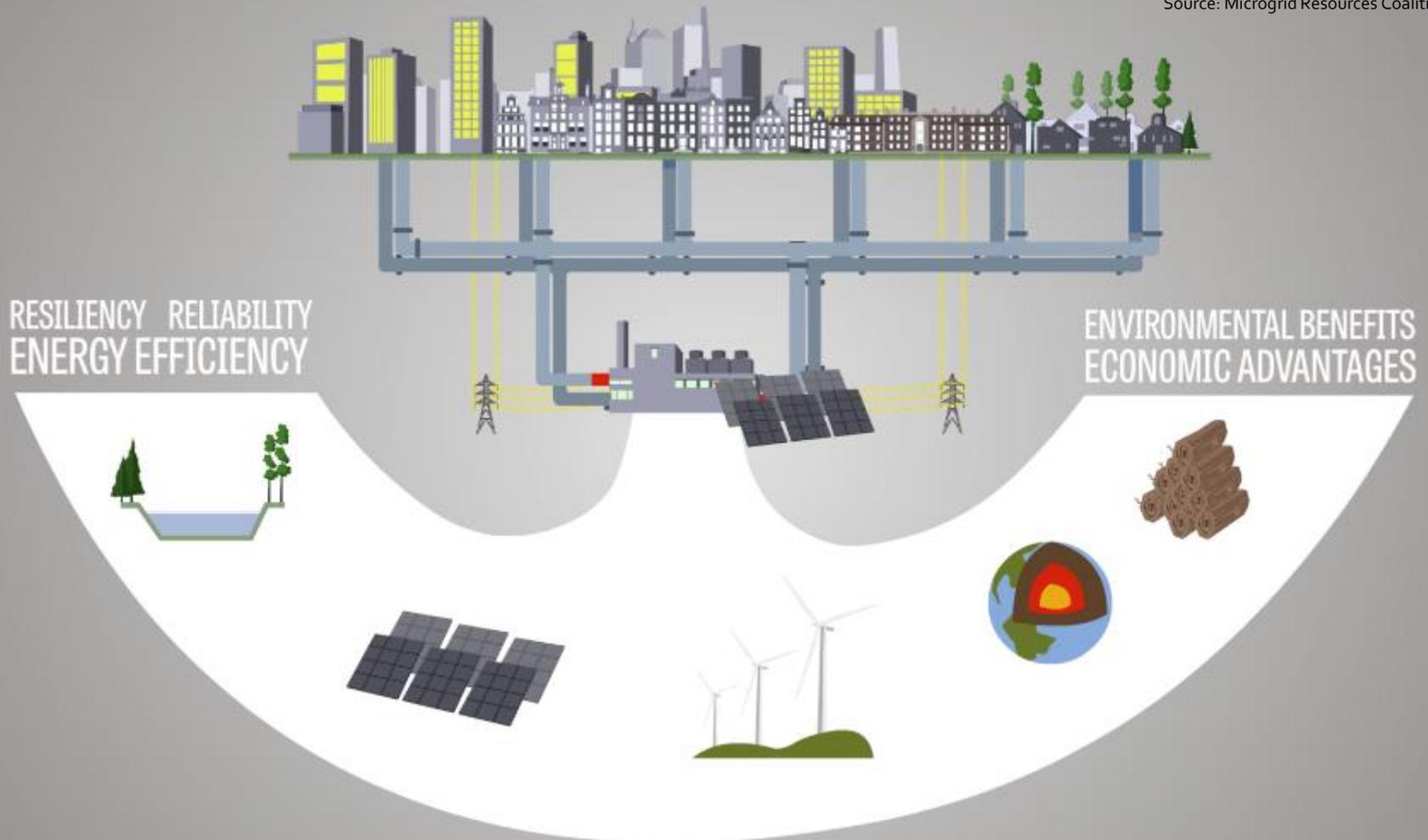




# RENEWABLE MICRO-GRIDS

Community Action

Source: Microgrid Resources Coalition





# VII. WATER RESTRICTION ADVISORY

Community Action

Drought Action Level Response signs are located around the Town of Harwich. These signs, as well as our website, are updated when an action level is active.

## HARWICH WATER DEPARTMENT DROUGHT ACTION LEVEL RESPONSES

ACTION LEVEL	RESPONSE	FREQUENCY OF MONITORING
<b>NORMAL</b>	NORMAL WATERING CONDITIONS	
<b>ADVISORY</b>	VOLUNTARY WATER RESTRICTIONS ODD/EVEN DAYS	
<b>WATCH</b>	<b>MANDATORY:</b> ODD/EVEN LAWN WATER & OFF-PEAK HOURS	
<b>WARNING</b>	<b>MANDATORY:</b> 2 DAY PER WEEK OUTDOOR USE & OFF-PEAK HOURS	
<b>EMERGENCY</b>	<b>MANDATORY:</b> BAN ON ALL NON- ESSENTIAL OUTDOOR WATER USE	

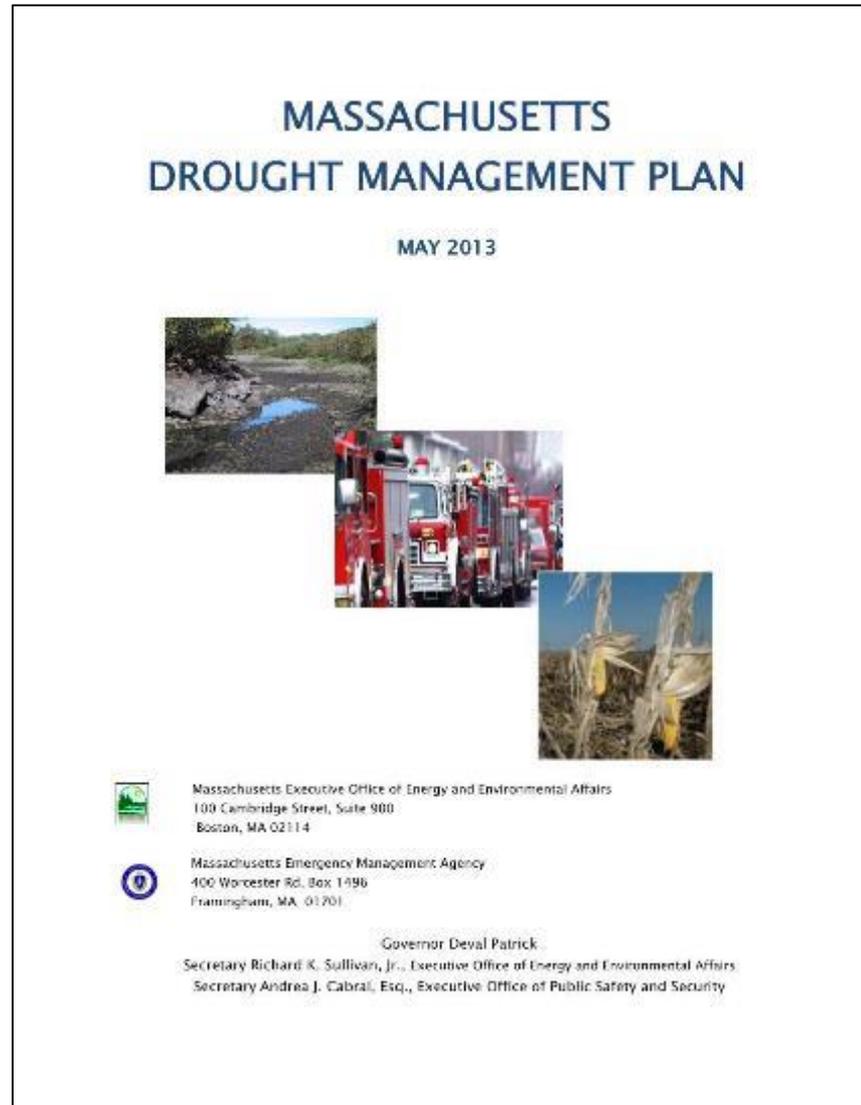
[Learn More ▶](#)

Source: Harwich Water Department



# VII. DROUGHT MANAGEMENT PLANS

## Community Action





# VII. BREAK – 15 MINS

## WORCESTER COMMUNITY RESILIENCE BUILDING WORKSHOP



# VIII. PRIORITY ACTIONS

Factors to consider:

- 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



## VIII. PRIORITY ACTIONS – GROUP ACTIVITY

- Small group presentation of Top Infrastructural, Societal, and Environmental features

# RESULTS – GROUP 1

- Infrastructure
- Societal
- Environmental

# RESULTS – GROUP 2

- Infrastructure
- Societal
- Environmental

# RESULTS – GROUP 3

- Infrastructure
- Societal
- Environmental

# RESULTS – GROUP 4

- Infrastructure
- Societal
- Environmental

# RESULTS – GROUP 5

- Infrastructure
- Societal
- Environmental

# RESULTS – GROUP 6

- Infrastructure
- Societal
- Environmental

# IX. SUMMARY AND CLOSING

- Reflections
- Next Steps
- Ways to stay involved

# THANK YOU!!!!

## The Kleinfelder Team

Robin Seidel

Nathalie Beauvais

Indrani Ghosh

Jonnas Jacques

John Rahill

*(from Punchard Consulting)*

Darrin Punchard

# Appendix B

## Worcester Flooding and Critical Assets Map

# Worcester MVP Planning Workshop - January 25, 2019

**Legend**

**Flooding Events Per Square Mile**

- 0 - 25
- 26 - 50
- 51 - 75
- 76 - 125
- 126 - 200

**Critical Infrastructure**

- Public Sites and Facilities
- Schools
- Universities
- Early Education
- Hospitals
- Assisted Living
- Dams
- Dam Failure
- Apartments
- Electrical Distribution
- Hazardous Waste Site
- Police
- Misc

Holden

West Boylston

Boylston

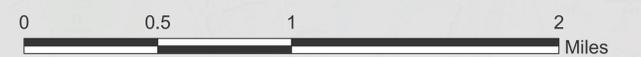
Paxton

Shrewsbury

Leicester

Auburn

Millbury



# Appendix C

## Final Risk Matrix Results from the CRB Workshop

# Community Resilience Building Risk Matrix



H-M-L priority for action over the Short or Long term (and Ongoing)

V = Vulnerability S = Strength

www.CommunityResilienceBuilding.org

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

Group	Features	Location	Ownership	V or S	Hazard	Flooding/ Heavy Rain	Ice/Snow Storms/Extreme Cold	Drought/Extreme Heat		Priority	Time
						Actions				H - M - L	Short Long Ongoing
						Infrastructural					
1	Combine Sewer - DCU Center (flooding)	City-center	City	V	Rain/Flooding	1. Betterment tax for properties along flooding route 2. Prioritized sewer separation program				M	L/O
1	Stormwater Drainage System (Worcester Diversion Project.) --> clogging catch basin --> culverts in water course	City-wide	City	V/S	Rain/Flooding	1. Examine stormwater utilities 2. Education program to residents 3. Revisit maintenance (asset management) 4. Evaluate heavily treed area, downtown w/ trash issue, city recycling program (education)				H	L/O
1	Road/Slope (potholes, steep street) --> Asphalt/Drainage	City-wide City-wide	City/State	V/S	ALL	1. Belmont Street - high friction pavement 2. Cambridge street - raise bridge, lower road				L M	L L
1	Built water reservoirs (drought)	Outside city	City	V	Heat/Drought Rain/Snow	1. Building permits, low flow fixtures 2. Public education on level conditions 3. Continue to acquire property in and around reservoirs				M	O
1	Dams (conditions School (aging facilities)	City-wide City-wide	City/private City	V/S	Rain/Flooding Cold/Heat	1. Continue to evaluate dams for assessment / elimination 2. Continue with school upgrade/replacement (yearly)				M H	O O
1	Power Lines (tree canopy / location / access)	City-wide	Utility	V	ALL	1. Continue with Right Tree, Right place, Worcester Tree Initiative 2. Continue coordination with National Grid 3. Combination of education and grant opportunity				H	O
1	Housing (public/residential), age of construction	City-wide	City/residential	V	ALL	Combination of education and grant opportunity				L	L
2	Retaining Walls	Uplands	Private/Public	V	Flooding/Drought	Inventory, zoning to prevent flattening of hills				M	O
2	Old bridge deterioration - freeze/thaw	City-wide	City/State	V	Heat/Cold	Assessment of undersized culverts, bridges restricting flow. (Southgate St bridge, Quinsig @ Cambridge street --> identify car safety)				H	O
2	Undersized / outdated stormwater infrastructure / pipes	City-wide	City	V	Flooding	Green infrastructure. Create stormwater bylaws --> stormwater utility fee. Incentives --> LI credit, high strength sewer discharge				H	S
2	Electricity Infrastructure	City-wide	National Grid / City	V/S	Flooding Ice/Heat	Hardening system (above / below ground) strategically, Battery Storage, solar ordinance, staff				M	L
2	Communication Infrastructure	City-wide	City	V	ALL	Study to identify community leaders to communicate without using cell phones, resiliency hub - social network map. --> Flash flood identification lights/signs				H	S
3	DCU Center (Could be a shelter)	50 Foster St	City	S/V	Flooding / Heat	Green infrastructure to address/mitigate flooding of public right of way. (would improve St Vincent hospital)				L	L
3	Worcester Technical High School (shelter) Primary city shelter	1 Skyline Drive (top of hill)	City	S	Snow/Ice	No action - skyline road already priority road				H	O
3	Railroad track and vehicular underpasses	City-wide	Private/City	V	Flood	1. City to advocate to MBTA for reliable contingency plan. 2. Develop a work in Worcester program so people work where they live				H	S
3	Combined Sewer	City-wide		V	Flood	Challenge is retrofitting to new standards and tap on new development				M/H	O
3	MBTA Commuter rail (regional issue) Worcester Transit WRTA Depot (Endicott street)		State / City	V	Snow flooding						
3	Wastewater treatment plant		State	S/ V	Flooding						
3	Medical Infrastructure (Amass campus, St. Vincent Hospital)		Private	V	Flooding						
3	Schools	City-wide	City	V	Extreme cold / heat	1. Proceed with vulnerability and risk assessment of buildings to identify most at risk / privatized. 2. Identify early actions 3. Develop guidelines for resilient facilities to integrate flooding and heat resilience				H	S

Group	Features	Location	Ownership	V or S	Hazard	Actions	H - M - L	Short Long Ongoing
4	Water filtration plant and reservoir	Holden / Worcester	Public	V/S	Drought	1. Reduce treated water consumption with LID solutions, monetize 2. Fix pipe leaks, increase water use costs, greywater, rationing during drought	H	L
4	Rear power lines and telephone poles	Residential Areas	City	V/S	Ice/Snow	1. Map grid inventory and make it public 2. City and utility company figure out a proactive plan	M	L
4	Transportation system (auto-focus)	City-wide	City	V/S	Cold/Heat/ Flooding	"Complete Streets Initiative" in MA, community education about transportation, Connection with upcoming master plan, and bicycle master plan, hire additional city planner for transportation	M	O
4	National Grid Electricity/Utilities System (Chandler St, Webster St, Lancaster St substations)	City-wide		V/S	Flooding/wind/ Heat	City to work with DPU and utility companies to develop a more effective plan, Public meetings about changes, FUTURE bill in legislature	H	L
4	Older Schools (Doherty and South) - there are lots	City-wide			Heat/Snow/Cold	New buildings are ideal to fix heating/cooling problems. Otherwise fix leaks in insulation, retrofit windows, keep a mind towards efficiency, regular maintenance, potential danger as emergency shelters	H/M	O
4	Aging building Infrastructure				Flooding / Heat / Cold	Help people utilize MassSave, aggregate services, energy efficient building score - initiative for homeowners	H/M	O
5	Water Distribution System	Regional	City	Both	Snow/Ice Extreme Heat	Education about frozen pipes, redundancy systems, public education on water use/reuse	M/H	L/O
5	School Buildings	City-wide	City	Both	ALL	Adaptive capacity (extreme temps.). Schools as neighborhood resilience hub. Green roofs, HVAC, Air quality	H	L
5	Emergency Response (Facilities and Systems)	Regional	Private	Both	ALL	Multi-lingual communications/messaging. (Reverse 911, etc.) Expand CERT to resilient neighborhood network	L/H	S/L
5	Utility Systems	Regional	Private	Both	ALL	Decentralization / Microgrids --> incentives Community / Neighborhood scale solutions	H	L
5	Transportation systems	Regional	ALL	Both	ALL	WRTA building --> Flood risk! Dual-use flood storage / infiltration / education / conveyance, Daylighting Blackstone Canal	H	L
5	Sewer / Stormwater Systems	Citywide	City	Both	Extreme Heat Flooding	Rain gardens, permeable pavement. On-site prevention vs. pipe replacements. Stormwater utility fee + incentives/credits for GI/LID		
6	Hospitals + community health centers + need for urgent care facilities	Various	Private	S	Floodplain	Use as showcase of LID (\$) best practices + accessibility to vulnerable populations	H	O
6	Highway access	West access	Local / State	S/V	All	1. Triage roadways and emergency routes and communication. 2. Identify plan to communicate, public campaign to know what to do	H	S/O
6	Water and Sewer (esp. CSO + Quinsig Ave)	Various		V	Precipitation	1. Wayfinding plan with real-time messaging 2. Shelter access, facilities, evacuation plan 3. Low tech solutions of where flooding occurs (Shore Dr, Harding St, Canal District)	H	S/O
6	Electric Transmission Lines (Old)			V	Wind	Put utilities underground, microgrids / decentralized infrastructure - flood resistant design	M	L/O
6	Reservoirs / Drinking water systems	Holden, Leicester	Local	V/S	Precipitation / drought	Increase water quality monitoring, both recreational and drinking water, including non-regulated sources, better public info campaign on water quality	M/L	L/O
6	Fire/Police/EMS (infrastructure)	Especially vulnerable locations at Route 20 and Amass	Local	V/S	All	High water capability, increase water training, plan and equipment		
6	Stormwater		Local	V	Precipitation	Alternative methods of treating excessive stormwater and keeping drinking water clean, especially as relates to contamination. (ex. Scaling living systems lab and locating GI in needed vulnerable areas to increase capacity of known hazards)	H	S/O
6	Roadway Triage and Management (especially ice and flooding), maintaining roadway network access (especially the west side of the city), develop emergency routes	City-wide, state-wide	Local / State	V	Snow/Ice	Triage roadways and emergency routes and communication? ID plan to communicate, public campaign to know what to do	H	S/O
6	Old housing stock (need retrofitting, health, efficiency)		Private / Local	V	All			
6	Schools K-12 (Sheltering regulations, efficiency --> A/C, etc.)		Private / Local	S	All			
6	Universities (Sheltering regulations, efficiency --> A/C, etc.)		Private / Local	S	All			

Group	Features	Location	Ownership	V or S	Hazard	Actions	H - M - L	Short Long Ongoing	
	<b>Societal</b>								
S	1	Community Action (engagement) Municipal Involvement	City-wide City-wide	Community Community	S S	Heat/Drought ALL	Engage neighborhood communities with educational info	H	O
S	1	Diversity (broadly) Emergency communication	City-wide City-wide	Community Community	S V	ALL	1. Flashing light system for communication hazard / emergencies (educational) 2. Planning work to include diversity form the city (community engagement/outreach) 3. Educate transient population on climate related precautions	H	O
S	1	Displaced populations/housing Mobility of Vulnerable population (especially elderly)	City-wide City-wide	Community Community	V V	Heat / ALL			
S	1	Population distribution / living (access to services)	City-wide	City	V	ALL	WRTA to serve greater community	M	S
S	1	Availability of emergency response staff	City-wide	Community	V/S	ALL	1. Preparing residents to shelter in place 2. Continue collaboration with neighboring communities / agencies 3. Consider engaging emergency volunteers (National Guard)	M	S
S	1	Portion of city may be susceptible to mobility, communication and access issues (especially vulnerable populations)	City-Center	Community	V	ALL	1. Consider utilize ride-share/taxis for emergency transport 2. Tweak building code to be more stringent in flood areas	M	L
S	2	Bus Ops Center / Maintenance Garage	Green Island	WRTA	V	Flooding	Plan for alternative maintenance during flooding events	L	S
S	2	Age of Building Stock	City-wide	Private	V	ALL	Tenant/Owner Education	H	S/O
S	2	Designated storm shelters	City-wide	City	V	Snow / Flood	More robust study of storm shelters overlaid w/hazards (ex: light green = open, red = closed)	H	S
S	2	Vulnerable population at risk (gentrification, lack of education, lack of resources)	City-wide	City	V	Flood Heat	Education (multilingual), Displaced people --> resettlement specialist connected to city	H	O
S	2	Overstressed health providers	City-wide	City/Private	V	Heat	Health Department can facilitate continuity of operations plans for regular hazards	M	S
S	2	Absentee Landlords	City-wide	City	V	ALL	Rental registration - including climate considerations	H	S/O
S	2	Translation / Access to important info	City-wide	City	V	All			
S	2	Green island neighborhood --> social services		private	V	Flooding			
S	3	The Village Family Homeless Shelter (150 Residents, 80 households)	Cambridge Road	Private, OMHA operated	V	Flooding	1. Make sure population at risk know about services available - define and identify population at risk and building trust 2. Building needs to be significantly upgraded and made resilient - challenge is funding. (governance issue) 3. Be more inclusive of population that is disproportionately impacted - broader representation/broader means of communication	H	O
S	3	St. John (temporary shelter, hotel grace over shelter)	44 Temple Street	Private	S	Flooding (Green Island)	Gap between population in need and resources & communication in time of stress		
S	3	People relying on T for jobs in Boston		City	V	Heat		H	S
S	3	Healthy Buildings / Schools		City	V	Wintry Mix (flooding)			
S	3	Affordable Housing (Worcester Housing Authority)		City	V	Wintry Mix (flooding)			
S	3	Senior Centers (Assisted Living)	Mt. Vernon / Multiple	City	V	Flooding / Heat	1. Make sure that they have emergency plans coordinating with public health department and first responders. 2. Assess vulnerability and develop a plan	H L	O L
S	3	Areas for growth/economic development	Downtown	Mixed	V	Flooding / Heat	1. Work with developers on implementing resilient infrastructure 2. Explore ideas for the city to enforce or encourage resiliency measures in new buildings or renovations 3. Advocate for building code to be updated for resiliency regulations 4. The new baseball stadium presents and opportunity for water management/storage in area vulnerable to flooding and UHI and opportunity to join stakeholders in common projects	H	O
S	4	Foreign Language Speaking Populations	City-wide		V/S	Cold/Heat	More engagement and outreach, sustainability focus, information accessibility	H	L
S	4	Leaf Disposal Practices	City-wide		V/S	Flooding/ snow removal	Boost composting programs and education, take leaves/debris to community garden	M	S
S	4	Homeless Population/Shelters				Cold/Heat			
S	4	School Closings / Busing Issues	City-wide			Heat/Cold Snow/Ice	City is working hard on the busing problem, fewer car drop-offs and more effective busing system. Need more data on students/parents routines. Why drop-off?	L	O

Group	Features	Location	Ownership	V or S	Hazard	Actions	H - M - L	Short Long Ongoing	
S	4	Homeowner/Renter disconnect (EJ population)	city-wide		All				
S	4	Poor Populations	City-wide		ALL	More engagement and outreach, sustainability focus	H	L	
S	4	Seasonal Populations	City-wide	V/S	Snow/Ice Flooding	Integrate campuses with sidewalks, bike paths, safe pedestrian walkways, utilize college student energy with internships, research opportunities and summer programs, orientation information	M	L	
S	5	Transportation Fleet / Mobility	Regional	ALL	Both	ALL	Use school buses to address mobility limitations during emergencies Privatize transit system / redevelop	H	L
S	5	Health / Medical Access	Regional/State	Regional/State	S	All	Decrease hospital visits / reliability as 1st resort (hubs, onsite, shelters/schools) Tap into medical resource corps (underused) Alternative treatment options	M	O
S	5	Student Population	Citywide	Public/Private	Both	All	Emerging resource / problem solvers Require unique / specific preparedness / response measures (EOP, etc.)	L	O
S	5	Vulnerable Populations (Seniors, special needs, immigrants, disabled, low/limited income, etc.)	City-wide		V	All	Property protection / personal preparedness (education / outreach) Empower renters / incentivize landlords + property managers to retrofit, adapt, invest in resilience)	H	L
S	5	Inclusive / Collaborative Culture	Citywide		S	All	Build coalitions / resilience hubs --> connect with other social service organizations, demonstrate and replicate	H	L
S	6	Community centers, connections		Private / Local	S/V	All	1. Sheltering plan, public info to be accessible, communication plan, invest in emergency management planning and clear regulations, build CERC team, better interdepartmental cooperation and collaboration 2. Work with state to increase needs and benefits of unifying administrative collaboration. Needed in all municipalities 3. Enhance partnership with other municipalities for regional emergency management	H	S/O
S	6	Fire / Safety Communications		Local	S/V	All			
S	6	Emergency Sheltering and Communication		Private / Local	V	All	1. Sheltering plan, public info to be accessible, communication plan, invest in emergency management planning and clear regulations, build CERC team, better interdepartmental cooperation and collaboration 2. Work with state to increase needs and benefits of unifying administrative collaboration. Needed in all municipalities 3. Enhance partnership with other municipalities for regional emergency management	H	S
S	6	Homeless populations (especially sheltering during extreme weather events, caring for mental health / addicted groups)			V	All	Training program for municipal staff to understand resources available and advisory council (informed by representatives from the community), marketing and outreach (website to reduce language barriers and improve access to services), multidisciplinary training for non-profits, religious organizations etc.	H	L
S	6	Public knowledge / awareness vs. existing conditions of hazards			V	All	Create coding of hazards (ex. flag colors) of water quality and drought to eliminate language barriers and improve communications. Create phone tree to get messages out to neighborhood groups and homeless population by name/list	H	S/O
S	6	Nonprofits (legal, language, housing, and religious organizations)			S	All	Training program for municipal staff to understand resources available and advisory council (informed by representatives from the community), marketing and outreach (website to reduce language barriers and improve access to services), multidisciplinary training for non-profits, religious organizations etc.		
S	6	Public Transportation		Local	S/V	All	Smaller buses - run more frequently, walkable neighborhoods, bikeable streets, city transportation plan, hire transportation planner	H	S/O
S	6	Recreation - waterways, trail system		Local / State	S	All	Campaign for increased use, make inviting	M	L/O
<b>Environmental</b>									
E	1	Topography (7 hills in Worcester) - impact to weather microclimate	City-wide		V	ALL	1. Revisit zoning with respect to microclimates 2. Limit the slope of driveways, stormwater management requirements	M	L
E	1	Residential / Forested brush fires (land use)	City-wide		V	Heat	Right Tree, Right Place	L	O
E	1	Wetlands Conservation Areas	City-wide City-wide	State City/Private/State	S/V S	Rain/Flood	1. Continue with protection and maintenance/inspection, ordinance 2. Provide public education	M	O
E	1	Invasive species (lake organisms, aquatic species, beetles, etc.)	City-wide City-wide		V V	Heat/Flood Flooding	1. Consider implementing pervious pavement 2. City could require landscape buffer	H	O/S
E	1	Air Quality			V	Heat	1. Focus on increased enforcement/compliance (school retrofits) 2. Expand reporting, implement carbon tax	H	L
E	1	Open Space Recreation / Waterways			S/V	Flooding	1. City to evaluate vacant/unused lots for green infrastructure (Park aver, Mill stop/shop)	H	S
E	2	Hills	City-wide	City	S/V	Flooding/Heat	Wind power, improving pedestrian network	L/H	L/S/O

Group	Features	Location	Ownership	V or S	Hazard	Actions	H - M - L	Short Long Ongoing	
E	2	Parks + Open Space	City-wide	City	S	Heat	1. Open space under I90 near Indian lake 2. Upland stormwater detention 3. Bike infrastructure --> complete streets	M M H	L L S
E	2	Trees	City-wide	City	S/V	ALL	Urban forest master plan	M	S
E	2	Water Bodies	City-wide	City	S/V	All	1. Study Beaver Brook daylighting 2. Purchase repetitive loss properties for stormwater retention / storage 3. Wetland migration / growth plan	L L M	L L L
E	2	Soil Contamination	City-wide	City/EPA	V	Flooding	LID zoning requirement for new parking, education on upland fertilizer use, city could set a % of GI funds relative to grey infrastructure	H	S
E	2	Waste/Trash/Garbage/Water	City-wide	City	V	Drought / Flood	City food composting --> commercial and residential. Study or policy. Cost benefit analysis of waste bin practices	H	S
E	3	Water Reservoirs	Holden	City	V	Drought	There is a plan B to purchase		
E	3	Waterway - Water Quality	System	City	V	Flood	1. Continue sewer separation - proceed with feasibility study. 2. Timing opportunity with new development for integrated approach (GI)	M/H	O
E	4	Gas Leaks and Methane Emission	Near Schools			Heat	Fix gas leaks, FUTURE bill in legislature	H	O
E	4	Tree Canopy	Downtown		V	Drought/Heat	Plant trees in urban areas of the city, Worcester Tree Initiative, more funding, trees on the street should be default, not homeowner choice.	M	O
E	4	City Parks	Not near downtown			Drought/Heat	MVP Plan should dovetail with Worcester Open Space plan, pocket parks, converting parking lots / unused space to public parks downtown	H	S
E	4	Recreational Water Bodies	Indian Lake, Coen Pond, Quinsig Lake			Heat/ Flooding			
E	4	Pathogens	City-wide			Heat/Drought flooding	Assess and collect data to define problem, align solution with existing community health improvement plan, get college students involved in research (could be an add-on to community gardening)	H	L/S
E	5	Tree Cover	City-wide	All	S/V	Flooding Snow/Ice/ Extreme Heat	Expand Worcester Tree Initiative (replace plantings, preserve), Incentives for private land owners, drought resistant landscaping	H	O
E	5	Waterways / Wetlands	City-wide	All	Both	Flooding	Expand, enhance, protect existing resources (lakes and ponds) Stormwater improvements	H	O
E	5	Hills	City-wide	All	Both	Snow/Ice Flooding	Power generation, LID (restrictions?), Snow melt / stormwater retention? Deicing / Road treatment	L	L
E	5	Brownfield Sites	Mostly CBD (but elsewhere)	All	V	Flood	Cap / prevent infiltration but full redevelop in a resilient way	L	O
E	5	Green / Open Space	City-wide	All	S	Flood			
E	5	Soil Contamination	City-wide	City	S	All			
E	6	Blue Space	V/S	Local	S/V	Drought / Precipitation	Maintain and market as a resource, especially drought and temperature. Increase role of blue space as a park. Integrate blue/green interface and work with nonprofits and schools to foster environmental	M	L/O
E	6	Watershed and Forest Management		Local	S/V	Heat, wind			
E	6	Urban tree canopy - downed power lines and GI	V/S	Local	S/V	Wind	1. Management - Identify dead trees, regular pruning / maintenance 2. Identify heat islands for planting locations. 3. Urban tree inventory (work with universities) 4. Create program for private investment to plant 5. Tree replacement program and regulations.	H	S/O
E	6	Planning for drought resistant species		Local / State	V	Drought / Precipitation	Improve local and state design standards to increase open space, LID, decrease flooding with pervious surfaces and adopt LID. Tree replacement program and regulations	H	S
E	6	Increase bioretention area, decrease impervious projects		Local / State	V	Drought / Precipitation	Improve local and state design standards to increase open space, LID, decrease flooding with pervious surfaces and adopt LID. Tree replacement program and regulations	H	S
E	6	Biophilic design, sustainable development, landscape principles, living landscape		Local / State	V	Drought / Precipitation	Improve local and state design standards to increase open space, LID, decrease flooding with pervious surfaces and adopt LID. Tree replacement program and regulations	H	S
E	6	Planning for GI/LID incorporation		Local / State	V	Drought / Precipitation	Improve local and state design standards to increase open space, LID, decrease flooding with pervious surfaces and adopt LID. Tree replacement program and regulations	H	S
E	6	Blackstone River and National Park		Local / State	V	Drought / Precipitation	Headwaters of Narragansett Bay, have National Park be example of LID at headwaters		

# Appendix D

Presentation from the Listening Session (6/13/2019)



# WORCESTER COMMUNITY RESILIENCE LISTENING SESSION

JUNE 13, 2019

Massachusetts Executive Office of Energy and Environmental Affairs  
Municipal Vulnerability Preparedness (MVP) Program  
Planning Grant



# AGENDA

**Municipal Vulnerability Preparedness Planning Process (10 mins)**

**Overview of the Key Findings (30 mins)**

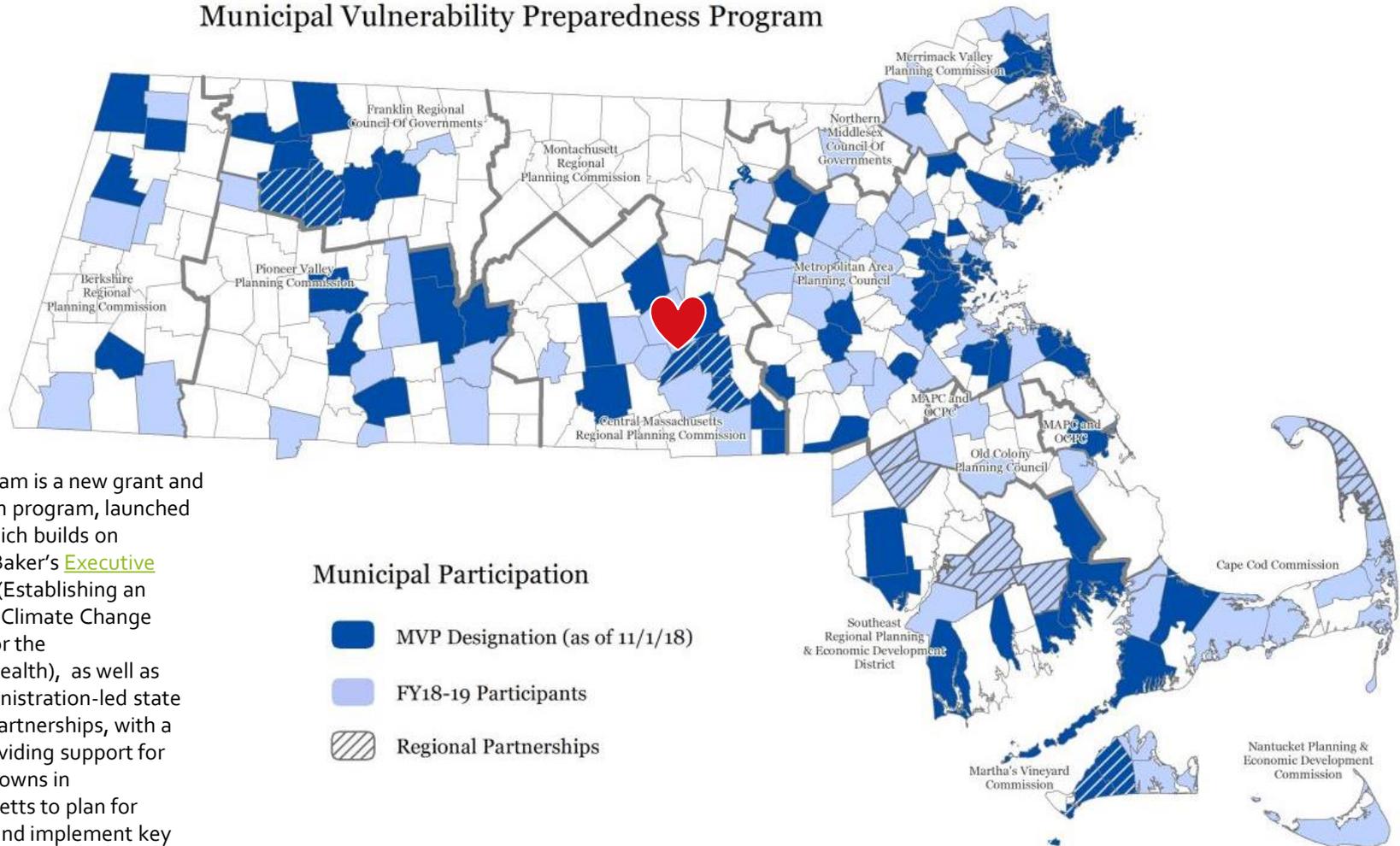
- **Identified Hazards and Climate Change Projections**
- **Community Vulnerabilities**
- **Community Strengths**
- **Recommended Priority Actions To Improve Community Resilience**

**Questions and Answers (15 mins)**

**Next Steps and Closing (5 mins)**

# THE MVP PROGRAM

## Municipal Vulnerability Preparedness Program



MVP program is a new grant and designation program, launched in 2017, which builds on Governor Baker's [Executive Order 569](#) (Establishing an Integrated Climate Change Strategy for the Commonwealth), as well as other administration-led state and local partnerships, with a goal of providing support for cities and towns in Massachusetts to plan for resiliency and implement key climate change adaptation actions.

### Municipal Participation

-  MVP Designation (as of 11/1/18)
-  FY18-19 Participants
-  Regional Partnerships

# THE WORCESTER MVP PROCESS

1. **SPRING-FALL 2018:** Applied for the MVP planning grant, formed a Core Group, and selected state-certified MVP consultant (Kleinfelder)
2. **DECEMBER 2018:** Gathered available background information
3. **JANUARY 25 2019:** Held 8-hour workshop
4. **MAY-JUNE 2019:** Performed 5 risk and vulnerability assessments
5. **JUNE 2019:** Finalized workshop outcomes into a report
6. **JUNE 13:** Hold public listening session
7. **SUMMER 2019:** Be designated a “Climate Change Municipal Vulnerability Preparedness Community”
8. **FUTURE:** Increased funding opportunities through MVP Action grant program



# OTHER PLANNING EFFORTS IN WORCESTER

- Hazard Mitigation Plan (adopted February 2019)
- Integrated Water Resource Management Plan (ongoing)
- Green Worcester Strategic Plan (ongoing)
- Master Plan (forthcoming)



## Worcester Hazard Mitigation Plan Update

*[ Last Revised – March 8, 2019 ]*



*Tatnuck area of the City, December 2017*

Adopted by the City Council February 26, 2019

Prepared by the Central Massachusetts Regional Planning Commission  
1 Mercantile Street, Suite 520  
Worcester, MA 01608  
[www.cmrpc.org](http://www.cmrpc.org)

&

Local Hazard Mitigation Team  
City of Worcester, Massachusetts

# MVP WORKSHOP: JANUARY 25, 2019

## Objectives:

1. Define local climate-related **hazards**
2. Identify existing community **strengths & vulnerabilities** related to those hazards
3. Identify and prioritize **actions** to improve community **resiliency** to those hazards

## Participants (about 60):

- Core Group and City department staff
- Representatives of various committees, residents, non-profit organizations, educational institutions and businesses
- State-certified MVP consultant / group facilitators (Kleinfelder)

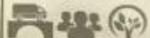




# Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.org

5



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, earthquake, drought, sea level rise, heat wave, etc.)

#2 Green Island Infrastructure

Features	Location	Ownership	V or S	Hazard	Actions	Priority	
						H-M-L	Short Long Ongoing
<b>Infrastructural</b>							
WATER DISTRIBUTION SYSTEM	Regional	City	Both	ALL	Education: savings p.p.p.p. Resilience systems (Proof) Public Education on water use/Reuse	M	L/O
SCHOOL BUILDINGS	Citywide	City	"	ALL	Adaptive capacity (Extreme temps) Schools as neighborhood resource hubs. Multi-lingual communication / messaging (Reverse 911, etc.)	H	L
EMERGENCY RESPONSE (FACILITIES + SYSTEMS)	Regional	City+	"	ALL	Expand CERT to resident neighbors' networks	L	S
UTILITY SYSTEMS	Regional	Private	"	ALL	Decentralization / Microgrids = Incentives Community/Neighborhood scale solutions	H	L
TRANSPORTATION SYSTEMS	Regional	ALL (mostly City/State)	"	ALL	WVTA Bldg → Flood Risk !! Drain-USE FLOOD STORAGE/INFILTRATION/Retention / CONSUMPTION	H	L
SEWER/STORMWATER SYSTEMS	Citywide	City	"	1/2	RAIN CHIMBES, Portable pump-out, Stormwater Utility fee + incentives/credits for LID		
<b>Societal</b>							
TRANSPORTATION FLEET/VEHICLE	Regional	ALL	Both	ALL	Use school buses to address mobility challenges during emergencies Privatize transit system / Redesign Alternative treatment options	H	L
HEALTH/MEDICAL ACCESS	Regional/State	Regional/State	S	II	Decrease hospital visits/reliability as 1st resort (hubs, onsite, shelter/shops) Tap into medical reserve corps (unretired)	M	O
STUDENT POPULATION	Citywide	Public/Private	Both	II	Emerging resource / problem solvers!! Prepare unique specific preparedness/resilience exercises (EQ, etc.)	L	O
VULNERABLE POPULATIONS (Senior, special needs, immigrant, disabled low/limited income, etc.)	Citywide		V	II	Property protection, personal preparedness (Education/outreach) Empower renters / incentivize landlords + property managers	H	L
INCLUSIVE / COLLABORATIVE CULTURE	Citywide		S	II	* Build coalitions (resilience hubs) Connect w/ other social service orgs Demurstrate + Replicate	H	L
<b>Environmental</b>							
TREE COVER	Citywide	ALL	S/V	FLOOD	Expand Worcester Tree Initiative (Replace, plant, pop, preserve) Incentivize private land owners. Drought resistant landscaping	H	O
WATERWAYS/WETLANDS	Citywide	II	Both	FLOOD	Expand/enhance/protect existing resources. Lake + Ponds Stormwater improvements	H	O
HILLS	II	II	Both	Snow/Ice FLOOD	Power generation? LID (development restrictions) Stormwater/stormwater retention Delving / road treatment	L	L
BROWNFIELD SITES	Mostly CBD but elsewhere	II	V	FLOOD	Cap/prevent infiltration but fully redevelop in a fashion		
GREEN/OPEN SPACE	Citywide	II	S	FLOOD			
PARKS + REC	Citywide	City	S	ALL			

Part 1

Part 2



# IDENTIFIED TOP HAZARDS

Worcester's past, current, and future hazards



**Flooding from  
extreme precipitation  
(heavy rain)**



**Ice/snowstorms  
coupled with  
extreme cold**



**Extreme  
Heat / Drought**



# INFRASTRUCTURE



**Critical Infrastructure** – provides essential services and serves as the backbone of the city's security and health.

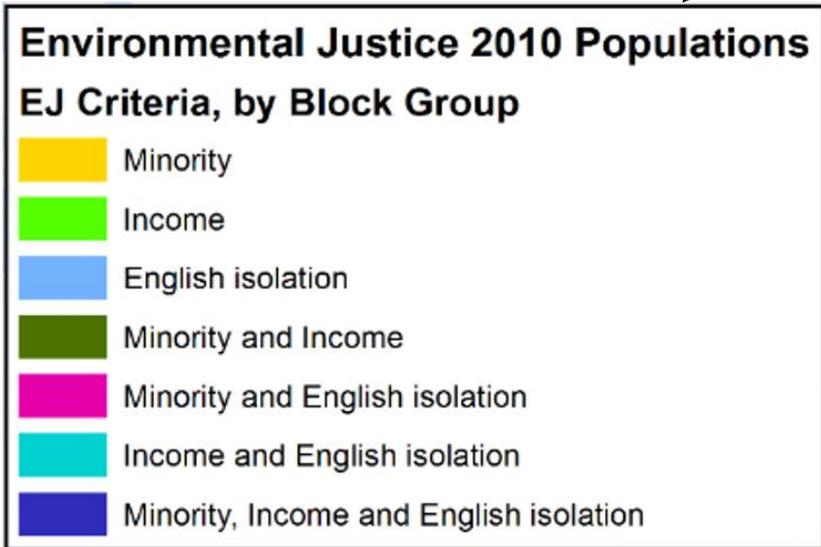
- Vital to the hazard response effort.
- Maintains existing level of protection from hazards for the community.
- Would create a secondary disaster if a hazard were to impact it.
- Facilities and populations to especially protect from a hazard.

*Examples Include:*

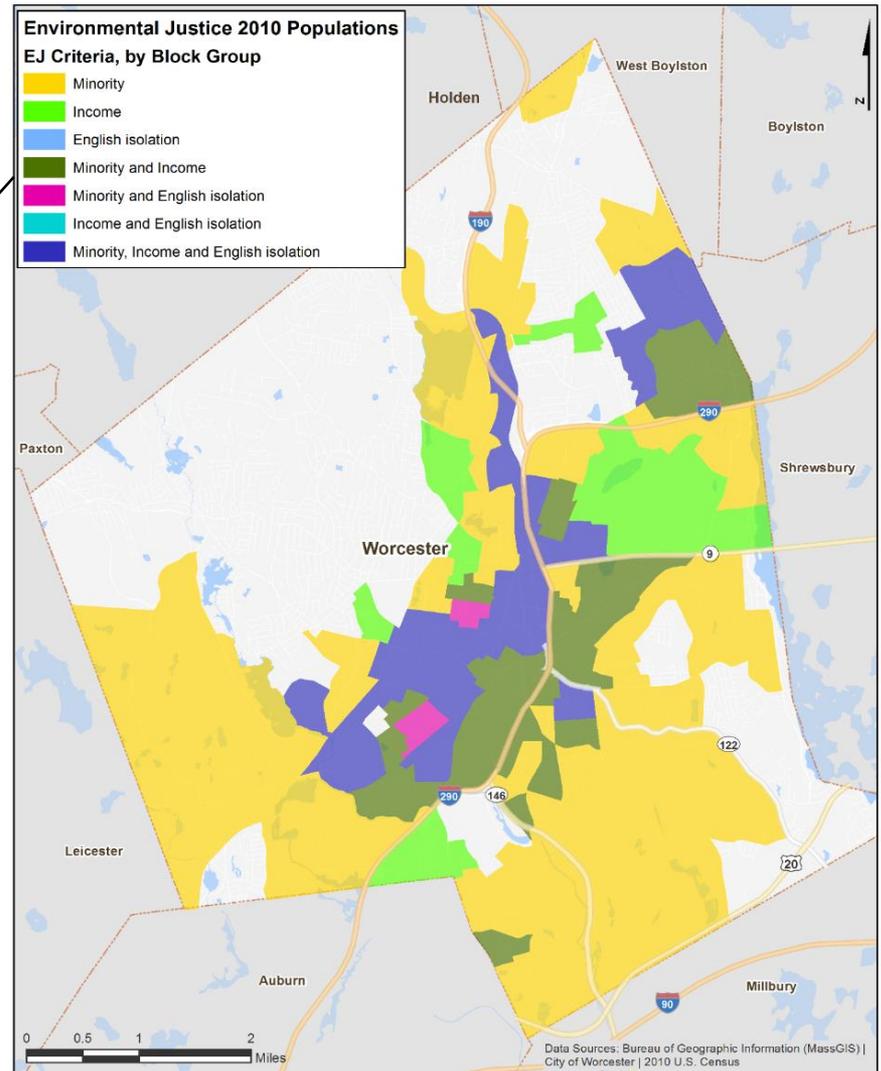
- Bridges, Roads
- Dams, Reservoirs
- Emergency Operations
- Municipal Buildings, Schools, Hospitals
- Utilities, Water and Sewer System
- Commercial Buildings and Businesses
- Historic Sites



Combination of factors and forces that affect the susceptibility of various groups within a community to harm, as well as their ability to respond positively after extreme events.



## Environmental Justice Populations Map





# ENVIRONMENT



## Benefits of natural systems include:

- Flood storage
- Recreation and tourism
- Cooling during heat waves
- Biodiversity conservation
- Water filtration
- Water quality and quantity
- Air quality



## Environmental Challenges:

- Erosion
- Invasive plant material
- Chronic flooding
- Sedimentation
- Ground and surface water pollution
- Impaired water bodies

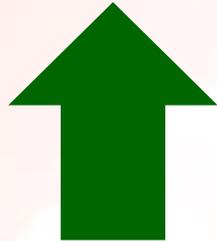
# CLIMATE CHANGE: OBSERVED

Temperature:



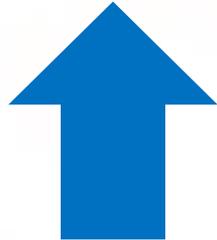
**2.9°F**  
Since 1895

Growing Season:



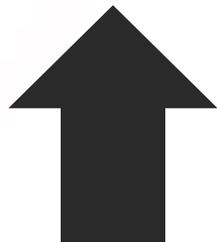
**11 Days**  
Since 1950

Sea Level Rise:



**11 inches**  
Since 1922

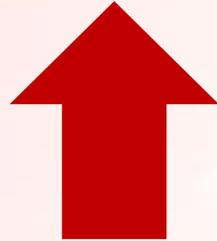
Stronger Storms:



**55%**  
Since 1958

# CLIMATE CHANGE: PREDICTED

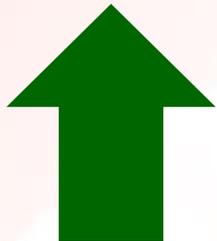
Temperature:



**3 to 11°F**

By 2100

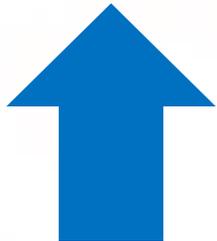
Growing Season:



**5 Weeks**

By 2100

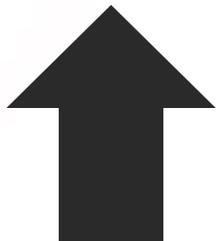
Sea Level Rise:



**3 to 7'**

By 2100

More Storms:



**47%**

By 2100

# Climate change

# Development

increased precipitation

increased temperature

impervious surfaces

stormwater & WQ issues

heat-related illnesses

flooding & infrastructure damage

more cooling shelters



# CLIMATE CHANGE IN MASSACHUSETTS



**Total annual precipitation  
has increased by:**

**15%**

***1.2 trillion more  
gallons of water or  
equivalent snow falling on  
Massachusetts each year.***



***~9,700 filled Prudential Towers***

# CLIMATE CHANGE AND WORCESTER IN 2016

Consider this:

In October, 2016, the City was in the midst of a severe drought (stage III), while also being affected by one of the most severe and damaging rain events in its history...



City Manager Edward Augustus Jr. standing in the Quinepoxet Reservoir after announcing a stage three drought emergency.

*Photo by Scott Croteau*

[https://www.masslive.com/news/worcester/2016/09/five\\_things\\_you\\_need\\_to\\_know\\_a.html](https://www.masslive.com/news/worcester/2016/09/five_things_you_need_to_know_a.html)



<https://www.youtube.com/watch?v=YLvUaPlgEsc>



# Flooding from extreme precipitation

## COMMUNITY VULNERABILITIES



### Two types of precipitation flooding:

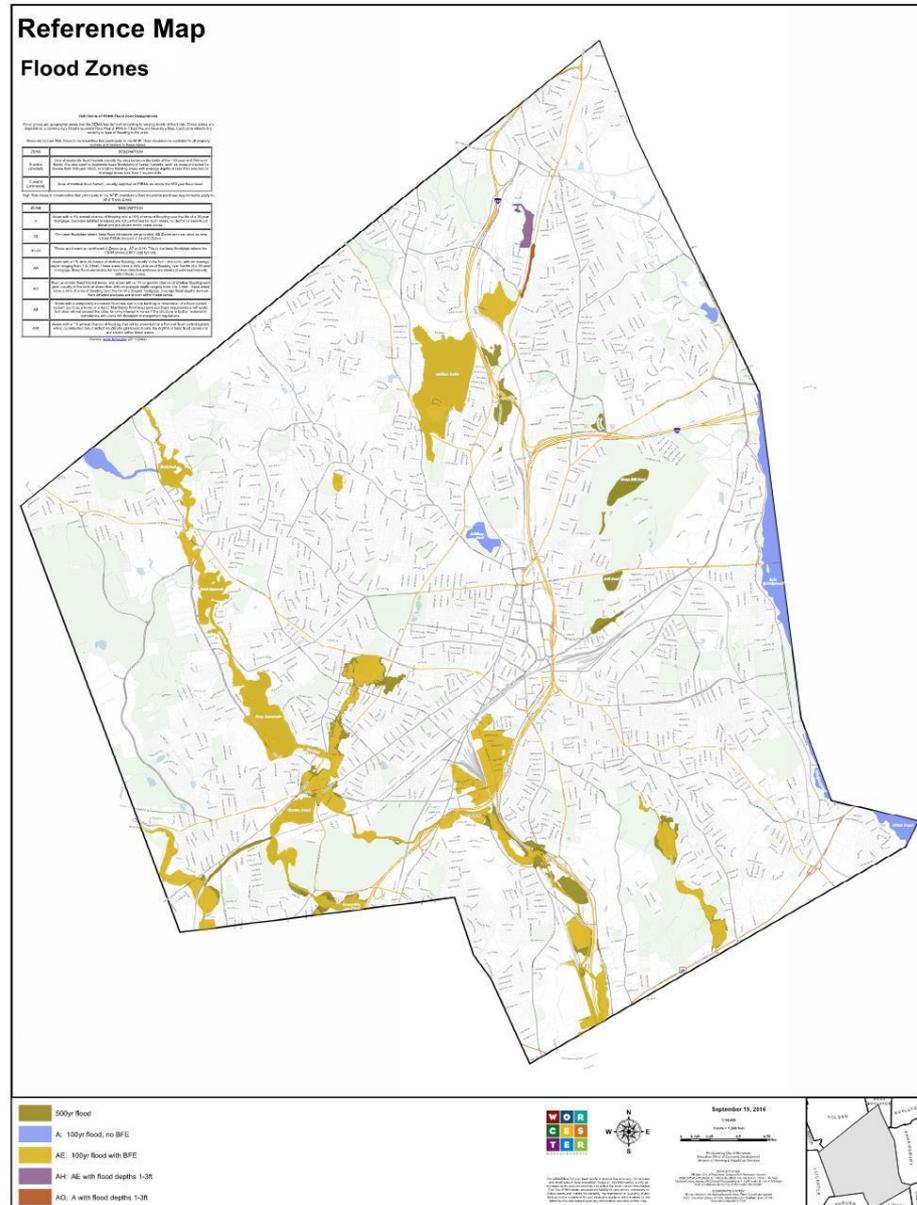
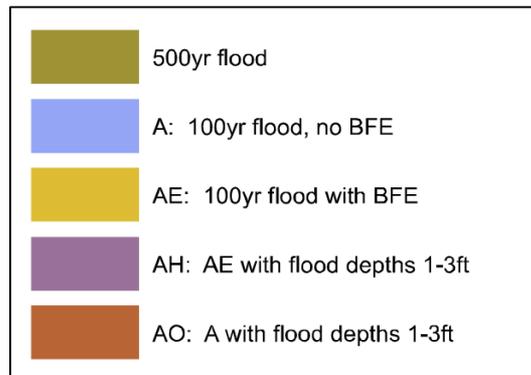
- Overbank flooding from rainfall / snowmelt
- Piped Infrastructure backup / failure (culverts, combined sewer overflow, sanitary sewer overflow)



# FEMA FLOOD ZONES (OVERBANK FLOODING)

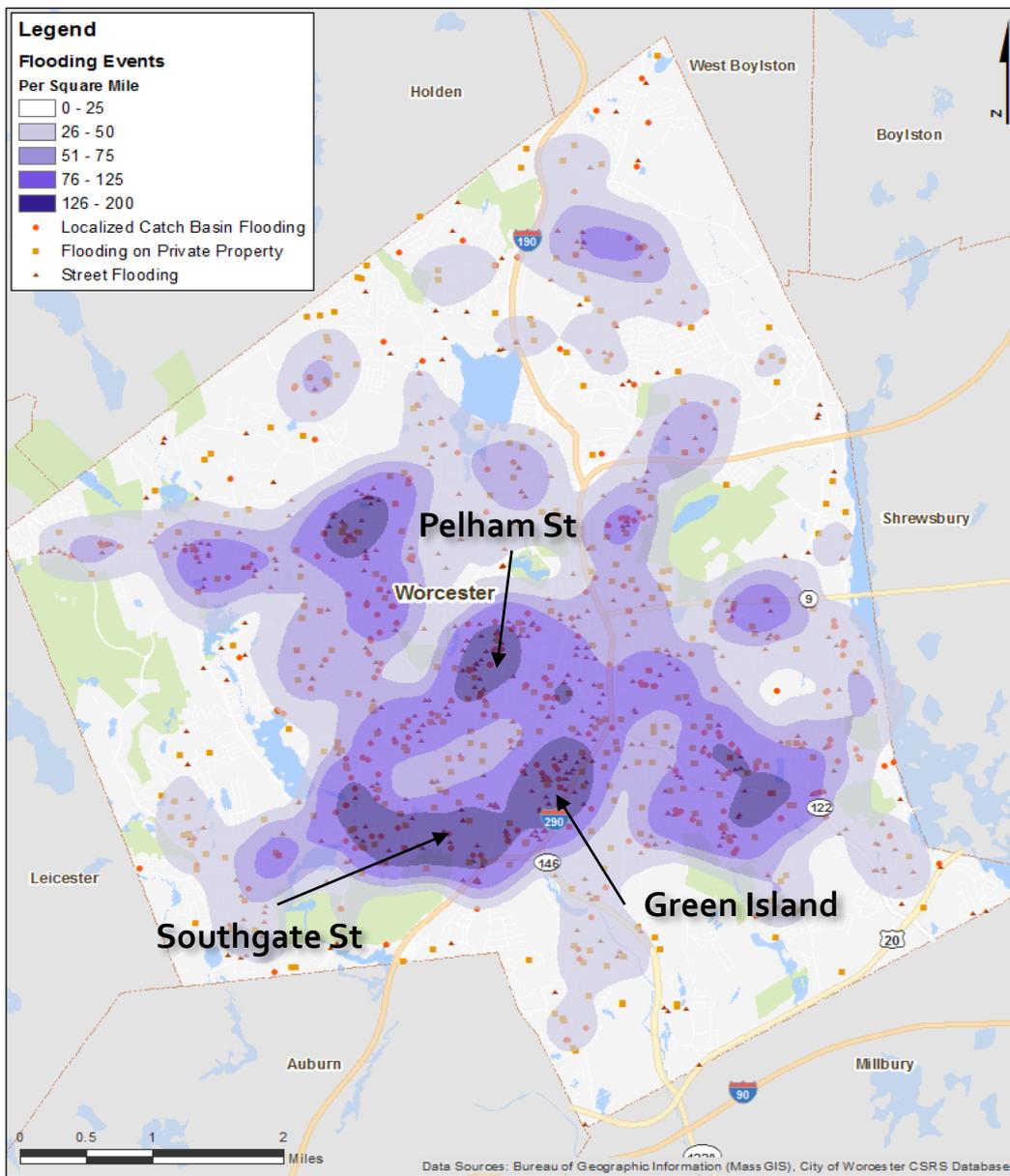
- **Based on historic data** to predict flooding events (doesn't account for climate change)
- **Example:** A 100-year flood is a an event that has a 1% probability of occurring in any given year (500-year flood has 0.2% probability)
- **Used to set requirements** for building code and flood insurance

Source: <https://www.fema.gov/disaster/updates/fema-flood-maps-and-zones-explained>





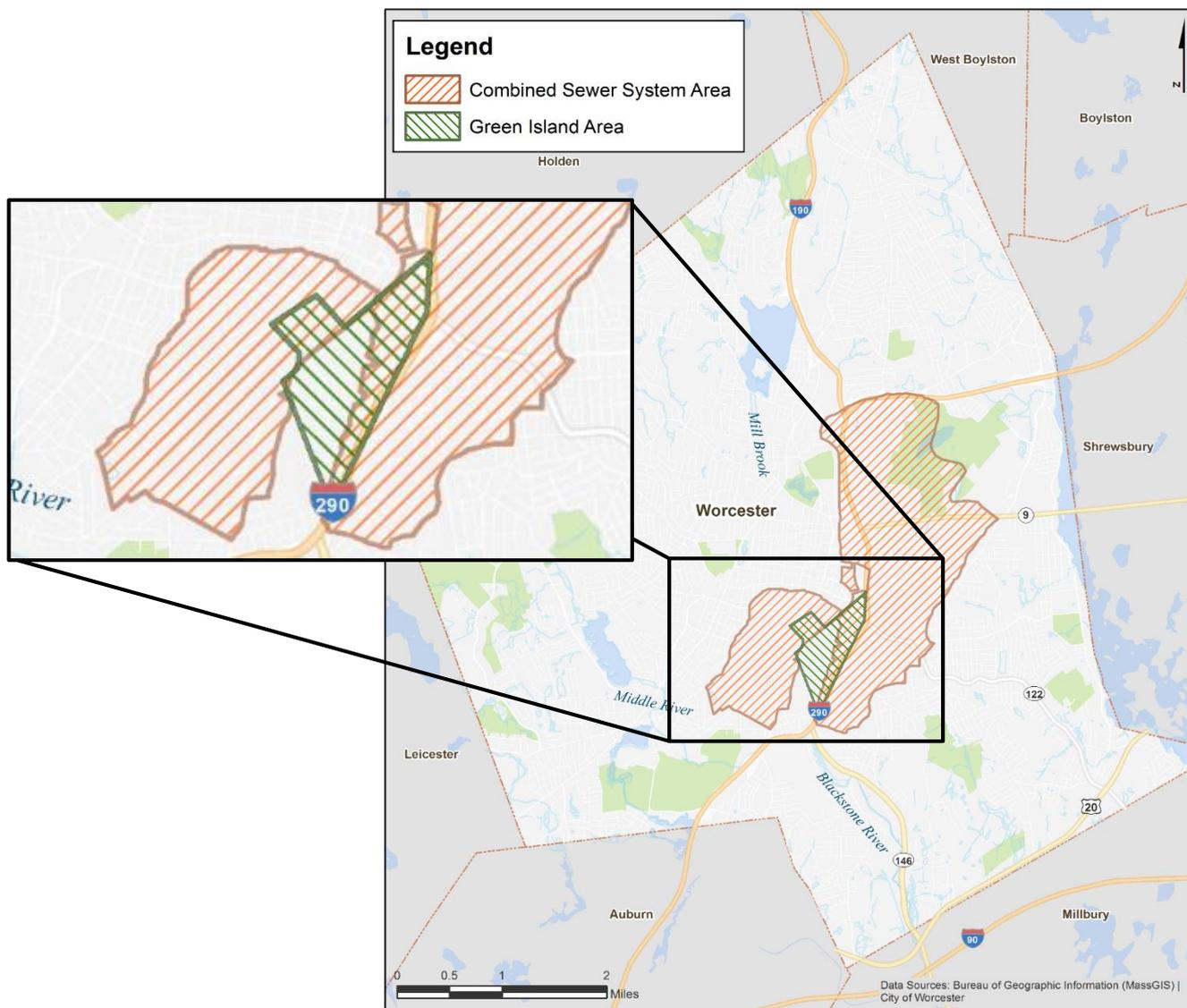
# FLOODING DUE TO FINITE STORMWATER DRAINAGE CAPACITY



Concentration of Reported Flooding Events, 2006-2016



# COMBINED SEWER INFRASTRUCTURE



- Combined sewer areas (in brown) are located in the oldest and typically most populated areas of the city.
- Locations are vulnerable to Combined Sewer Overflows (CSOs) during heavy rain events.
- Green Island (in green) area is particularly susceptible given its low-lying topography and location .

Combined sewer infrastructure map



# Flooding from extreme precipitation

## COMMUNITY VULNERABILITIES

Some of the concerns included:

- inadequate conveyance capacity
- clogged catch basins
- undersized culverts
- poor surface water quality
- disrupted emergency communications
- transient and immigrant population with lack of local knowledge on resources and service providers
- degrading water quality
- lack of enforcement on other pollution prevention measures
- managing risk for groundwater contamination and pollution of waterways from industrial sites





# Flooding from extreme precipitation

## CLIMATE CHANGE PROJECTIONS

Climate Indicator		Observed Value	Mid-Century	End of Century
		1971-2000 Average	Projected Change in 2050s	Projected Change in 2090s
 Days with Precipitation > 1"	Annual	7 days	Increase by 10-42% 8-10 more days per year	Increase by 15-55% 8-11 more days per year
	Winter	2 days	Increase by 10-69% 2-3 more days per year	Increase by 25-109% 2-3 more days per year
	Spring	2 days	Increase by 2-46% 2 more days per year	Increase by 11-82% 2-3 more days per year
 Total Precipitation	Annual	47 inches	Increase by 2-13% Increase of 1 - 6 inches	Increase by 3-16% Increase of 1.2 - 7.3 inches
	Winter	11.2 inches	Increase by 1-21% Increase of 0.1 - 2.4 inches	Increase by 4-35% Increase of 0.4 - 3.9 inches
 Consecutive Dry Days	Summer	12 days	Variable (-1 - +2 days)	Variable (-1 - +3 days)
	Fall	12 days	Increase by 0 - 3 days	Increase by 0 - 3 days

Source: <http://resilientma.org/changes/changes-in-precipitation>



# SNOW/ICE STORMS

## COMMUNITY VULNERABILITIES

**Worcester is susceptible to large snow and ice storm events.**



**Some of the concerns included:**

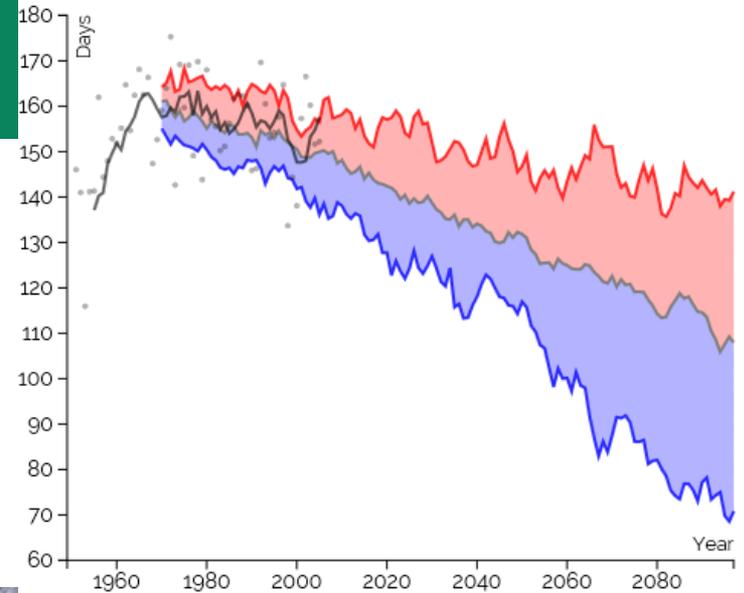
- Obstructed emergency access/evacuation
- Managing frozen water pipes
- Obstructed access to emergency shelters
- Property damage
- Negative impact on economic business opportunities
- Inadequate capacity for sheltering vulnerable populations



# SNOW/ICE STORMS CLIMATE CHANGE PROJECTIONS

- Annual precipitation volume in winter is projected to **increase** 30% due to climate change.
- Annual days below freezing is projected to **decrease** over the next 80 years due to climate change.
- This will cause **more winter precipitation to fall as rain or freezing rain** instead of snow.

Annual Days with Minimum Temperature Below 32°F  
Worcester County, MA





# EXTREME HEAT COMMUNITY VULNERABILITIES

**Yes, heat is a problem  
in New England!**

- Heat effect exacerbated in impervious surface areas known as “heat islands”



**Some of the concerns included:**

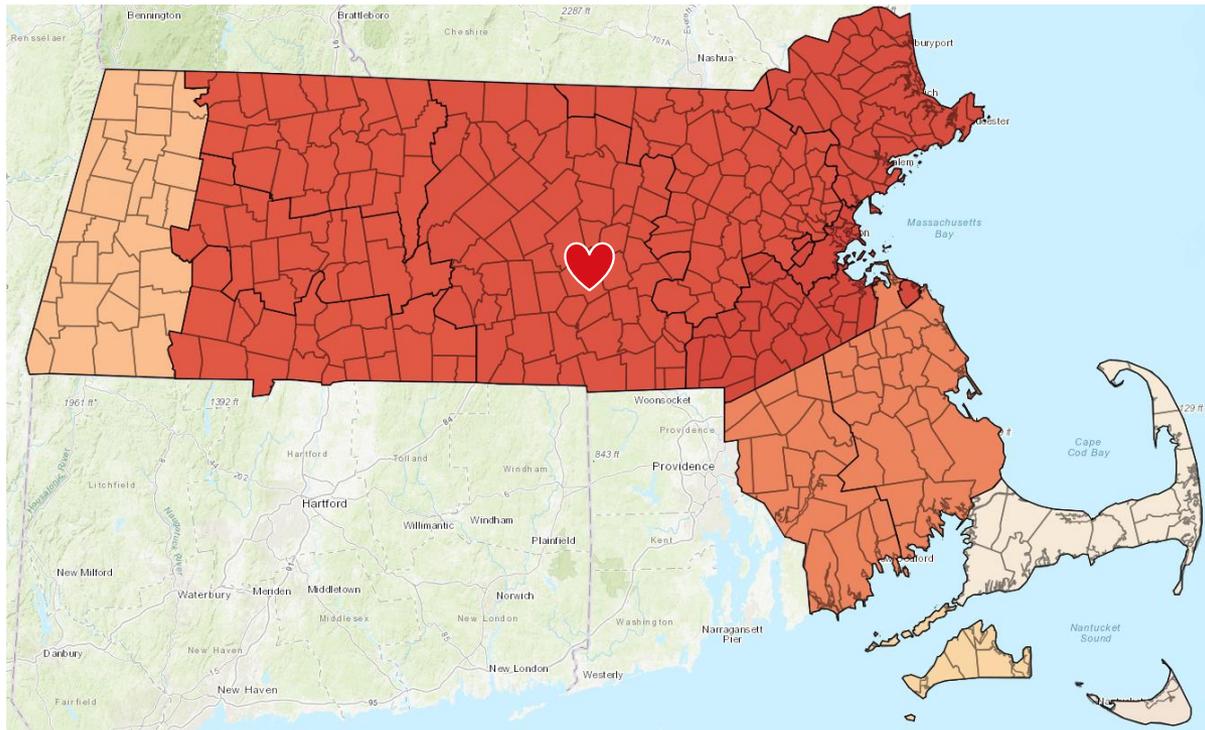
- power outages (brownouts) and service interruptions.
- inadequate energy efficiency of buildings
- inadequate capacity for sheltering vulnerable populations
- overstressed healthcare providers
- combatting invasive species





# EXTREME HEAT CLIMATE CHANGE PROJECTIONS

2070 projection: 25 *more* days over 90°



Decade:  2070s

Season:

Projected change in # days above 90°F



+8.3   +11.3   +16.5   +23.1   +28.4



# EXTREME HEAT CLIMATE CHANGE PROJECTIONS



By the end of the century, summers in Massachusetts will “feel” more like summers in the South.



**2070-2099  
Higher “Business as Usual”  
Emissions**

**How Summer Temperatures Will Feel  
Depending on Future Greenhouse Gas Emissions**

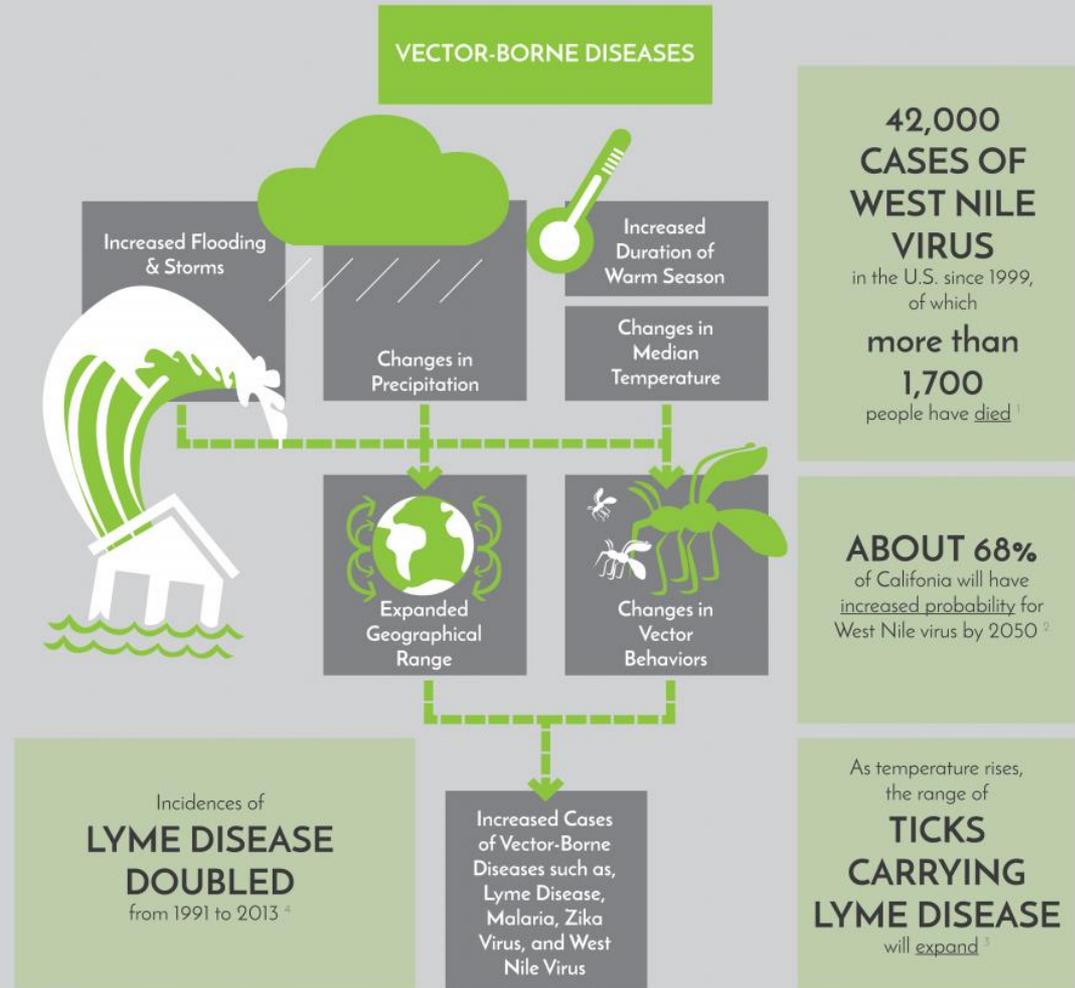


# EXTREME HEAT CLIMATE CHANGE PROJECTIONS

## Human health issues:

- Heat-related illness and mortality
- Air quality, asthma
- Vector-borne diseases

## HOW CLIMATE CHANGE AFFECTS YOUR HEALTH



1. <http://www.cdc.gov/features/westnilevirus/>  
 2. <http://www.library.wiley.com/doi/10.1111/j.1365-3113.12554.x>  
 3. <https://www12000.com/ClimateChange/ClimateChangeExpandedHealth.html>  
 4. <https://www12000.com/ClimateChange/ClimateChangeExpandedHealth.html>



# DROUGHT COMMUNITY VULNERABILITIES

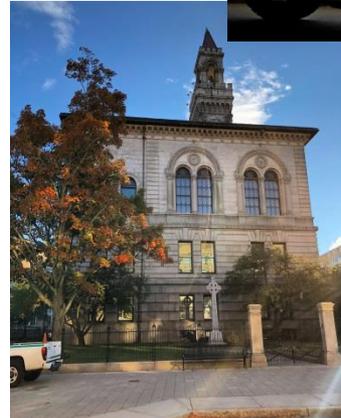
- Reduces surface water storage & recharge of groundwater supplies
- Exacerbates the impacts of flood events on water quality (less vegetation, drier soils lose capacity to hold water)
- Weaken tree root systems, making them more susceptible to toppling during high wind events.



*Worcester City Manager Edward Augustus Jr. standing inside a portion of the Quinapoxet Reservoir during the drought in September 2016.*

- In Worcester, there have been 7 major droughts since 1930 (3-8 years each)

# COMMUNITY STRENGTHS



© Donna Dufault 2009

# **RECOMMENDED PRIORITY ACTIONS TO IMPROVE COMMUNITY RESILIENCE**

# RECOMMENDATIONS - INFRASTRUCTURE

- **Develop a public outreach and education initiative**
- **Stormwater management**
  - System-wide hydrologic/hydraulic drainage evaluation and model
  - Investigate a stormwater enterprise fund/stormwater utility fee
  - Prioritize green infrastructure projects to mitigate urban heat island and reduce flooding
- **Buildings**
  - Implement adaptation/resiliency strategies to harden critical city-owned buildings
- **Transportation**
  - Advocate and assist in creating a resilient transportation network
- **Drinking Water**
  - Assess the vulnerability of drinking water supply to future drought conditions

# RECOMMENDATIONS – SOCIETAL FEATURES

- **Initiate an education program/campaign**
  - Be inclusive, multi-lingual, make info accessible
  - Help people know when and how to shelter
- **Improve the City's emergency planning to incorporate climate change**
  - Increase collaboration
  - Increase communication during emergency to most vulnerable populations
- **Empower renters and property owners to prepare**
  - Update old building stock to improve resilience

# RECOMMENDATIONS - ENVIRONMENT

- **Protect open space and water resources**
  - Continue Blue Spaces program
  - LID requirements in regulations to manage stormwater
- **Improve waste collection practices**
  - Composting
  - Recycling
- **Increase urban tree canopy**
  - ID locations, create inventory
  - Replacement programs, regulations, & maintenance

# QUESTIONS & ANSWERS

1. What surprised you or was inconsistent with your perception of Worcester?
2. What concerns you? Where are opportunities?
3. Where would you like to see more information? What's missing?
4. Which recommendations are the highest priority?



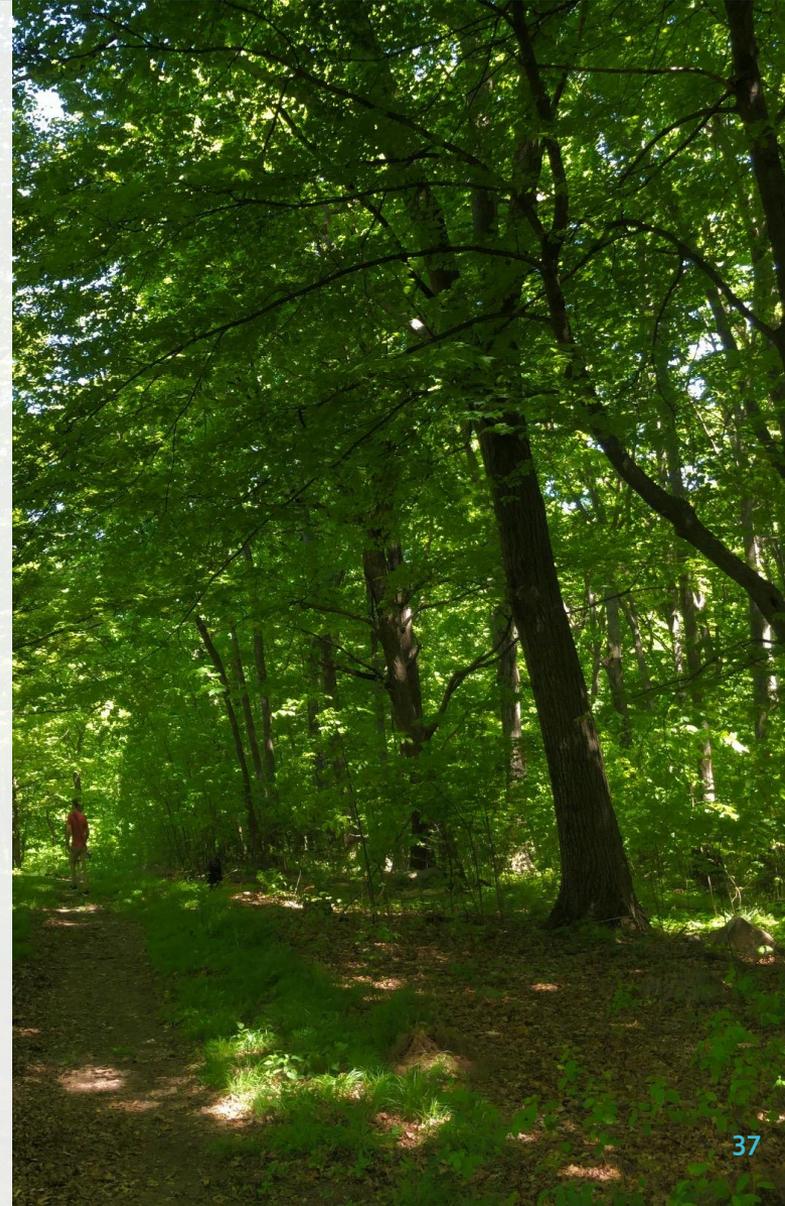
# QUESTIONS & ANSWERS

## Next Steps

- Finalize report
- Be designated an MVP Community
- MVP Action Grant

## Where to get more information

- **Current** - <http://www.worcesterenergy.org/leading-by-example/resilient-worcester>
- **Upcoming** – [www.worcesterma.gov/Resilience](http://www.worcesterma.gov/Resilience)



# COMMENTS

Submit comments on the Report by June 25<sup>th</sup>, 2019  
to

**WorcesterEnergy@worcesterma.gov**

# THANK YOU !!!

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