Town of Leicester
Hazard Mitigation & Resiliency Plan

2024

Leicester Hazard Mitigation & Resiliency Plan

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Boards and Commissions	Town Offices	
Agricultural Commission	Assessor	Mass Department of Fish and Wildlife
Arts Council	Building/Code Enforcement	MassPort
Board of Health	Emergency Management	Leicester Housing Authority
Burncoat Park Sports Planning Committee	Fire/EMS	Town of Auburn
Capital Improvement Planning Committee	Planning Department	Town of Charlton
Commission on Disabilities	Police Department	Town of Paxton
Conservation Commission	Public Library	Town of Spencer
Economic Development Committee	Public Works	City of Worcester
Emergency Planning Committee	Recycling Center	
Historical Commission	School Department	CARE Leicester
Moose Hill Water Commission	Senior Center/Council on Aging	Common Ground Land Trust
Parks and Recreation Committee	Town Clerk	Greater Worcester Land Trust
Planning Board	Treasurer/Collector	Cedar Meadow Lake Watershed District
Zoning Board of Appeals		Burncoat Pond Watershed District

Water Supply Districts	Wastewater
Cherry Valley and Rochdale Water District	Cherry Valley Sewer District
Hillcrest Water District	Oxford Rochdale Sewer District
Leicester Water Supply District*	
Stiles Lake Water Supply District	
Worcester Water Department	

Utilities
National Grid (Gas & Electric)
Verizon
Spectrum

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1. Introduction

1.1. Hazard Mitigation and Resiliency

Hazard Mitigation is a sustained action taken to permanently reduce or eliminate long-term risk to people and their property from the effect of natural, technological, or human-caused hazards. Mitigation actions help safeguard people and public safety and can significantly reduce the impact of future disasters.

Resilience is the capacity of individuals, communities, businesses, institutions, and governments to adapt to changing conditions and prepare for, withstand, and rapidly recover from disruptions to everyday life, such as hazard events.

The Disaster Mitigation Act (DMA) 2000 (Public Law 106-390) provides the legal basis for FEMA mitigation planning requirements for State, Local and Tribal governments as a condition of mitigation grant assistance. DMA 2000 amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act by repealing the previous mitigation planning provisions and replacing them with a new set of requirements that emphasize the need for State, Local, and Tribal entities to closely coordinate mitigation planning and implementation efforts.

ResilientMass is the state's initiative to build capacity for climate change adaptation and resiliency. The 2023 Massachusetts State Hazard Mitigation and Climate Adaptation Plan identifies strategies and specific, measurable actions state agencies will take to address risks to the human health and safety, communities, critical assets and infrastructure, natural resources, governance, and economy of the Commonwealth. The Municipal Vulnerability Preparedness (MVP) Program supports communities in Massachusetts to identify climate hazards, assess vulnerabilities, and develop action plans to improve resilience to climate change.

Pre-disaster planning and investment in preventative measures can significantly reduce the cost of tomorrow's post-disaster recovery and help post-disaster operations become more efficient. By planning ahead, Leicester minimizes the economic and social disruption that results from natural hazards including floods, severe weather Nor'easters and hurricanes which can result in the destruction of property, loss or interruption of jobs, loss of business and loss of life.

Mitigation strategies include a mix of physical initiatives to limit the impacts of natural hazards, such as rebuilding culverts and XXXXXXX, as well as regulatory/planning initiatives such as revised zoning ordinances and maintaining land use regulations.

The purpose of this plan is to identify actions and policies for the Town of Leicester to minimize the social and economic loss and hardships resulting from natural hazards. These hardships include the loss of life, destruction of property, damage to crucial infrastructure and critical facilities, loss/interruption of jobs, loss/damage to businesses, and loss/damage to significant historical structures.

Formal adoption and implementation of this document will allow Leicester to continue to participate in the NFIP Regulations pertaining to FEMA's flood mitigation grants and local hazard mitigation plans are provided in the Code of Federal Regulations (CFR), Title 44, Part 201.

Adoption of this Hazard Mitigation Plan will also protect Leicester's eligibility for federal grants available through FEMA's Hazard Mitigation Assistance Programs, including the Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA), and Pre-Disaster Mitigation (PDM).

FEMA's Pre-Disaster Flood Mitigation Assistance Program makes grants available for communities to implement flood mitigation planning and activities such as acquisition, relocation, and retrofitting of structures. This program is only available for communities having a pre-existing approved hazard mitigation plan.

FEMA's Post-Disaster Hazard Mitigation Grant Program is only available for communities after a federally declared disaster. An approved mitigation plan expedites the application process for pre- and post-federal mitigation funding, as well as assist in ensuring a funded project is eligible and technically feasible.

1.2. Purpose of the Plan

The purpose of the Local Hazard Mitigation Plan is to provide the Town of Leicester with a comprehensive examination of all natural hazards affecting the area, as well as a framework for informed decision-making regarding the selection of cost-effective mitigation actions. When implemented, these mitigation actions will reduce the Town's risk and vulnerability to natural hazard. The 2024 Leicester Hazard Mitigation & Resiliency Plan is a comprehensive update from the 2018 Hazard Mitigation Plan which was produced as part of a Central Mass Regional Planning Commission effort to develop 27 individual community plans in central Massachusetts. The 2024 Leicester HMRP has a modified format and additional content to better align with 2023 Massachusetts State Hazard Mitigation and Climate Adaptation Plan.

The 2024 Leicester HMRP provides a strategy for mitigation and resiliency. It focuses on strategies to address risks to the human health and safety, the community, critical assets and infrastructure, natural resources and environment, cultural resources, governance, and economy of the Town. The 2024 Leicester HMRP aligns with the MA SHMCAP vision, ensuring that the Town is prepared to withstand, respond to, recover from, and mitigate all types of emergencies and disasters.

This plan is a result of a collaborative effort between several key stakeholders within Town government, the community, our neighboring communities, and several state agencies. Throughout the development of the plan, the Hazard Mitigation Planning Committee (HMPC) consulted the public and key stakeholders for input regarding identified goals, mitigation actions, risk assessment, and mitigation implementation strategy.

2. Planning Process

The plan update process began in early 2023 with a review of the previous plan, the 2018 MVP Community Resilience Building Workshop, the updated FEMA guidance, and numerous community, state, and federal supporting documents and information sources, including:

- 2022 Massachusetts Climate Chage Assessment (MCCA)
- 2023 Massachusetts State Hazard Mitigation and Climate Action Plan (SHMCAP)

2.1. Stakeholders

2.2. Public Participation

2.3. Abutter Communities

3. Planning Area Profile

The Town of Leicester, Massachusetts was incorporated in 1713. Leicester is bisected by Route 9 and Route 56 and is the first community west of the City of Worcester. Leicester is largely a bedroom community. The Town includes four (4) distinct villages, Leicester Center, Cherry Valley, Rochdale, and Greenville (which is now officially part of Rochdale).

Leicester is bordered by Paxton to the north, Worcester to the east, Auburn, Oxford, and Charlton to the south and Spencer to the west. Leicester lies within three watersheds, Quinebaug, Blackstone, and Chicopee.

Leicester has a total area of 24.53 square miles and a population of 11,033 (2022 U.S. Census estimate). Of Leicester's approximately 15,700 acres, only 12% had been developed as of 2017. Forests, wetlands, and water account for 76% of Leicester's total area, while 10% is open land consisting of agricultural areas, bare soil, barren land, and low vegetation (Mass Audubon, 2020).

3.1. Population

The Town population has remained stable for the past several decades, having changed by less the 5% since 2000. Leicester is an aging community, with 29.8% of the population between the ages of 40-59 years and 24.7% over 60 years. The number of housing units in Leicester as of the 2020 census is 4,193. The number of units increased by 11.5% in the period between 2001-2010 but has seen a minor decline of less than 2% between 2011-2020. According to the Central Massachusetts Regional Planning Commission's (CMRPC) Long Range Transportation Plan, Mobility 2040, the Town of Leicester is expected to experience minimal population growth, compared to the region, over the next 25 years.

There are two (2) Environmental Justice block groups (Minority) that compose much of the eastern portion of Leicester from Route 56 to the Worcester and Auburn lines (FIGURE). Leicester is in the lower 20% of Massachusetts municipalities for income. At $83,015, median household annual income is slightly above the state ($xxxxx) and Worcester County ($xxxxx) medians. The median single family home value in fiscal year 2024 is $360,819 with 94% of homes occupied and 85% owner-occupied.

Leicester is also part of the Blackstone River Valley National Heritage Corridor. The Corridor, an affiliated area of the National Park Service, was established by Congress in 1986 to tell the story of the American Industrial Revolution, promote the environmental recovery of the Blackstone River, and encourage the preservation of historic resources in the Corridor. The Corridor is currently managed by the Blackstone River Valley National Heritage Corridor, Inc. (Blackstone Heritage Corridor), a non-profit.

School demographics

3.2. Structures (Land Use and Development)

Leicester has relatively large minimum lot sizes, relatively small maximum lot coverages in any zone, and no areas where multifamily housing is allowed by right. Development has been concentrated in the central and southern portions of town along Route 9 and Route 56. Most recent construction is on frontage lots on established roads.

Additionally, Leicester's residential construction may be constrained by the availability of water and sewage infrastructure. New houses need access to water and waste disposal, but there are large areas of Leicester without public water or sewage access. Private wells and septic tanks require relatively large lots to accommodate these systems.

3.3. Natural Resources

From the late nineteenth to the mid-twentieth century, Worcester began acquiring the waterways in Leicester to establish a reservoir system for its growing population

3.3.1. Rivers and Streams

Leicester is a Town with 28 waterbodies and 35 miles of streams. Glaciers scraped across Leicester's landscape and left behind a series of north-south oriented drumlins that rise 50 to 150 feet. Dendritically shaped drainage patterns form three distinct river basins. Most of the drumlins are excessively drained, while most of the valley floors are poorly drained. These soil characteristics create a risk of water contamination from non-point sources, affecting above- and below-ground drinking water supplies.

The topography of Leicester divides the landscape into three watersheds, each with numerous streams and ponds. The town's glaciated terrain serves as the headwaters of the Blackstone, French, and Chicopee Rivers. Groundwater aquifers are the source of headwater streams

3.4. Conservation Lands

3.5. Open Space

3.6. Critical Facilities and Infrastructure

The term "critical facilities" is often used to describe structures necessary for a community to respond and recover in emergency situations. These facilities often include emergency response facilities (fire stations, police stations, emergency operation centers, health care facilities, schools, emergency shelters, utilities (water supply, wastewater treatment facilities, and power), communications facilities, and any other assets determined by the community to be of critical importance for the protection of the health and safety of the population. The adverse effects of damaged critical facilities can extend far beyond direct physical damage. Disruption of health care, fire, and police services can impair search and rescue, emergency medical care, and even access to damaged areas.

The number and nature of critical facilities in a community can differ greatly from one jurisdiction to another, and usually includes both public and private facilities. Each community needs to determine the relative importance of the publicly and privately owned facilities that deliver vital services, provide important functions, and protect special populations.

3.6.1. Stormwater

3.6.2. Water

Approximately 50% of the Town is serviced by public water supply while the remaining 50% gets the water from private wells. Three existing water districts service different portions of Leicester: the Cherry Valley and Rochdale Water District (CVRWD), the Hillcrest Water District (HWD), and the Leicester Water Supply District (LWSD). Each of these districts is subscriber owned, separately administered and operates its own facilities for water service. However, the Hillcrest Water District supplements its water supply with water from the Leicester Water Supply District.

Existing water lines serve most properties in Leicester's eastern, central, and southern sections along Route 9 and Route 56 south of Leicester Center. While water lines serve these relatively densely settled areas, most vacant developable land in Leicester has no water service. Private wells serve most residential developments constructed during the last few decades.

3.6.3. Sewer

There are four sewer districts operating within designated service areas in Leicester including the Cherry Valley Sewer District (CVSD); the sewer district operated by the LWSD; the Hillcrest Sewer District and the Oxford-Rochdale Sewer District (ORSD).

3.6.4. Utilities

3.6.5. Critical Facilities

3.6.6. Transportation Infrastructure

The principal highways through Leicester are Massachusetts Route 9, which runs east-west through the state, and Massachusetts Route 56, running north-south. The Massachusetts Turnpike (Interstate 90) passes near the town's southern boundary and is easily accessible from Route 56 through Auburn. The Worcester Regional Transit Authority serves Leicester with regular daily bus service along Route 9, providing access to Union Station in Worcester to the east and Spencer and the Brookfields to the west.

Public transit and pedestrian access are essential resources for low-income members of a community. Since publishing its 2009 Master Plan, Leicester commissioned a Complete Streets Prioritization Plan, which recommended pedestrian and cycling infrastructure improvements at specific locations in town. This study found that many of the suburban or rural roads in town are suitable for cycling given their width and low traffic volumes. However, several especially narrow and winding roads in town were rated as less safe given their limited sight lines and lack of shoulder (Howard Stein Hudson, 2018). The Leicester Complete Streets Prioritization Plan (2018) also confirmed that the sidewalk network is disjointed, in poor condition, or challenging to navigate with wheelchairs or strollers in many areas. In 2019, Leicester was awarded a Complete Streets Grant to improve sidewalk conditions and install a shared-use path around the Town Common.

3.6.7. Dams

According to the Massachusetts Office of Dam Safety, there are 25 dams in Leicester, of which 16 are under government or quasi-government ownership and 9 are privately owned.

Dam Ownership	Quantity
Town of Leicester	2
Town of Spencer	2
City of Worcester	5
State of Massachusetts	1
Water Districts	3
Watershed Districts	2
Land Trust	1
Private	9

The Massachusetts Office of Dam Safety develops criteria for classifying dams for the purpose of establishing inspection schedules and adherence to design criteria in accordance with their potential for causing damage to life or property in the downstream area in the event of failure. The Hazard Potential Classifications are shown in the table below.

High Hazard Potential (Class I)	Dams located where failure will likely cause loss of life and serious damage to home(s), industrial or commercial facilities, important public utilities, main highway(s) or railroad(s).
Significant Hazard Potential (Class II)	Dams located where failure may cause loss of life and damage to home(s), industrial or commercial facilities, secondary highway(s) or railroad(s) or cause interruption of use or service of relatively important facilities.
Low Hazard Potential (Class III)	Dams located where failure may cause minimal property damage to others. Loss of life is not expected.

Hazard and 6 are Significant Hazard. One of the Dams rated as a Significant Hazard actually meets the standard of High Hazard. The table below shows the number of dams in each category of ownership.

Owner	Dam Name	Hazard Rating	Condition
Town of Leicester	Greenville Pond Dam	High Hazard	Fair
City of Worcester	Kettle Brook Reservoir #1 Dam	High Hazard	Satisfactory
City of Worcester	Kettle Brook Reservoir #2 Dam	High Hazard	Satisfactory
City of Worcester	Kettle Brook Reservoir #3 Dam	High Hazard	Satisfactory
City of Worcester	Lynde Brook Reservoir Dam	High Hazard	Satisfactory
City of Worcester	Lynde Brook Reservoir Dike	High Hazard	Fair

Private	Rochdale Pond Dam	High Hazard	Fair
Private	Smiths Pond Dam	High Hazard	Unk
Stiles Lake Water District	Stiles Reservoir Dam	High Hazard	Satisfactory
Private	Brick City Mill Pond Dam	Significant Hazard	Unsatisfactory
Burncoat Pond Watershed District	Burncoat Pond Dam	Significant Hazard	Fair
Cedar Meadow Lake Watershed District	Cedar Meadow Lake Dam	Significant Hazard	Fair
Private	Health Camp Dam	Significant Hazard	Unsatisfactory
Private	Sargent Pond Dam	Significant Hazard	Satisfactory
Town of Leicester	Waite Pond Dam	Significant Hazard	Poor
Town of Spencer	Shaw Pond Dam	Low Hazard	
Greater Worcester Land Trust	Southwick Deep Pond Dam	Low Hazard	
Private	Southwick Upper Pond Dam	Low Hazard	

3.7. Economy

Leicester has a relatively small economic base. In 2023, there are approximately 182 businesses in Town. The most prominent industry sectors are construction/contractors (24%); health care and social assistance (12%); accommodation and food services (8%); and retail (8%). The Town is heavily reliant on residential property tax, with only 13% of the annual tax levy received from the commercial industrial sector. The majority of Leicester's physical businesses are located along Route 9 & the southern portion of Route 56.

3.8. Historic and Cultural Resources

3.9. Historic Events in Leicester and the Surrounding Area

4. Risk Assessment

The risk assessment process is used to determine potential impacts of the identified hazards on the people, economy, property, and the environment. Identifying the risk and vulnerability of Leicester to natural hazards is the primary factor in determining how to allocate finite resources to determine what mitigation actions are feasible and appropriate. The hazard analysis involves identifying the hazards that potentially threaten the town, and then analyzing them individually to determine the degree of threat that is posed by each natural hazard. Addressing risk and vulnerability through hazard mitigation measures will reduce societal, economic and environmental exposure to natural hazards impacts.

4.1. Hazard Identification

A hazard is defined as "an event or physical condition that has the potential to cause fatalities, injuries, property and infrastructure damage, agricultural loss, damage to the environment, interruption of business, or other types of harm or loss." A natural hazard can also be exacerbated by societal behavior and practice, such as building in a floodplain, or an earthquake fault. Natural disasters are inevitable, but the impacts of natural hazards can, at a minimum, be mitigated or, in some instances, prevented entirely.

In completing the updated hazard identification process, the HMPC considered the results of the Town's Municipal Vulnerability Preparedness (MVP) planning effort (2018), as well as the 2023 State Hazard Mitigation and Climate Adaptation Plan (SHMCAP), and the 2022 State Climate Change Assessment. As a result of this process all hazards from the 2018 Leicester HMP remain in this updated risk assessment. For this updated assessment, some hazards have been consolidated or renamed to be consistent with the SHMCAP, as seen in the table below.

2018 Leicester HMP	2024 Leicester HMRP
• Dam Failure	• Average/Extreme Temperatures
• Drought	• Drought
• Earthquakes	• Earthquakes
• Extreme Temperatures	• Flooding from Precipitation
• Flooding	• Dam Overtopping
• Hurricanes	• Hurricanes/Tropical Cyclones
• Severe Snowstorms/Ice Storms/Nor'easter	• Invasive Species
• Severe Thunderstorms/Tornadoes/Wind	• Landslides/Mudflows
• Wildfire/Brushfire	• Other Severe Weather
• Other hazards	• Severe Winter Storms
	• Tornados
	• Wildfires

The Town of Leicester identified hazards, assessed the degree of vulnerability to the hazards throughout the town, examined the possible impacts of the hazards and assessed future risk. Leicester has mapped the hazard risks within the town. The map identifies critical facilities (such as emergency shelters and emergency response facilities) and the potential hazard risks in Town. The potential hazard risk data presents land uses, flood zones, public infrastructure, and social and economic risk areas.

4.2. Exposure and Vulnerability Sectors

The Risk Assessment process includes an analysis of the exposure and vulnerability of the community's assets, citizens, lifelines, critical facilities, economic activity, natural resources, and other areas or items that may be impacted.

	Human sector Impacts to people's health, welfare, and safety. Includes mortality, injury, and mental health impacts. This sector also identifies the characteristics that make populations more vulnerable to hazard exposure. To inform this sector, Leicester used data from the U.S. Census, the MA environmental justice data mapping tool, and population projections, among other sources.

	Governance sector Impacts to municipal owned buildings, government finances, and the ability of the government to run effectively and achieve its mission and functions and provide services to its service populations. Includes damage to state- or municipality-owned buildings, reductions in tax revenue, expenses for maintenance of state- or municipality-owned transportation infrastructure and impacts to government workers.
	Infrastructure sector Impacts to buildings and transportation assets and services, and to utilities infrastructure involved in providing power, communications, wastewater, stormwater, and potable water. This sector includes an assessment of community lifelines and critical assets, which enable all other aspects of society to function. Critical facilities were identified as critical assets that enable all other aspects of society to function.
	Natural environment sector Impacts to ecosystems, native species, ecosystem functions, recreation assets and open spaces, and natural resources, and how plants and animals can thrive there. Assesses vulnerabilities and consequences for critical resources and conserved lands. The Risk Assessment used geospatial data and tools such as BioMap, U.S. Geological Survey data, and others.
	Economy sector Impacts to people's ability to work and make a living, due to damage to buildings, infrastructure, industries, and the natural environment. Includes interruptions to workplace or regular economic activity; disruptions to specific sectors such as agriculture, fisheries, or tourism; and economic damages to individuals.

Source: 2023 Massachusetts SHMPCAP

4.2.1. Human Sector

Leicester is a sparsely developed community with a population density of 476.6 people per square mile. Development has been concentrated in the central and southern portions of town along Route 9 and Route 56. Most recent construction is on frontage lots on established roads.

As noted in Section 3.1, there are two (2) Environmental Justice block groups (Minority) that compose much of the eastern portion of Leicester from Route 56 to the Worcester and Auburn lines (FIGURE). Priority populations are people or communities who are disproportionately affected by climate change due to life circumstances that systematically increase their exposure to climate hazards or make it harder to respond. In addition to factors that contribute to environmental justice status (i.e., income, race, and language), other factors like physical ability, access to transportation, health, and age can indicate whether someone or their community will be disproportionately affected by climate change. In addition to the identified Environmental Tracts, the Town has reviewed census data to identify clusters or segments of other vulnerable populations including the elderly, mobility impaired, economically challenged, and reduced access to transportation.

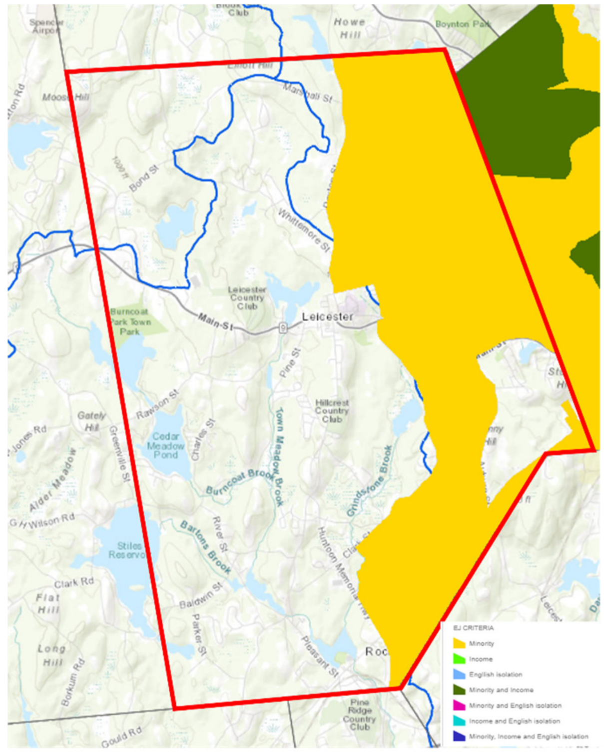


Figure XX-XX Environmental Justice Block Groups

According to the 2022 Massachusetts Climate Change Assessment Regional Reports, reduction in Food Safety and Security and Health and Cognitive Effects from Extreme Heat are the most urgent Human sector impacts in the Central region, with both projected to produce major magnitudes of consequence. The Assessment also addresses the negative effects of weather and climate change on mental health, including a broad range of impacts on overall wellbeing associated mostly with temperature stress.

4.2.2. Governance Sector

According to the 2022 Massachusetts Climate Change Assessment Regional Reports, the most urgent Governance Sector impacts in the Central Region include increased cost in preparing for and responding to climate migration, increase demand for municipal government services including emergency response, food assistance, and state sponsored healthcare, and a reduction in state and municipal revenues. With more significant impacts expected in urban areas, Leicester’s proximity to Worcester may increase reliance on the Town’s strained emergency medical assets.

The age of Leicester’s core governance facilities increases the vulnerability of Town owned structures and other property from flooding, extreme heat, and extreme storms, including damage repair costs and service losses during closures.

4.2.3. Infrastructure Sector

Leicester’s infrastructure is susceptible to a variety of hazards because of age and a lack of maintenance. During the Community Resilience Building Workshop conducted during the 2017-2018 MVP process, infrastructure and environmental vulnerability to four hazards were identified. Storm events, such as Nor’easters, and associated wind, ice, and snow were identified as one of the Town’s top hazards. Extreme precipitation and flooding, especially drainage-driven issues such as flooded roads, was identified as a second hazard. Wind and associated tree and infrastructure damage was identified as a third hazard. Impacts of extended drought, such as those seen during summer 2016 were identified as a fourth hazard. These four hazards have already had demonstrated impacts on the Town, and as climate change progresses, these hazards are expected to have ever greater consequences for infrastructure and the environment, as well as for various societal elements.

Bridges and Culverts

There are 34 municipally owned bridges and culverts and 4 MassDOT bridges and culverts in Leicester.

Facility	Town	MassDOT	Total
Culvert	24	1	25
Bridge	5	1	6
Bridge (short span)	5	2	7
	34	**4**	**38**

Other than local roads and stormwater, the Town relies on private utilities and subscriber owner water and sewer districts for critical services.

4.2.4. Natural Environment Sector

Leicester has already seen the effects of a changing climate. Invasive species have taken over several bodies of water. According to the 2022 MCCA, Freshwater Ecosystem Degradation and Forest Health Degradation are both projected to have extreme magnitudes of consequence in the Central region. Climate change threatens freshwater ecosystems through increased nutrient loading and harmful algal bloom growth, increased contaminant concentrations during drought conditions, and shifting habitat regimes as air and water temperatures rise.

4.2.5. Economy Sector

Leicester has a relatively small economic base. In 2023, there are approximately 182 businesses in Town. The most prominent industry sectors are construction/contractors (24%); health care and social assistance (12%); accommodation and food services (8%); and retail (8%). The Town is heavily reliant on residential property tax, with only 13% of the annual tax levy received from the commercial industrial sector. Climate change hazards can make it difficult for people to work because of dangerous conditions (i.e., extreme heat), transportation disruptions, and illness. Workers in the region in high-risk industries (those exposed to outdoor conditions) are projected to lose 31 hours per worker each year by 2050 and 128 hours per worker each year by 2090 (2022 MCCA).

4.3. Hazards

Each listed hazard has been defined based on previous occurrences and frequency, location, extent, speed of onset (warning time), secondary hazards, and impact of climate change.

4.4. Hazard Characterization

Table X.X Hazard Characterization

Category	Definition
Description	Description of hazard, its characteristics, and potential effects
Location	Describes geographic areas within Town that are affected by the hazard
Previous Occurrences	Provides information on the history of events, including their Impact on people and property
Extent	Describes the potential strength or magnitude of the hazard
Probability of Future Events	Describes the likelihood of future hazard occurrences
Vulnerability	Describes the potential impact on the community

The scales used for each category have been modified from those used in the 2018 Leicester HMP to align with the process used in the 2023 SHMPCAP.

4.4.1. Location

The initial geographic reach of the hazard—that is, the locations where the hazard occurs. This ranges from regional to localized. The geographic reach of consequences of the hazard scale ranges from regional to localized, as defined in Table XXX above; it differs from the scale of impact in that it considers indirect consequences of the hazard.

Regional	Townwide	Extensive	Localized
Impacts spanning several municipalities or large regions of the state or consistent single-point occurrences	Effects on 75% or more of the Town without significant overflow to other towns or consistent single-point occurrences	An effected area between 10% - 74% of the Town or frequent single point occurrences	A focused and limited area of impact or isolated single-point occurrences.

Hazard	Impact	Consequences
Average/Extreme Temperatures	Regional	Regional
Drought	Regional	Townwide
Earthquakes	Regional	Regional
Flooding from Precipitation	Localized	Localized
Dam Overtopping	Extensive	Extensive
Hurricanes/Tropical Cyclones	Regional	Regional
Invasive Species	Regional	Regional
Landslides/Mudflows	Localized	Localized
Other Severe Weather	Townwide	Townwide
Severe Winter Storms	Regional	Townwide
Tornados	Regional	Townwide
Wildfires	Townwide	Townwide

4.4.2. Extent

The extent, or magnitude of consequence for three categories: human impacts, economic impacts, and natural environmental impacts, with a scale from very high to very low.

	Very High	High	Medium	Low	Very Low
Human	Loss of human life	Any injuries; disruptions of emergency routes, inability to carry out daily activities	Disruption in ability to work and/or carry out daily life and activities	Limited effects, inconvenience, minor power outages	Minimal injury and/or inconvenience
Economic	National-level disruption to and long-term impacts to the state and possibly at the national economy; severe economic losses across multiple sectors	Significant long-term disruption to the state economy with repercussions across multiple sectors, likely to result in economic decline, with impacts that last several years after a disaster	Prolonged disruption to economic activity that limits or restricts growth, with risk of mid- or long-term economic decline	Economic consequences to people, state, and business conditions requiring expense and effort to overcome; long-term constraints unlikely	Economic costs and consequences do not affect economic growth; economic costs may be incurred, but they are planned and are sustainable expenses
Natural Environment	Irreversible loss of ecosystem and/or key organisms	Extensive damage to ecosystem and/or key organisms; unlikely to recover to pre-disaster state	Damage to ecosystems or organisms, but a likely recovery to a pre-disaster state	Some losses to individual organisms but permanent ecosystem impacts unlikely	Minimal risk of impact to individual organisms or overall ecosystems

Hazard	Human	Economic	Natural Environment
Average/Extreme Temperatures	Very High	High	Very High
Drought	High	High	High
Earthquakes	High	Medium	Low
Flooding from Precipitation	Very High	High	High
Dam Overtopping	Very High	Medium	High
Hurricanes/Tropical Cyclones	Very High	High	Medium

Invasive Species	High	High	Very High
Landslides/Mudflows	High	Low	Medium
Other Severe Weather	High	Low	Low
Severe Winter Storms	Very High	Medium	Low
Tornados	High	Medium	Medium
Wildfires	High	Medium	Very High

4.4.3. Probability of Future Events

The likelihood of a hazard occurring is informed by the historical record (if available) and climate projections, as well as the best available data and science for each hazard. All hazard analysis included the best available information on the likelihood of a hazard occurring.

Very High	**High**	**Medium**	**Low**	**Very Low**
Almost certain to occur multiple times in a year	Almost certain to occur at least once in a year	Likely to occur at least once every 50 years (two or more occurrences in the next century)	Likely to occur at least once by the end of the century; some examples of historical occurrences, anticipated every 10 years	Very unlikely; minimal examples of historical occurrences

The probability of future events also factors the amount of warning time expected prior to each hazard. The warning time is the time available to prepare in advance of the hazard. Warning time is most often used to mean the time available to provide information to the relevant agencies and exposed assets and populations to allow them to prepare for the hazard and evacuate if warranted.

No Warning	Hours	1 Day	1-5 Days	1 Week	More than 1 Week (Months or Years
Very difficult to predict and anticipate location, severity, and onset; information available does not enable preparation	Occurs with little warning; a limited number of hours to adjust behavior or prepare	Reliable, actionable information on impact available one day (about 24 hours) allowing at least one day to prepare	Predictions of impact are accurate within one to five days before the hazard occurs	Predictions of impact are accurate enough within one week, enabling several days for preparation	Reliable, accurate prediction of hazard onset at several weeks (or significantly longer), specific enough to direct action

Hazard	Likelihood	Warning Time
Average/Extreme Temperatures	Very High	1-5 days
Drought	Medium	More than 1 week
Earthquakes	Low	No warning
Flooding from Precipitation	Very High	1-5 days
Dam Overtopping	Very High	1 day
Hurricanes/Tropical Cyclones	Medium	1-5 days
Invasive Species	Very High	More than 1 week
Landslides/Mudflows	High	No warning
Other Severe Weather	Very High	1 day
Severe Winter Storms	High	1-5 days
Tornados	High	Hours
Wildfires	Very High	Hours

4.4.4. Vulnerability

4.5. Hazard Description

The hazard descriptions contained in this update have been adapted to align with the 2023 SHMCAP and the 2022 Climate Assessment.

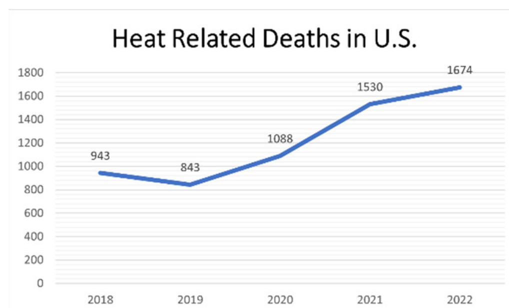
4.5.1. Average/Extreme Temperatures

4.5.1.1. Description

According to the SHMCAP, extreme heat for Massachusetts is usually defined as a period of three or more consecutive days above 90 degrees Fahrenheit (°F), but more generally as a prolonged period of excessively hot weather which may be accompanied by high humidity. Extreme cold is also considered relative to the normal climatic lows in a region. Extreme cold temperatures are characterized by the ambient air temperature dropping to approximately 0°F or below.

Extreme cold is a dangerous situation that can result in health emergencies for susceptible or vulnerable people, such as those without shelter or who are stranded or who live in homes that are poorly insulated or without heat. Extreme cold events are events when temperatures drop well below normal in an area. When winter temperatures drop significantly below normal, staying warm and safe can become a challenge. Extremely cold temperatures often accompany winter storms, which may also cause power failures and icy roads. During cold months, carbon monoxide may be high in some areas because the colder weather makes it difficult for car emission control systems to operate effectively, and temperature inversions can trap the resulting pollutants closer to the ground.

Extreme heat is a dangerous situation that can result in health emergencies for susceptible and vulnerable people, such as those without shelter or who are stranded or who live in homes that are poorly insulated or without adequate cooling. A basic definition of a heat wave implies that it is an extended period of unusually high atmosphere-related heat stress, which causes temporary modifications in lifestyle, and which may have adverse health consequences for the affected population. Heat waves cause more fatalities in the U.S. than the total of all other meteorological events combined. According to CDC data, 6,078 heat related deaths have been reported in the United States between 2018-2022.



Heat impacts can be particularly significant in urban areas. Buildings, roads, and other infrastructure replace open land and vegetation. Dark-colored asphalt and roofs also absorb more of the sun's energy. These changes cause urban areas to become warmer than the surrounding areas. This forms "islands" of higher temperatures, often referred to as "heat islands." Heat islands can affect communities by increasing peak energy demand during the summer, air conditioning costs, air pollution and Green House Gas emissions, heat-related illness and death, and water quality degradation (EPA).

Many conditions associated with heat waves or more severe events (including high temperatures, low precipitation, strong sunlight, and low wind speeds) contribute to a worsening of air quality in several ways. High temperatures can increase the production of ozone from volatile organic compounds and other aerosols. Weather patterns that bring high temperatures can also transport particulate matter air pollutants from other areas of the continent. Additionally, atmospheric inversions and low wind speeds allow polluted air to remain in one location for a prolonged period of time.

4.5.1.2. Location

Extreme temperatures are present throughout Massachusetts and can be expected to be uniform across Leicester.

4.5.1.3. Previous Occurrences

There have been 123 Cold/Wind Chill or Extreme Cold/Wind Chill events in Massachusetts since 2000; six of these events occurred in Southern Worcester County.

4.5.1.4. Extent

Extreme Cold

The extent (severity or magnitude) of extreme cold temperatures are generally measured through the Wind Chill Temperature Index. Wind Chill Temperature is the temperature that people and animals feel when outside and it is based on the rate of heat loss from exposed skin by the effects of wind and cold. On November 1, 2001, the NWS implemented a Wind Chill Temperature Index designed to more accurately calculate how cold air feels on human skin. The chart shows three shaded areas of frostbite danger. Each shaded area shows how long a person can be exposed before frostbite develops. In Massachusetts, a wind chill advisory is issued when the index based on sustained wind, is between -15°F and -24°F for at least 3 hours using only sustained wind. A warning is issued when the wind chill temperature index, based on sustained wind, is –25ºF or lower for at least three hours.

Wind Chill Chart

Wind (mph)	Temperature (°F)																	
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

Wind Chill (°F) = $35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$

Where, T= Air Temperature (°F) V= Wind Speed (mph) *Effective 11/01/01*

Extreme Heat

The Heat Index is a measure of how hot it really feels when relative humidity is factored in with the actual air temperature.

Another technique for determining the effects of temperature on humans in the Wet Bulb Global Temperature (WBGT). The WBGT factors the temperature, relative humidity, wind speed, and solar radiation. Three types of thermometer readings are used.

- Black Globe Thermometer - Calculates the solar factor
- Wet Bulb Thermometer – Measures humidity
- Dry Bulb Thermometer – Measures ambient temperature

General Thresholds for WBGT

Disclaimer: Always check with local officials for appropriate actions and activity levels. Experienced heat stress will depend upon duration and intensity of activity and personal health and vulnerability.

WBGT by Region (°F)			Threat Level WBGT at these values increasing heat stress.	Risk of heat illness
Region 1	Region 2	Region 3		
< 72.3	< 75.9	< 78.3	Low Threat	Increased risk for heat illness
72.3 - 76.1	75.9 - 78.7	78.3 - 82.0	Elevated Threat	
76.2 - 80.1	78.8 - 83.7	82.1 - 86.0	Moderate Threat	
80.1 - 84.0	83.8 - 87.6	86.1 - 90.0	High Threat	
>84.0	>87.6	>90.0	Extreme Threat	

Regions are from Grundstein, A., Williams, C., Phan, M and Cooper, E., 2015. Regional heat safety thresholds for athletics in the contiguous United States. *Applied Geography*, 56, pp.55-60. 10.1016/j.apgeog.2014.10.014.

Most of Massachusetts, including all of Barnstable, Bristol, Essex, Norfolk, Middlesex, Plymouth, Suffolk and Worcester Counties falls within Region 1. The most eastern portions of Franklin, Hampden, and Hampshire Counties are also in Region 1. All of Berkshire and the majority of Franklin, Hampden, and Hampshire Counties are in Region 2.

The impact of extreme temperatures on Leicester

Impact on vulnerable populations

Elderly

Children

Minority

Economically Challenged

Workforce- Re section 4.2.5, 24% of Leicester labor force is engaged in construction/contracting.

Extreme cold could lead to energy supply concerns and utility failures during times of extreme need, and periods of both hot and cold weather can stress energy infrastructure (e.g., brownouts caused by hot weather)

4.5.1.5. Probability of Future Events

There are significant long-term trends in the frequency of extreme hot and cold events. In the last decade, U.S. daily record high temperatures have occurred twice as often as record lows (as compared to a nearly 1:1 ratio in the 1950s). Models suggest that this ratio could climb to 20:1 by midcentury, if GHG emissions are not significantly reduced. High, low, and average temperatures in Massachusetts are all likely to increase significantly over the next century as a result of climate change.

In spite of having a record cold snap in February, 2023 was the warmest year recorded in the history of Leicester. According to the Massachusetts Climate Change Projections Dashboard, the Leicester mean cold weather temperatures will decrease 3.6°F in 2030, 5.4°F in 2050, and 8.1°F in 2070. Summer mean temperatures will increase by 3.6°F by 2030, 5.4°F by 2050, and 8.1°F by 2070. The region will experience an increase in the number of days above 90°F to 11 in 2030, 19 in 2050, and 38 in 2070.

4.5.1.6. Vulnerability

Extreme temperatures are not a hazard with a defined geographic boundary. The entire town should be considered exposed to the hazard. Excessive heat can occur at any time during the year, but is most dangerous during the summer between June and August when average temperatures are at their highest. Extreme cold temperatures are typically most dangerous during winter months between December and February.

4.5.2. Drought

4.5.2.1. Description

Droughts are typically defined as periods of deficient precipitation. How this deficiency is experienced can depend on factors such as land use change, the existence of dams, and water supply withdrawals or diversions. Droughts can vary widely in duration, severity, and local impact.

The National Drought Mitigation Center references five common, conceptual definitions of drought:

1. Meteorological drought is a measure of departure of precipitation from normal.
2. Hydrological drought is related to the effects of precipitation shortfalls on stream flows and on reservoir and groundwater levels.
3. Agricultural drought links various characteristics of meteorological and hydrological drought to agricultural impacts, and occurs when there is not enough water available for a particular crop to grow at a particular time.
4. Socioeconomic drought is associated with the supply and demand of economic goods with elements of meteorological, hydrological, and agricultural drought.
5. Ecological drought is an episodic deficit in water availability that drives ecosystems beyond thresholds of vulnerability and impacts ecosystem services.

Drought conditions can cause a shortage of water for human consumption and reduce local firefighting capabilities. Public water suppliers may struggle to meet system demands while maintaining adequate pressure for fire suppression and meeting water quality standards. The Massachusetts DEP requires all PWSs to maintain an emergency preparedness plan.

With declining groundwater levels, private well owners may experience dry wells or sediment in their water due to the more intense pumping required to pull water from the bedrock or overburden aquifer.

Wells may also develop a concentration of pollutants, which may include nitrates and heavy metals depending on local geology.

The loss of clean water for consumption and for sanitation may be a significant impact depending on the affected population's ability to quickly drill a deeper or a new well or to relocate to unaffected areas. During a drought, dry soil and the increased prevalence of wildfires can increase the amount of irritants (such as pollen or smoke) in the air. Reduced air quality can have widespread deleterious health impacts but is particularly significant to the health of individuals with pre-existing respiratory health conditions like asthma (CDC).

Lowered water levels can result in direct environmental health impacts, as the concentration of contaminants in swimmable bodies of water will increase when less water is present. Harmful algal blooms may occur, closing recreational areas.

One primary hazard in this plan that is commonly associated with drought is wildfire. A prolonged lack of precipitation dries out soil and vegetation, which becomes increasingly susceptible to ignition as the duration of the drought extends. A drought may increase the probability of a wildfire occurring.

4.5.2.2. Location

Because of this hazard's regional nature, a drought would likely impact the entire community, meaning the location of occurrence would encompass the entire town.

4.5.2.3. Previous Occurrences

Since 2013, Leicester has experienced 10 years with at least some period of a drought condition; nine years with a period of moderate drought condition; four years with a period of a severe drought condition; and three years with period of extreme drought condition.

In 2016, an extended drought period caused a number of private wells to dry up. Public water supplies were also significantly impacted. The Leicester Water Supply District (LWSD), reported significant drought effects on one of their public supply wells located in Paxton. LWSD's superintendent stated that water levels had dropped 500 feet over 5 years. The Cherry Valley & Rochdale Water District also experienced concerns with water supply. In response, they established a connection line to Worcester for use on an emergency basis in 2016. The Cherry Valley & Rochdale Water District now purchases its public drinking water exclusively from the City of Worcester and the supply they manage

Annual Drought Status in Worcester County, Mass.	
Year	**Maximum Severity**
2013	D0 conditions in 100% of the county D1 conditions in 91% of the county
2014	D0 conditions in 100% of the county D1 conditions in 79% of the county
2015	D1 conditions in 100% of the county
2016	D2 conditions in 100% of the county D3 conditions in 57% of the county

Annual Drought Status in Worcester County, Mass.	
Year	**Maximum Severity**
2017	D1 conditions in 100% of the county D2 conditions in 77% of the county
2018	D0 conditions in 100% of the county D1 conditions in 33% of the county
2019	D0 conditions in 100% of the county
2020	D2 conditions in 100% of the county D3 conditions in 15% of the county
2021	D0 conditions in 100% of the county D1 conditions in 51% of the county
2022	D2 conditions in 100% of the county D3 conditions in 53% of the county

4.5.2.4. Extent

The severity of a drought determines the scale of the event. Much of Leicester is served by the water districts: Leicester Water Supply, Cherry Valley & Rochdale Water and Hillcrest. The remainder of the town is served by wells. The U.S. Drought Monitor also records information on historical drought occurrence based on its categorization of drought on a D0-D4 scale as shown below.

U.S. Drought Monitor		
Classification	**Category**	**Description**
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered
D1	Moderate Drought	Some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; voluntary water-use restrictions requested
D2	Severe Drought	Crop or pasture losses likely; water shortages common; water restrictions imposed
D3	Extreme Drought	Major crop/pasture losses; widespread water shortages or restrictions
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells creating water emergencies

Source: US Drought Monitor, http://droughtmonitor.unl.edu/.

4.5.2.5. Probability of Future Events

Based on recent occurrences and the latest climate science, the projected warmer temperatures and increased number of heat waves will result in more periods of drought at higher levels of severity for longer periods of time.

4.5.2.6. Vulnerability

4.5.3. Earthquake

4.5.3.1. Description

An earthquake is the vibration of the Earth's surface that follows a release of energy in the Earth's crust. New England experiences intraplate earthquakes because it is located within the interior of the North American plate. Although damaging earthquakes are rare in Massachusetts, low-magnitude earthquakes occur regularly in the state.

An earthquake is a sudden rapid shaking of the earth caused by the breaking and shifting of rock beneath the earth's surface. Earthquakes can cause buildings and bridges to collapse; disrupt gas, electric, and telephone lines; and often cause landslides, flash floods, fires, avalanches, and tsunamis. Earthquakes can occur at any time without warning.

The underground point of origin of an earthquake is called its focus; the point on the surface directly above the focus is the epicenter. Earthquakes are described based on their magnitude and intensity as explained below under Extent.

New England's earthquakes appear to be the result of the cracking of the crustal rocks due to compression as the North American Plate is being very slowly squeezed by the global plate movements. As a result, New England epicenters do not follow the major mapped faults of the region, nor are they confined to particular geologic structures or terrains. Because earthquakes have been detected all over New England, seismologists suspect that a strong earthquake could be centered anywhere in the region. Furthermore, the mapped geologic faults of New England currently do not provide any indications detailing specific locations where strong earthquakes are most likely to be centered.

In addition to earthquakes occurring within the Commonwealth, earthquakes in other parts of New England can impact widespread areas. Large earthquakes in Canada, which is more seismically active than New England, can affect buildings Massachusetts. This is due in part to the fact that earthquakes in the eastern U.S. are felt over a larger area than those in the western U.S. The difference between seismic shaking in the East versus the West is primarily due to the geologic structure and rock properties that allow seismic waves to travel farther without weakening (USGS, 2012).

4.5.3.2. Location

4.5.3.3. Previous Occurrences

4.5.3.4. Extent

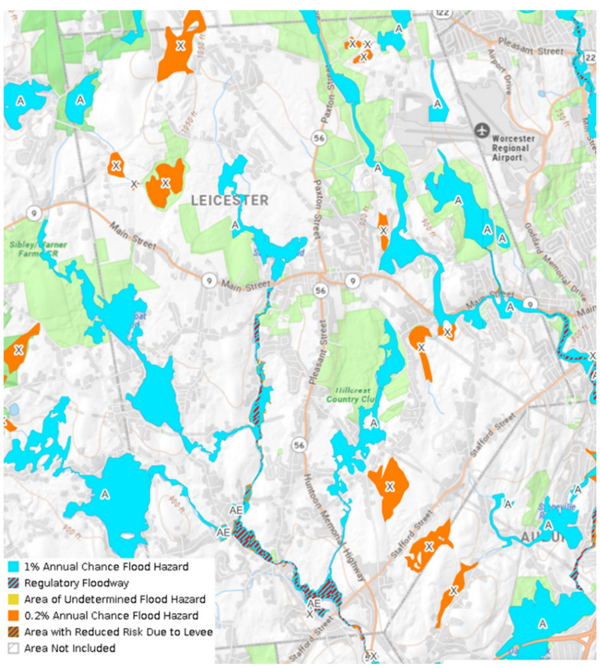
4.5.3.5. Probability of Future Events

4.5.3.6. Vulnerability

4.5.4. Flooding From Precipitation

4.5.4.1. Description

Nationally, flooding causes more damage annually than any other severe weather event. Flooding in Massachusetts is often the direct result of frequent weather events such as coastal storms, nor'easters, tropical storms, hurricanes, heavy rains, and snowmelt. In an inland community such as Leicester, flooding is the result of moderate precipitation over several days, intense precipitation over a short period, or melting snowpack. Climate change will exacerbate these issues over time with the potential for more severe and frequent storm and rainfall events. Increases in precipitation and extreme storm events will result in increased inland flooding.



<u>Riverine Flooding</u>
The topography of Leicester riverine flooding often occurs after heavy rain. Areas of the Town with high slopes and minimal soil cover are particularly susceptible to flash flooding caused by rapid runoff that occurs in heavy precipitation events and in combination with spring snowmelt, which can contribute to riverine flooding. Frozen ground conditions can also contribute to low rainfall infiltration and high runoff events that may result in riverine flooding. Some of the worst riverine flooding in Massachusetts' history occurred because of strong nor'easters and tropical storms in which snowmelt was not a factor. Tropical storms can produce very high rainfall rates and volumes of rain that can generate high runoff when soil infiltration rates are exceeded.

<u>Drainage-Related Flooding</u>
Drainage systems are designed to remove surface water from developed areas as quickly as possible to prevent localized flooding on streets and adjacent properties. They make use of a conveyance system that channels water away from a developed area to surrounding streams, bypassing natural processes of water infiltration into the ground, groundwater storage, and evapotranspiration. Flooding from

overwhelmed drainage entails floods caused by increased water runoff due to development and drainage systems that are not capable of conveying high flows. Since drainage systems reduce the amount of time the surface water takes to reach surrounding streams, flooding can occur more quickly and reach greater depths than if there were no urban development at all. In almost any community with some degree of development, basement, roadway, and infrastructure flooding can result in significant damage due to poor or insufficient stormwater drainage.

Ice Jam

An ice jam is an accumulation of ice that acts as a natural dam and restricts the flow of a body of water. A freeze-up jam usually occurs in early winter to midwinter during extremely cold weather when super-cooled water and ice formations extend to nearly the entire depth of the river channel. This type of jam can act as a dam and begin to back up the flowing water behind it. A breakup jam, forms as a result of the breakup of the ice cover at ice-out, causing large pieces of ice to move downstream, potentially piling up at culverts, around bridge abutments, and at curves in river channels. Breakup ice jams occur when warm temperatures and heavy rains cause rapid snowmelt. The melting snow, combined with the heavy rain, causes frozen rivers to swell. The rising water breaks the ice layers into large chunks, which float downstream and often pile up near narrow passages and obstructions (bridges and dams). Ice jams may build up to a thickness great enough to raise the water level and cause flooding upstream of the obstruction.

4.5.4.2. Location

Flooding and flood-prone areas in Leicester are closely associated with the course of the Kettle Book, Lynde Brook and Town Meadow Brook and its tributary water bodies and waterways. According to a GIS analysis performed by CMRPC, there are 720 parcels in Leicester that are susceptible flooding during a 100-year or base flood events, with 188 of these parcels containing structures. Due to the hilly nature of the town, much of Leicester is upland, away from rivers and ponds and as a result, the location of this hazard is relatively “small”. Map 2 in Appendix A illustrates the FEMA FIRM 100-year flood zones in the town, as well as other locally-identified flooding areas. Despite much of the town being upland, the suburban environment, and network of imperviousness combined with inadequate drainage systems and steep slopes often leads to localized flooding due to excessive surface water runoff.

Stormwater management and drainage-driven flooding on roadways are recognized as concerns Townwide. In particular, the Route 56 & Marshall Street culvert is a known point of flooding due to an undersized culvert. A detailed inventory is needed to catalog the size and condition of culverts. Regardless of condition, culvert and bridge structures were designed to accommodate historic patterns of precipitation and runoff, which are rapidly transforming as a result of climate change. As precipitation events become more intense and less predictable, undersized culverts are expected to pose a greater threat of failure and flooding. Other concerns related to excessive pressure on bridges and culverts include beaver-influenced flooding, the intentional filling of wetlands, and new developments falling short of achieving best practices for stormwater management.

4.5.4.3. Extent

The average annual precipitation for Leicester and surrounding areas in central Massachusetts has been 45 to 50 inches during the past several years.

Water levels in Leicester's rivers, streams, and wetlands rise and fall seasonally and during high rainfall events. High water levels are typical in spring, due to snowmelt and ground thaw combined with rainfall. This is a period when flood hazards are normally expected. Low water levels occur in summer due to high evaporation and plant uptake (transpiration). At any time, heavy rainfall may create conditions that raise water levels in rivers and streams above bank full stage, which then overflow to adjacent land.

Based on past records and the knowledge and experience of members of the Leicester Hazard Mitigation team and residents, the extent of the impact of localized flooding would be considered "minor".

4.5.4.4. Previous Occurrences

In addition to the floodplains mapped by FEMA for the 100-year and 500-year flood, Leicester often experiences flooding at various locations due to drainage problems, or problem culverts. The following specific flooding locations were identified by the Leicester Hazard Mitigation Team based on knowledge of past flood events:

- Pine Street near the pumps for the water treatment facility. This location repeatedly floods during heavy rain events.
- Church Street at Boyd Street and Tobin Road this area repeatedly floods during rain storms
- Woodland Road

Additionally, undersized culverts and the surface sewer system are a problem town wide.

In addition to the locations listed here (and mapped in Appendix A, Map 2), there are many areas with no record of previous flood incidents that could be affected in the future by heavy rain and runoff.

In recent years, there have been 9 loss claims in Leicester made to FEMA by National Flood Insurance Program (NFIP) participants, totaling $117,453.40. As of January, Leicester has 3 repetitive loss properties. As defined by the NFIP, a repetitive loss property is any property which the NFIP has paid for two or more flood claims of $1,000 or more in any given 10-year period since 1978.

4.5.4.5. Probability of Future Events

4.5.4.6. Vulnerability

4.5.5. Dam Overtopping

4.5.5.1. Description

Dam overtopping is caused by floods that exceed the capacity of the dam, and it can occur as a result of inadequate spillway design, settlement of the dam crest, blockage of spillways, and other factors. Overtopping accounts for one-third of all dam failures in the U.S. The two primary types of dam failure are catastrophic failure (characterized by the sudden, rapid, and uncontrolled release of impounded water) and design failure (which occurs as a result of minor overflow events).

There are a number of ways in which climate change could alter the flow behavior of a river, causing conditions to deviate from what the dam was designed to handle. For example, more extreme precipitation events could increase the frequency of intentional discharges. Many other climate impacts, including shifts in seasonal and geographic rainfall patterns, could also cause the flow behavior of rivers to deviate from previous hydrographs. When flows are greater than expected, spillway overflow events (often referred to as "design failures") can occur. These overflows result in increased discharges downstream and increased flooding potential. Therefore, although climate change will not increase the probability of catastrophic dam failure, it may increase the probability of design failures.

4.5.5.2. Location

Of the 25 registered dams in Leicester

Owner	Dam Name	Hazard Rating	Condition
Town of Leicester	Greenville Pond Dam	High Hazard	Fair
City of Worcester	Kettle Brook Reservoir #1 Dam	High Hazard	Satisfactory
City of Worcester	Kettle Brook Reservoir #2 Dam	High Hazard	Satisfactory
City of Worcester	Kettle Brook Reservoir #3 Dam	High Hazard	Satisfactory
City of Worcester	Lynde Brook Reservoir Dam	High Hazard	Satisfactory
City of Worcester	Lynde Brook Reservoir Dike	High Hazard	Fair
Private	Rochdale Pond Dam	High Hazard	Fair
Private	Smiths Pond Dam	High Hazard	Unk
Stiles Lake Water District	Stiles Reservoir Dam	High Hazard	Satisfactory
Private	Brick City Mill Pond Dam	Significant Hazard	Unsatisfactory
Burncoat Pond Watershed District	Burncoat Pond Dam	Significant Hazard	Fair
Cedar Meadow Lake Watershed District	Cedar Meadow Lake Dam	Significant Hazard	Fair
Private	Health Camp Dam	Significant Hazard	Unsatisfactory
Private	Sargent Pond Dam	Significant Hazard	Satisfactory
Town of Leicester	Waite Pond Dam	Significant Hazard	Poor
Town of Spencer	Shaw Pond Dam	Low Hazard	
Greater Worcester Land Trust	Southwick Deep Pond Dam	Low Hazard	
Private	Southwick Upper Pond Dam	Low Hazard	

4.5.5.3. Previous Occurrences

4.5.5.4. Extent

4.5.5.5. Probability of Future Events

4.5.5.6. Vulnerability

4.5.6. Hurricane/Tropical Cyclone

4.5.6.1. Description

Historically, hurricanes that have struck the New England region re-curved northward on tracks that paralleled the eastern seaboard by maintaining a slight north-northeast track direction. The states of Connecticut, Rhode Island, and Massachusetts geographically project easterly into the Atlantic and have southern exposed shorelines, which place them in direct line of any storm that tracks in this manner.

Therefore, even though New England is a relatively far distance from the tropics, its susceptibility to hurricane strikes can statistically be greater than other states closer to the tropics.

Another explanation giving evidence to New England's unique vulnerability to hurricanes is that hurricanes that eventually strike the region undergo significant increases in forward speed. Historically, it can be shown that hurricanes tend to lose their strength and accelerate in a forward motion after passing the outer banks of Cape Hatteras, North Carolina. The increase in forward speed that usually occurs simultaneously as a hurricane weakens with further northward movement can often compensate for any discounting in hurricane intensity. Surge flooding, wave effects, and wind speeds that accompany a faster moving, weaker hurricane may exceed overall conditions caused by more intense hurricanes. This means that for some locations, depending on the meteorology of the storm, the affects from a Category 2 hurricane traveling at 60 MPH might be worse than that from a Category 4 hurricane moving at 20 MPH.

There are primarily three components of vulnerability from the impact of a hurricane: storm surge (coastal flooding); ability to evacuate in a timely manner; and shelter capacity. Storm surge has the potential to create a serious problem in Scituate because the waters can rise to high levels with the potential to flood coastal properties, cover roads completely with water. If roads are inundated with water evacuation routes can be eliminated, which can be of particular concern in frequently flooded areas.

Electrical utilities and communications, as well as transportation infrastructure, are vulnerable to significant coastal events. Damage to power lines or communication towers has the potential to cause power and communication outages for residents, businesses and critical facilities. In addition to lost revenues, downed power lines present a threat to personal safety. Furthermore, downed wires and lightning strikes have been known to spark fires.

Human vulnerability is based on the availability, reception, and understanding of early warnings of coastal hazard events (i.e., Hurricane Watches and Warnings issued by the NWS), as well as access to substantial shelter and a means and desire to evacuate if so ordered. In some cases, despite having access to technology (computer, radio, television, outdoor sirens, etc.) that allows for the reception of a warning, language differences are sometimes a barrier to individuals understanding them. Once warned of an impending significant coastal hazard event, seeking shelter in a substantial indoor structure, that is wind resistant and outside of storm surge zones, is recommended as the best protection against bodily harm

4.5.6.1. Location

4.5.6.2. Previous Occurrences

4.5.6.3. Extent

4.5.6.4. Probability of Future Events

4.5.6.5. Vulnerability

4.5.7. Invasive Species

4.5.7.1. Description

All of Massachusetts is susceptible to effects from invasive species. Invasive species threaten biodiversity and natural resources and have significant economic impacts. Specific costs associated with invasive species include control and management activities, prevention and early detection, and rapid response programs, as well as funding for research, public outreach campaigns, and removal and restoration programs. In Massachusetts, aquatic invasive species threaten water quality, fish and wildlife habitat, coastal infrastructure, and economically important fisheries. Invasive species can damage and disrupt the existing ecosystem, outcompete native flora and fauna, eradicate native species, and in some cases increase wildfire risk.

Emerald Ash Borer -Statewide
Asian Longhorned Beatle – Worcester
Beach Leaf Disease – Worcester, Paxton, Spencer
Spotted Lanternfly – Worcester

Other environmental issues occurring in Leicester include algal blooms in swimming holes and ponds due to agricultural runoff, increasing illness caused by tick-and-mosquito-borne diseases, and invasive plants, including the water chestnut, pressuring the sustainability of the local, native ecosystems.

4.5.7.2. Location

4.5.7.3. Previous Occurrences

4.5.7.4. Extent

4.5.7.5. Probability of Future Events

4.5.7.6. Vulnerability

4.5.8. Landslide/Mudflows

4.5.8.1. Description

4.5.8.2. Location

4.5.8.3. Previous Occurrences

4.5.8.4. Extent

4.5.8.5. Probability of Future Events

4.5.8.6. Vulnerability

4.5.9. Other Severe Weather

4.5.9.1. Description

4.5.9.2. Location

4.5.9.3. Previous Occurrences

4.5.9.4. Extent

4.5.9.5. Probability of Future Events

4.5.9.6. Vulnerability

4.5.10.Severe Winter Storms

4.5.10.1. Description

Severe winter storms can pose a significant risk to property and human life. Severe snowstorms and ice storms can involve rain, freezing rain, ice, snow, cold temperatures and wind. Heavy snowfall and extreme cold can immobilize an entire region. Even areas that normally experience mild winters can be hit with a major snowstorm or extreme cold. Winter storms can result in flooding, storm surge, closed highways, blocked roads, downed power lines and hypothermia. A northeast coastal storm, known as a nor'easter, is typically a large counter-clockwise wind circulation around a low-pressure center often resulting in heavy snow, high winds, and rain.

4.5.10.2. Location

The entire Town of Leicester is susceptible to severe snowstorms, which means the location of occurrence is "large." Because these storms occur regionally, they would impact the entire town. A portion of the Worcester Regional Airport is in Leicester and is especially vulnerable to severe snow storms due to its high elevation. There are access roads to the airport in Leicester, this could impact response and recovery during these types of storms.

4.5.10.3. Extent

The Northeast Snowfall Impact Scale (NESIS) developed by Paul Kocin of The Weather Channel and Louis Uccellini of the National Weather Service (Kocin and Uccellini, 2004) characterizes and ranks high-impact Northeast snowstorms. These storms have large areas of 10-inch snowfall accumulations and greater. NESIS has five categories: Extreme, Crippling, Major, Significant, and Notable. The index differs from other meteorological indices in that it uses population information in addition to meteorological measurements. Thus, NESIS gives an indication of a storm's societal impacts.

NESIS scores are a function of the area affected by the snowstorm, the amount of snow, and the number of people living in the path of the storm. The aerial distribution of snowfall and population information are combined in an equation that calculates a NESIS score which varies from around one for smaller storms to over ten for extreme storms. The raw score is then converted into one of the five NESIS categories. The largest NESIS values result from storms producing heavy snowfall over large areas that include major metropolitan centers.

Northeast Snowfall Impact Scale Categories		
Category	**NESIS Value**	**Description**
1	1—2.499	Notable
2	2.5—3.99	Significant
3	4—5.99	Major
4	6—9.99	Crippling
5	10.0+	Extreme

4.5.10.4. Previous Occurrences

The 2011 Halloween Nor'easter produced unusually early snowfall on trees that were often still in leaf, adding extra weight, with the ground in some areas still soft from a preceding warm, rainy period that increased the possibility trees could be uprooted. Based on data available from the National Oceanic and Atmospheric Administration (NOAA), there are 62 high-impact snowstorms, according to the NESIS scale, since 1958 which affected the Northeast Corridor. Of these, 33 storms resulted in snowfalls in Leicester of at least 10 inches. These storms are listed in the table below:

Winter Storms Producing Over 10 Inches of Snow in Leicester, 1958-2018

Date	NESIS Value	NESIS Category	NESIS Classification
3/11/2018	3.16	2	Significant
3/05/2018	3.45	2	Significant
1/03/2018	1.71	1	Notable
3/12/2017	5.03	3	Major
2/8/2015	1.32	1	Notable
1/29/2015	5.42	3	Major
1/25/2015	2.62	2	Significant
3/4/2013	3.05	2	Significant
2/7/2013	4.35	3	Major
10/29/2011	1.75	1	Notable
1/26/2011	2.17	1	Notable
1/9/2011	5.31	3	Major
2/12/2006	4.1	3	Major
1/21/2005	6.8	4	Crippling
2/15/2003	7.5	4	Crippling
3/31/1997	2.29	1	Notable
2/2/1995	1.43	1	Notable
2/8/1994	5.39	3	Major
3/12/1993	13.2	5	Extreme
2/10/1983	6.25	4	Crippling
4/6/1982	3.35	2	Significant
2/5/1978	5.78	3	Major
1/19/1978	6.53	4	Crippling

Winter Storms Producing Over 10 Inches of Snow in Leicester, 1958-2018

2/18/1972	4.77	3	Major
12/25/1969	6.29	4	Crippling
2/22/1969	4.29	3	Major
2/8/1969	3.51	2	Significant
2/5/1967	3.5	2	Significant
2/2/1961	7.06	4	Crippling
1/18/1961	4.04	3	Major
12/11/1960	4.53	3	Major
3/2/1960	8.77	4	Crippling
2/14/1958	6.25	4	Crippling

4.5.10.5. Probability of Future Events

Based upon the availability of records for Worcester County, the likelihood that a severe snow storm will affect Leicester is “very high” (greater than 70 percent in any given year).

Research on climate change indicates that there is great potential for stronger, more frequent storms as the global temperature increases. The Massachusetts State Climate Change Adaptation Report says that predicted changes in the amount, frequency, and timing of precipitation, and the shift toward more rainy and icy winters would have significant implications. By the end of the century, under the high-emissions scenario, annual precipitation is expected to increase by 14%, with a slight decrease in the summer, and a 30% increase in the winter.

4.5.10.6. Vulnerability

The town faces a “limited” impact or less than 10 percent of total property damaged, from snowstorms.

The weight from multiple snowfall events can test the load ratings of building roofs and potentially cause significant damage. Multiple freeze-thaw cycles can also create large amounts of ice and make for even heavier roof loads and lead to ice dams and both interior and exterior structural damage.

Other impacts from snowstorms and ice storms include:

- Disrupted power, internet, and phone service
- Damage to telecommunications structures and utility infrastructure
- Infrastructure and other property are also at risk from severe winter storms and the associated flooding that can occur following heavy snow melt.

- Tree damage and fallen branches that cause utility line damage and roadway blockages – particularly during ice, sleet, or heavy snow storms
- Unsafe driving conditions and increased traffic accidents
- Reduced ability of emergency officials to respond promptly to medical emergencies or fires

Based on the above assessment, Leicester has a hazard index rating of "2 — high risk" from snowstorms and ice storms.

Utilizing the town's total value of all property, $899,572,172 (Massachusetts Department of Revenue, 2016), and an estimated 5 percent of damage to 10 percent of residential structures, approximately $4,497,861 worth of damage could occur from a severe snowstorm. This is a rough estimate and likely reflects a worst-case scenario. The cost of repairing or replacing the roads, bridges, utilities, and contents of structures is not included in this estimate.

4.5.11. Tornados

4.5.11.1. Description

4.5.11.2. Location

4.5.11.3. Previous Occurrences

Between 2018 and 2022, the National Oceanographic and Atmospheric Administration (NOAA) listed the following events in Massachusetts (NOAA, 2022):

- 20 coastal flooding events
- 19 tornadoes, with eight in Worcester County alone
- 27 temperature warnings, 10 for heat and 17 for cold

4.5.11.4. Extent

4.5.11.5. Probability of Future Events

4.5.11.6. Vulnerability

4.5.12. Wildfires

4.5.12.1. Description

Wildfires are typically fires triggered by lightning or accidents, involving full-sized trees as well as meadows and scrublands. Brushfires are uncontrolled fires that occur in meadows and scrublands, but do not involve full-sized trees. Typical causes of brushfires and wildfires are lightning strikes, human carelessness, and arson.

FEMA has classifications for 3 different classes of wildfires:

- Surface fires are the most common type of wildfire, with the surface burning slowly along the floor of a forest, killing or damaging trees.
- Ground fires burn on or below the forest floor and are usually started by lightening
- Crown fires move quickly by jumping along the tops of trees. A crown fire may spread rapidly, especially under windy conditions.

Potential vulnerabilities to wildfires include damage to structures and other improvements and impacts on natural resources. Smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations including children, the elderly, and those with respiratory and cardiovascular diseases.

4.5.12.2. Location

Worcester County has approximately 645,000 acres of forested land, which accounts for 64% of total land area (Massachusetts Office of GIS, 2007). In Leicester, an estimated 63% of the land is forested. Leicester is developed in a mostly suburban pattern and few uninterrupted tracts of forest are present, the tree coverage does present some risk for wildfires and brush fires. The total amount of the town that could be affected by a wildfire is categorized as “small,” or less than 10 percent of the total area.

4.5.12.3. Previous Occurrences

In 2023 there have been ten surface fire incidents in Leicester. The primary reason these incidents did not expand to larger or more impactful fires is the rapid response and action by the Leicester Fire Department.

4.5.12.4. Extent

Wildfires can cause widespread damage. They can spread very rapidly, depending on local wind speeds and can be very difficult to get under control. Fires can last for several hours up to several days. In Leicester, approximately 63% percent of the town’s total land area is forested, and is therefore at risk of fire. This forested area is generally scattered throughout the community, with developed areas, rivers and major transportation corridors (Route 9) breaking up the forest. In drought conditions, a brushfire or wildfire would be a matter of concern. As noted in the next section describing previous occurrences of wildfire, there have not been any major wildfires recorded in Leicester in recent decades. Based on historic data for 2006-2017, it is estimated that a brush fire might destroy 58 acres of forested area (Massachusetts Fire Incident Reporting System).

4.5.12.5. Probability of Future Events

4.5.12.6. Vulnerability

4.6. National Flood Insurance Properties

4.7. Hazard Ranking

5. Capability Assessment

5.1. Assessment Purpose

5.2. Planning and Regulatory Capabilities

The building department has responded to storm hazards by not issuing permits in flood zones. Also, building codes have changed drastically in recent years after “a bunch” of commercial roofs collapsed under snow load brought by the storm of 2011. Wind-bracing is now considered necessary on all buildings due to recent changes in the weather experienced in Town.

5.3. Administrative and Technical Capabilities

5.4. Financial Capabilities

5.5. Education and Outreach Capabilities

5.6. National Flood Insurance Participation

5.7. Opportunities to Improve Capabilities

6. Mitigation Strategy

6.1. Mitigation Goals

6.2. Range of Mitigation Actions

6.3. Mitigation Action Plan

6.4. Potential Funding Sources

7. Plan Integration and Maintenance