ResilientMass Plan

2023 MASSACHUSETTS STATE HAZARD MITIGATION AND CLIMATE ADAPTATION PLAN

Executive Office of Energy and Environmental Affairs

ResilientMass

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MAURA T. HEALEY
GOVERNOR

KIMBERLEY DRISCOLL
LIEUTENANT GOVERNOR

I am pleased to present and formally adopt the ResilientMass Plan, our 2023 Massachusetts State Hazard Mitigation and Climate Adaptation Plan. This plan implements Executive Order No. 569, which calls for an "Integrated Climate Change Strategy for the Commonwealth" and development of a statewide climate adaptation plan. The ResilientMass Plan builds on the findings of the 2022 Massachusetts Climate Change Assessment and the science and robust public engagement underpinning it. The ResilientMass Plan also constitutes the federally mandated five-year update to the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP).

The ResilientMass Plan represents a statewide and comprehensive collaborative planning effort to prepare for, adapt to, and reduce the risk of natural hazards and exacerbated impacts from climate change. The plan focuses on strategies to address risks to human health, financial security, and safety; critical assets and infrastructure; natural resources and environment; cultural resources; governance; and the economy of Massachusetts. The Healey-Driscoll Administration has also applied an equity lens to our resilience planning, taking into consideration analyses of environmental justice communities and other populations disproportionately impacted by climate change. This work is an historic opportunity to right past wrongs. Actions taken to bolster resiliency should focus first and foremost on the people being harmed by this crisis today.

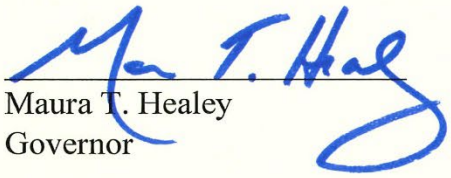
Over the next five years, the plan will continue to evolve through regular reviews by the interagency ResilientMass Action Team, with input from other stakeholders. The team will enhance the plan to reflect the most up-to-date science, incorporate lessons learned, and implement best practices. This plan, as updated, meets the requirements of Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, and other federal requirements, including 44 CFR 201 and 206, maintaining the Commonwealth of Massachusetts' eligibility for Stafford Act assistance and non-disaster hazard mitigation programs.

On behalf of the Commonwealth of Massachusetts, I adopt the 2023 ResilientMass Plan; assure that the Commonwealth of Massachusetts will continue to comply with all applicable federal statutes and regulations in effect with respect to the periods for which it receives grant funding in compliance with 44 CFR 13.11(c); and will amend this plan as necessary to reflect changes in state or federal statutes and regulations as required in 44 CFR 13.11(d).

The climate crisis is our greatest threat and greatest opportunity. The ResilientMass Plan acknowledges that state government must lead in guarding against the natural hazards and

exacerbated impacts of climate change. We will seize this moment to build a thriving, resilient Commonwealth for all of our residents and for future generations.

Sincerely yours,



Maura T. Healey
Governor

Acknowledgments

The 2023 ResilientMass Massachusetts State Hazard Mitigation and Climate Adaptation Plan (MA SHMCAP) was developed through an intensive and collaborative planning process that involved numerous state agencies, a large cross-section of stakeholders, members of the public, working groups, and a consulting team. A special thanks to the following individuals and teams who contributed to the plan in addition to others who may not be listed.

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Massachusetts Division of Marine Fisheries (DMF)
Massachusetts Environmental Police (MEP)
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Massachusetts Office of Coastal Zone Management (CZM)

Executive Office of Health and Human Services (EOHHS)
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Massachusetts Department of Transitional Assistance (DTA)
Massachusetts Department of Veterans' Services (DVS)
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Massachusetts Department of Labor Standards (DLS)

Executive Office of Public Safety and Security (EOPSS)
Massachusetts Department of Fire Services (DFS)
Massachusetts Emergency Management Agency (MEMA)
Massachusetts National Guard (MANG)
Massachusetts Office of Public Safety & Inspections (OPSI)

Executive Office of Technology Services and Security (EOTSS)

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Massachusetts Port Authority (Massport)
Massachusetts Regional Planning Agencies
Northeast States Emergency Consortium
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Federal Emergency Management Agency, Region 1
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United States Geological Survey

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Acronyms

A&F	Executive Office of Administration and Finance
Ac	acre
ACEC	Area of Critical Environmental Concern
AGO	Office of the Attorney General
APR	Agriculture Preservation Restriction
ASCE	American Society of Civil Engineers
BBRS	Board of Building Regulations and Standards
BCE	Before Common Era
BEH	Massachusetts Bureau of Environmental Health
BIDLS	Bureau of Infectious Disease and Laboratory Sciences
BIL	Bipartisan Infrastructure Act
BLS	U.S. Bureau of Labor Statistics
BMPs	best management practices
BRIC	Building Resilient Infrastructure and Communities
CAMIS	Capital Asset Management Information System
CAPE	convective available potential energy
CAVA	Climate Adaptation Vulnerability Assessment
CDC	Centers for Disease Control and Prevention
CECP	Clean Energy and Climate Plan
CEMP	Comprehensive Emergency Management Plan
CERP	Clean Energy Results Program
CERT	Community Emergency Response Teams
CFI	Continuous Forest Inventory
CFR	Code of Federal Regulations
CHWQ	Coastal Habitat and Water Quality
CIP	Capital Investment Plan
CIRA	Climate Change Impacts and Risk Analysis
CMIP6	Coupled Model Intercomparison Project Phase 6
CMR	Code of Massachusetts Regulations
COG	Continuity of Government
COOP	Continuity of Operations Plan

COPD	chronic obstructive pulmonary disease
CPG	Comprehensive Preparedness Guide
CPI	Consumer Price Index
CRS	Community Rating System
CSO	combined sewer overflow
CY	cubic yard
CZM	Office of Coastal Zone Management
DART	Deep-ocean Assessment and Reporting of Tsunami
DCAMM	Division of Capital Asset Management and Maintenance
DCR	Department of Conservation and Recreation *(also MA DCR)*
DER	Division of Ecological Restoration
DFG	Massachusetts Department of Fish and Game
DHCD	Department of Housing and Community Development
DID	Dam Incident Database
DMF	Division of Marine Fisheries
DMP	Drought Management Plan
DMTF	Drought Management Task Force
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOER	Department of Energy Resources
DPU	Department of Public Utilities
DWSP	Division of Water Supply Protection
EAD	expected annual damage
EDDMapS	Early Detection and Distribution Mapping System
EF	Enhanced Fujita
EIA	U.S. Energy Information Administration
EJ	environmental justice
EMAP	Emergency Management Accreditation Program
EMS	emergency medical services
EOEEA	Executive Office of Energy and Environmental Affairs *(also EEA)*
EOHED	Executive Office of Housing and Economic Development *(also HED)*
EOHHS	Executive Office of Health and Human Services *(also HHS)*
EOLWD	Executive Office of Labor and Workforce Development *(also LWD)*
EOPSS	Executive Office of Public Safety and Security

EOTSS	Executive Office of Technology Services and Security *(also TSS)*
EPA	U.S. Environmental Protection Agency
ERG	Eastern Research Group, Inc.
ESF	Emergency Support Function
FAQ	frequently asked question
FCPA	Massachusetts Forest Cutting Practices Act
FEMA	Federal Emergency Management Agency
FHMP	Flood Hazard Management Program
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance
FSA	Farm Service Agency
FSIG	Food Security Infrastructure Grant Program
ft	foot
FY	fiscal year
GBRAG	Greater Boston Research Advisory Group
GDP	gross domestic product
GHG	greenhouse gas
GIS	geographic information system
GridMET	Gridded Surface Meteorological
GWh	gigawatt hours
GZA	GZA GeoEnvironmental, Inc.
HAB	harmful algal bloom
HGMP	Hazard Mitigation Grant Program
HIRA	hazard identification and risk assessment
HLC	Executive Office of Housing and Livable Communities
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HUC	Hydrologic Unit Code
ICC	International Code Council
ID	identity document
IDER	Infectious Disease Emergency Response
IEBC	International Existing Building Code
IEc	Industrial Economics, Incorporated
IIJA	Infrastructure Investment and Jobs Act

IPCC	International Panel on Climate Change
IRA	Inflation Reduction Act
IT	information technology
LHMP	local hazard mitigation plan
LIDAR	LIght Detection and Ranging
LiMWA	Limit of Moderate Wave Action
LST	land surface temperature
LST	Land-surface temperature
MA	Massachusetts
MACRIS	Massachusetts Cultural Resource Information System
MACRIS	Massachusetts Cultural Resources Information System
MAPC	Metropolitan Area Planning Council
MaPIT	Massachusetts Project Intake Tool
MassCEC	Massachusetts Clean Energy Center
MassDEP	Massachusetts Department of Environmental Protection *(also DEP, MA DEP)*
MassDOT	Massachusetts Department of Transportation *(also DOT)*
MassDPH	Massachusetts Department of Public Health
MassECAN	Massachusetts Ecosystem Climate Adaptation Network
MassGIS	Massachusetts Bureau of Geographic Information
MassWildlife	Division of Fisheries and Wildlife
MBTA	Massachusetts Bay Transportation Authority
MCD	minor civil division
MC-FRM	Massachusetts Coast Flood Risk Model
MDAR	Massachusetts Department of Agricultural Resources *(also DAR)*
MEMA	Massachusetts Emergency Management Agency
MEPA	Massachusetts Environmental Policy Act
MGL	Massachusetts General Laws
MHC	Massachusetts Historical Commission
MIPAG	Massachusetts Invasive Plant Advisory Group
MMI	Modified Mercalli Intensity
MORIS	Massachusetts Ocean Resource Information System
MOSPRA	Massachusetts Oil Spill Prevention and Response Act
MOTT	Massachusetts Office of Travel and Tourism
mph	miles per hour

MRP	mean recurrence period
MS4	Municipal Separate Storm Sewer System
MSBC	Massachusetts State Building Code
MVP	Municipal Vulnerability Preparedness
MWRA	Massachusetts Water Resource Authority
NA	not applicable
NASA	National Aeronautics and Space Administration
NCA4	Fourth National Climate Assessment
NCEI	National Centers for Environmental Information
NDCD	National Climatic Data Center
NDRF	National Disaster Recovery Framework
NECASC	Northeast Climate Adaptation Science Center
NEMTEC	Northeast Emergency Management Training & Education Center
NFIP	National Flood Insurance Program
NGO	non-governmental organization
NIACS	Northern Institute of Applied Climate Science
NIDIS	National Integrated Drought Information System
NISC	National Invasive Species Council
NISMP	National Invasive Species Management Plan
NOAA	National Oceanic and Atmospheric Administration
NPDP	National Performance of Dams Program
NPS	National Park Service
NSSL	National Severe Storms Laboratory
NWRAP	Northeast-Midwest Wildfire Risk Assessment Portal
NWS	National Weather Service
OCIR	Office of Climate Innovation and Resilience
OMB	Office of Management and Budget
OPSI	Office of Public Safety and Inspection
OSHA	Occupational Health and Safety Administration
OWR	Office of Water Resources
PAS	Program Administration by State
PDM	Pre-Disaster Mitigation
PGA	peak ground acceleration
PMF	probably maximum flood

PMT	project management team
PSP	paralytic shellfish poisoning
PTS	Production Tracking System
PWS	public water supplier
RCP	representative concentration pathway
RI DEM	Rhode Island Department of Environmental Management
Risk MAP	Risk Mapping, Assessment, and Planning
RL	repetitive loss
RMAT	Resilient MA Action Team
RMAT	Resilient Massachusetts Action Team
RSI	Regional Snowfall Index
SEC	Seaport Economic Council
SFHA	Special Flood Hazard Area
SFM	structure-from-motion
SHMCAP	State Hazard Mitigation and Climate Adaptation Plan
SHMP	State Hazard Mitigation Plan
SLAMM	Sea Level Affecting Marshes Model
SLOSH	Sea, Lake, and Overland Surges from Hurricanes
SMART	Solar Massachusetts Renewable Target
SME	subject matter expert
SPC	National Storm Prediction Center
SPR	Stakeholder Preparedness Review
SPR	Stakeholder Preparedness Review
sq. ft	square foot
SRL	severe repetitive loss
SSP	State Supplement Program
STORM	Safeguarding Tomorrow through Ongoing Risk Mitigation
SWG	Stochastic Weather Generator
TERT	Telecommunicator Emergency Response Taskforce
THIRA	Threat and Hazard Identification and Risk Assessment
THIRA	Threat Hazard Identification and Risk Assessment
TMDL	total maximum daily load
TRB	Transportation Research Board
UAS	unmanned aerial system

UHI	urban heat island
UMass	University of Massachusetts
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WBNERR	Waquoit Bay National Estuarine Research Reserve
WPA	Wetlands Protection Act
WUI	wildland-urban interface

Chapter 1. Introduction

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Figures

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Abbreviations

EEA	Executive Office of Energy and Environmental Affairs
FEMA	Federal Emergency Management Agency
MEMA	Massachusetts Emergency Management Agency
MVP	Municipal Vulnerability Preparedness
SHMCAP	State Hazard Mitigation and Climate Adaptation Plan

1.1 Introduction

ResilientMass is the umbrella initiative for the state's climate adaptation and resilience programs, policies, and initiatives. The 2023 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (MA SHMCAP) is a fundamental component of ResilientMass and serves as a blueprint that identifies the risks to the Commonwealth and the actions that state agencies and partners will take to reduce those risks over the next five years. The MA SHMCAP is designed to be both visionary and practical in its approach to protecting human health and wellbeing, critical assets, environmental resources, the economy, and cultural resources in the Commonwealth now and into the future.

Led by the Massachusetts Emergency Management Agency (MEMA) in close coordination with the Executive Office of Energy and Environmental Affairs (EEA), the 2023 MA SHMCAP serves as an update to the 2018 MA SHMCAP. The 2023 MA SHMCAP reflects the progress made since the release of the 2018 plan. It builds on the best available science, including the findings, data, and engagement leveraged through the *2022 Massachusetts Climate Change Assessment* (MA Climate Assessment, as described in Section 1.2.1). The MA Climate Assessment is a statewide analysis that uses the best available data and science to detail how Massachusetts' people, environments, and infrastructure could be affected by climate change and its related hazards through the end of the century.

The 2023 MA SHMCAP includes a robust update to the 2018 Risk Assessment, an assessment of the risk and vulnerability of a broader range of critical assets and services, and an assessment of 88 state agencies' current capacities and capabilities to manage these risks, as presented in Chapter 4 (State Capabilities and Capacity) and Chapter 5 (Risk Assessment). Additionally, the 2023 MA SHMCAP development process involved an assessment of the vulnerabilities of state agency assets and services with the participation

from the same 88 agencies, as presented in Chapter 6 (State Agency Vulnerabilities). The 2023 MA SHMCAP meets Federal Emergency Management Agency (FEMA) requirements to ensure the Commonwealth is eligible for federal disaster recovery and hazard mitigation funding.

The 2023 MA SHMCAP development process included engagement of a state agency working group made up of members of the Resilient Massachusetts Action Team (RMAT) and other partners. The RMAT is an interagency steering committee responsible for implementing, monitoring, and maintaining the MA SHMCAP. Engagement with the RMAT allowed all partners to work as a team during each step of the development process to ensure that the SHMCAP reflected the Commonwealth's capabilities and vulnerabilities, critical assets and services, and that the state has sufficient resources and capacity to implement the 2023 MA SHMCAP. Chapter 2 (Planning Process) describes in detail the engagement tools and approaches that the MA Climate Assessment and 2023 MA SHMCAP teams used to ensure state agencies, local municipalities, regional organizations, and others were engaged and involved throughout the 2023 MA SHMCAP development process.

1.1.1 Key Concepts and Terms

The following key terms and concepts are referred to throughout the 2023 MA SHMCAP.

- **Climate adaptation:** Actions taken at the individual, local, regional, and national levels to reduce risks from changed climate conditions and prepare for impacts from additional changes projected for the future.
- **Climate change:** A statistically significant variation in climate data or patterns over a given period of time, due to either natural climate variability or human activity.
- **Community lifelines:** The most fundamental services in the community that, when stabilized, enable all other aspects of society to function. The integrated network of assets, services, and capabilities that provide community lifeline services supports a community's recurring needs. Lifelines enable the continuous operation of critical government and business functions and are essential to human health and safety or economic security.
- **Consequence**: The effect of a hazard occurrence. Consequence is demonstrated by the impact on population, physical property (e.g., state facilities, local jurisdiction assets and general building stock, and critical facilities), responders, operations, the environment, the economy, and public confidence in state governance. A consequence analysis meets the EMAP standard for hazards identified in state plans.
- **Critical infrastructure:** Physical or virtual systems and assets so vital that their incapacity or destruction may have a debilitating impact on the security, economy, public health, safety, and environment of any local, state, Tribal, or federal jurisdiction.
- **Environmental Justice and other priority populations:** In Massachusetts, an "Environmental Justice population" is defined as "a neighborhood where one or more

of the following criteria are true: the annual median household income is 65 percent or less of the statewide annual median household income, minorities make up 40 percent or more of the population, 25 percent or more of households identify as speaking English less than 'very well,' minorities make up 25 percent or more of the population, and the annual median household income of the municipality in which the neighborhood is located does not exceed 150 percent of the statewide annual median household income."

Massachusetts also refers to priority populations as "people or communities who are disproportionately impacted 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. This is driven by underlying contributors such as racial discrimination, economic disparities, or accessibility barriers that create vulnerability. The term priority populations acknowledges that the needs of people with these experiences and expertise must take precedence when developing resilience solutions to reduce vulnerability to climate change." The 2023 MA SHMCAP refers to Environmental Justice, priority populations, and those that also face social vulnerabilities as **"Environmental Justice and other priority populations."**

- **Functions:** The programs and services an agency provides to its customers to fulfill its mission. These programs and services depend on the mission of each agency and could include activities such as planning, policy development, regulatory enforcement, research, permitting, outreach, education, or stewardship of critical resources.
- **Hazard mitigation:** Hazard mitigation is any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards. An example of hazard mitigation is elevating or strengthening a bridge to reduce damage, disruption, or loss from a flood or earthquake. It also includes developing regulations to require new construction to include new methods and procedures to reduce risks from current hazards and increasing risks from climate change.
- **Resilience:** 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.
- **Risk:** The potential for an unwanted outcome resulting from an event or occurrence, as determined by its likelihood and the associated consequences. Risk may degrade or hinder the performance of essential functions and affect critical assets associated with continuity operations.
- **Vulnerability:** For the 2023 MA SHMCAP, vulnerability was determined by assessing the likelihood of hazards that have occurred in Massachusetts in the past and are likely to occur there in the future. Based on an understanding of the hazards and climate influences, the 2023 MA SHMCAP Risk Assessment evaluated the vulnerability of people

and public health and safety, infrastructure, natural resources, economy, and governance for each hazard. The Risk Assessment also identified disproportionate impacts and sensitivities, as well as the magnitude of consequences from each vulnerability.

1.1.2 Purpose, Vision, and Principles

The 2023 MA SHMCAP represents a comprehensive planning effort that results in a mitigation and adaptation strategy. Specifically, it focuses on strategies to address risks to the human health and safety, communities, critical assets and infrastructure, natural resources and environment, cultural resources, governance, and economy of the Commonwealth. The 2023 MA SHMCAP aligns with Massachusetts' vision, ensuring that the Commonwealth is prepared to withstand, respond to, recover from, and mitigate all types of emergencies and disasters.

The resulting 2023 MA SHMCAP reflects the leadership of state agencies and active involvement of other participants, including subject matter experts, local municipalities, and regional and community organizations. The 2023 MA SHMCAP considers key issues such as sustainability, adaptation of the built and natural environment, considerations of social vulnerability, and assessments of environmental justice and other priority populations who may be disproportionately impacted by hazards and the effects of climate change.

The development and implementation processes associated with the 2023 MA SHMCAP are compliant with Emergency Management Accreditation Program (EMAP) standards. For example, the MA SHMCAP includes climate adaptation and hazard mitigation actions to reduce risks and loss, incorporates agency plans and procedures to ensure actions can be implemented, and identifies risks that could impact the continuity of government services.

The RMAT, in conjunction with EEA, MEMA, FEMA, and other partners, will annually evaluate the 2023 MA SHMCAP to measure the progress of each action. The MA SHMCAP Action Tracker will be updated in 2023 and will continue to serve as a living repository for all identified actions and provide a method for the Commonwealth to track and measure progress on action implementation.

1.2 Overview of 2023 SHMCAP

The 2023 MA SHMCAP drew from a range of state and local sources of data and information, including the MA Climate Assessment. These sources provided findings, information, and data to inform components of the 2023 MA SHMCAP Risk Assessment and strategy development. The MA Climate Assessment reflected the best available science and engaged key partners to identify priority impacts from climate change

projections. The 2023 MA SHMCAP affirmed these priority impacts through further analysis and engagement and used them to help state agencies develop actions and inform the 2023 MA SHMCAP hazard mitigation and climate adaptation strategy.

The MA Climate Assessment developed priority impacts and an urgency framework in which climate impacts were evaluated for the magnitude and urgency of their consequences across the Commonwealth. Each priority impact was assigned a score based on the following:

- **Magnitude of Consequence**: *How large of a climate effect do we expect from this impact?*
- **Disproportionality of Exposure**: *Will populations living in environmental justice areas be disproportionally affected*?
- **Need for Effective Adaptation**: *Are we currently doing enough to adapt to this impact, or are there gaps in effective adaptation actions*?

These component scores were averaged to create an urgency score within each of the five sectors (Human, Infrastructure, Natural Environment, Governance, and Economy) using the scales presented in Figure 1-1. The items with the highest scores were identified as "urgent priority impacts," depicted in Figure 1-2. Additional information on the priority impacts and how they were used during the 2023 MA SHMCAP risk assessment are presented in Section 1.2.1.

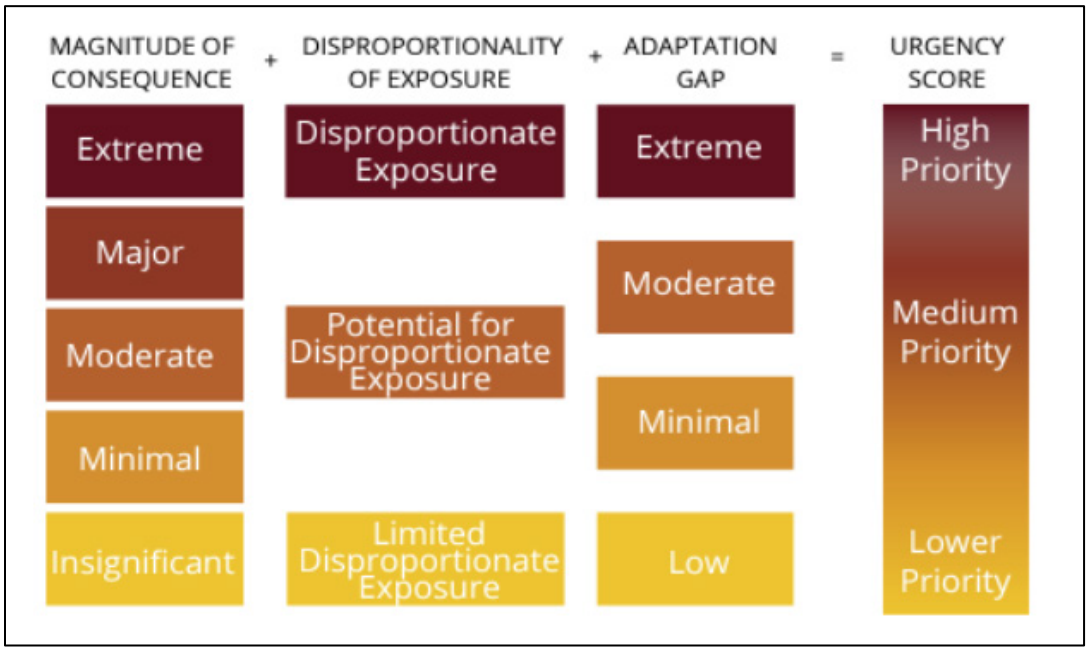

Figure 1-1. Urgency score components used in the MA Climate Assessment.

The MA Climate Assessment identified 37 priority impacts across the following five sectors:

- **Human:** Impacts to people's health, welfare, and safety.
- **Infrastructure:** Impacts to buildings, transportation systems, and electricity and water systems.
- **Natural Environment:** Impacts to ecosystems and natural resources, and how plants and animals can thrive there.
- **Governance:** Impacts to state and local government-owned buildings, government finances, and the ability of the government to run effectively.
- **Economy:** Impacts to people's ability to work and make a living due to damage to infrastructure, our natural environment, and people's health.

Figure 1-2. Priority impacts from the MA Climate Assessment (the most urgent priority impacts are identified in bold font).

1.2.1 Key Revisions since the 2018 MA SHMCAP

The 2023 MA SHMCAP updates the 2018 MA SHMCAP to reflect changes in development, populations, mitigation priorities, and recent hazards, including updated data science and related planning efforts. Like the 2018 MA SHMCAP, the 2023 MA SHMCAP presents an integrated planning effort to help the Commonwealth mitigate hazards and adapt to impacts from climate change. Due to the interconnected relationships between hazards and climate change, the 2023 MA SHMCAP promotes the continuation and enhancement of highly collaborative integrated planning efforts. In addition to integrating climate

change, the structure of the plan was further revised based on the integrated nature of the plan, scope of work, and the Commonwealth's preferences.

The primary difference between the 2023 and the 2018 MA SHMCAPs is the use of updated climate and hazard information and data, including:

- Incorporation of new population growth and development data
- The addition of the MA Climate Assessment findings
- The addition of groundwater to the hazards included in the risk assessment
- Incorporation of new Hazus data
- Inclusion of new data and mapping regarding environmental justice and other priority populations
- Addition of a section on state agency vulnerability findings
- A systematic evaluation of local hazard mitigation plans
- A robust assessment of the Commonwealth's capabilities, capacity, and vulnerability developed through close coordination with state agencies
- A revised approach to developing global/statewide and state agency actions to inform the strategy

Documentation of key changes since the 2018 SHMP as required by CFR Part 201 (i.e., changes in development, changes in risks/vulnerabilities, changes in priorities and goals, progress with mitigation efforts) is provided in the appropriate chapters of the MA SHMCAP and highlighted in the following subsections.

1.2.1.1 Updated Hazard and Climate Science and Other Data

The 2023 MA SHMCAP includes updated references to reflect the latest science, updated analyses with the latest data, and additional analyses of the 2018 plan. The list below outlines some of the new data, analyses, and information sources that were used to update the MA SHMCAP. For a full discussion of the latest methods and updates, refer to Chapter 5 (Risk Assessment).

1.2.1.1.1 Incorporating Updated Changes in Development

The 2023 MA SHMCAP incorporates considerations of changes in development and the impact these changes may have on risk and vulnerability at the state and local level. Changes in development in hazard-prone areas were analyzed using three approaches. First, the analysis evaluated population projections through mid-century and considered how these changes would impact housing and development pressure in hazard-prone areas. Second, the team analyzed a database of construction projects in Massachusetts to develop trends in recent and expected development. Third, the team systematically reviewed local hazard mitigation plans to understand how municipalities identified changes in development.

1.2.1.1.2 Considering Vulnerability and Distribution of Impacts Across Popuuations

The 2023 MA SHMCAP considered environmental justice and priority populations throughout the plan development processes. To build on the acknowledgment that historical inequities can result in disproportionate and unequal exposure to hazard impacts, the 2023 MA SHMCAP utilized EEA's Environmental Justice map to identify communities experiencing environmental injustice. The Risk Assessment analysis also considered how other factors such as income, age, ability, and socioeconomic conditions could impact exposure, vulnerability, and recovery for populations across the Commonwealth.

1.2.1.1.3 FEMA Hazus 6.0

The 2023 MA SHMCAP analyses used the latest publication of FEMA Hazus 6.0 for earthquakes and hurricanes. The analyses used Level 1 probabilistic analysis to estimate damage from hurricane wind gusts and displacement and Level 2 probabilistic analysis for the Hazus earthquake models. Updated data sources include new population estimates, new soil classification data, and the latest surficial geology map. Further details on the use of Hazus 6.0 are available in Chapter 5 (Risk Assessment). Hazus 6.0 presents data on building infrastructure that is more current and complete than the previous Hazus data.

1.2.1.1.4 Expanded Assessment of Existing Hazards with Latest Scientific Information

Development of the 2023 MA SHMCAP involved conducting a geospatial and data analysis that was not conducted in for the 2018 MA SHMCAP and includes new hazards from changes in groundwater. All hazards include the latest scientific information, with the latest data sets and references published after 2018. For additional information on groundwater risks in Massachusetts, refer to Chapter 5 (Risk Assessment).

1.2.1.1.5 Coastal Flooding Analysis

The 2023 MA SHMCAP includes several analyses to understand risk, exposure, and vulnerability from coastal flooding in the Commonwealth. Current and future flood depths were derived from the MassGIS Q3 Flood Zones, covering the entire coast of Massachusetts at a 2-meter grid resolution for six extreme flooding events. Coastal flood damages to buildings were estimated using differentiated depth-damage functions for residential, industrial, and commercial categories; estimated property values from readily available sources; and relevant building characteristics for residential, industrial, and commercial structures. The analysis also included the use of updates to the Massachusetts Coast Flood Model (MC-FRM), which incorporate risk projections of storm flooding based on the complex interconnections between winds, waves, wave setup, storm surge, wave runup, and overtopping. The model also provided information on inundation depths related to sea level rise to improve the understanding of potential impacts to communities and emergency services during flood events. This model was not available in 2018.

1.2.1.1.6 Evaluation of Flooding from Precipitation

The 2023 MA SHMCAP incorporated new information based on the MA Climate Assessment to improve the understanding of flooding from precipitation, which includes riverine flooding, flooding from extreme precipitation events, and impacts on high-hazard dams.

1.2.1.2 Inclusion of Priority Impacts and High Consequence Vulnerabilities

As mentioned in Section 1.2.1, the 2023 MA SHMCAP viewed hazards through the lens of priority impacts developed for the MA Climate Assessment. The 2023 MA SHMCAP expanded this lens by including high-consequence vulnerabilities identified through the 2023 MA SHMCAP's robust hazards and risk analysis. The priority impacts and high-consequence vulnerabilities for the 2023 MA SHMCAP are presented in Table 1-1. Additional information is available in Chapter 5 (Risk Assessment).

Table 1-1. Summary of Priority Impacts and High-Consequence Vulnerabilities Identified in the 2023 MA SHMCAP, Organized by Sector

Human Sector	High-Consequence Vulnerability	Priority Impact
Health and cognitive effects from extreme heat		✓
Health effects from degraded air quality		✓
Emergency service response delays and evacuation disruptions		✓
Reduction in food safety and security		✓
Increase in mental health stressors		✓
Health effects from aeroallergens and mold		✓
Health effects of extreme storms and power outages		✓
Damage to cultural resources		✓
Increase in vector borne diseases incidence and bacterial infections		✓
Loss of life or injury due to high vulnerability dams, hurricanes, wildfires, extreme flooding, or extreme temperatures	✓	
Disproportionate impacts on unhoused populations from extreme temperatures or extreme flooding	✓	

Infrastructure Sector	High-Consequence Vulnerability	Priority Impact
Damage to inland buildings		✓
Damage to electric transmission and utility distribution infrastructure		✓
Damage to rails and loss of rail/transit service		✓
Loss of urban tree cover		✓
Damage to coastal buildings and ports		✓
Reduction in clean water supply		✓
Damage to roads and loss of road service		✓
Loss of energy production and resources		✓
Increased risk of dam overtopping or failure		✓
Damage or loss of unreinforced masonry buildings due to earthquakes	✓	
Damage to infrastructure, utilities, and buildings in liquefaction zones due to earthquakes	✓	
Damage or loss to homes and critical facilities in the wildland urban interface	✓	
Natural Environment	**High-Consequence Vulnerability**	**Priority Impact**
Loss of biodiversity, habitats, and native species due to climate change impacts	✓	
Freshwater ecosystem degradation		✓
Coastal wetland degradation		✓
Marine ecosystem degradation		✓
Forest health degradation		✓
Shifting distribution of native and invasive species		✓
Coastal erosion		✓
Soil erosion		✓

Governance	High-Consequence Vulnerability	Priority Impact
Reduction in state and municipal revenues		✓
Increase in costs of responding to climate migration		✓
Increase in demand for state and municipal government services		✓
Damage to coastal state and municipal buildings and land		✓
Increase in need for state and municipal policy review and adaptation coordination		✓
Damage to inland state and municipal buildings and land		✓
Inability to carry out mission and services due to damage, disruption, or loss of state assets and services	✓	
Economy	**High-Consequence Vulnerability**	**Priority Impact**
Reduced ability to work		✓
Decrease in marine fisheries and aquaculture productivity		✓
Reduction in the availability of affordably priced housing		✓
Economic losses from commercial structure damage and business interruptions		✓
Damage to tourist attractions and recreation amenities		✓
Decrease in agricultural productivity		✓
Damage, disruption, or loss of coastal infrastructure such as seaports, airports, and maritime industries	✓	

1.2.1.3 Hazard Snapshots

The Risk Assessment for the 2023 MA SHMCAP designed a framework to consider risks across all hazards through a "hazard snapshot," which provides a high-level overview of the hazards. The snapshots consider the locations where the hazards are most likely to occur and the scale, likelihood, magnitude, and intensities of the hazards, with considerations of warning time. Refer to Chapter 5 (Risk Assessment) for additional information regarding hazard snapshots.

1.2.1.4 State Agency Vulnerability Assessment Chapter

The 2023 MA SHMCAP includes a new chapter that summarizes the vulnerabilities of state agencies and their assets and services. This chapter was informed by a fall 2022 survey taken by 85 state agency representatives (which also informed the capability and capacity analysis), the Risk Assessment, the RMAT meeting series, and input from state agencies. Refer to Chapter 6 (State Agency Vulnerabilities) for additional information.

1.2.1.5 Evaluation of Local Hazard Mitigation Plans

To better understand vulnerabilities and consequences from current and future hazards across the Commonwealth, the MA SHMCAP team evaluated 37 local hazard mitigation plans. The plans were selected from municipalities that reflect the diversity of Massachusetts' communities, climate, land use, and hazard exposure. The plans were evaluated to determine how hazards and climate change have affected local municipalities in the past, understand information related to changes to these hazards and their impacts due to changes in climate, develop population patterns, and understand how local municipalities are considering and preparing for current and future climate and hazard risks.

1.2.1.6 State Agency Action Development Process

The 2023 MA SHMCAP incorporated three rounds of action development to build state agency and cross-government actions through an iterative process. The process began with brainstorming actions and ended with identifying key milestones for proposed projects, prioritizing projects based on an updated prioritization tool. Each action includes leads, key partners, funding sources, consistency with 2023 MA SHMCAP goals, and scale and populations affected for each action.

1.2.2 Key Team Members

To develop a plan that is broadly supported and implementable, MEMA and EEA led the 2023 update to the MA SHMCAP. The Commonwealth hired the ERG (Eastern Research Group, Inc.) team to work closely with its project management team (PMT) composed of representatives from MEMA and EEA, as well as the RMAT; the Governor's Office and the Office of Climate Innovation and Resilience; and other federal, state, and local technical and issue area experts and stakeholders. Key team members and their respective roles are outlined below:

- **ERG:** Supported PMT in development of 2023 MA SHMCAP. ERG was the prime contractor and technical lead for the development of the MA SHMCAP and the engagement lead for the RMAT meeting series, the local municipality and regional agency meetings. ERG coordinated with various entities to synthesize and incorporate input on priorities, approaches, and actions in the 2023 MA SHMCAP.
- **IEc:** IEC was a subcontractor to ERG and incorporated results of the MA Climate Change Assessment into the 2023 MA SHMCAP. IEc contributed to the Risk Assessment sections on coastal flooding, flooding from precipitation, and dam safety, and provided some of the underlying data for extreme temperature.
- **LydRiv Communications:** LydRiv is a small, local business that worked with ERG to design focus group engagement with local and regional entities. LydRiv Communications held nine focus group meetings to collect input on community and

organizational priorities related to hazard mitigation and climate adaptation planning, actions, and the desired type and scale of state agency support.

1.2.2.1.1 Project Management Team

To support MA SHMCAP planning and development, a project management team (PMT) was co-chaired by the MEMA State Hazard Mitigation Officer and Massachusetts EEA Assistant Secretary of Climate Change. The PMT carried out the following actions:

- Helped raise awareness of the MA SHMCAP and integrate it into additional state efforts.
- Identified resources, data, and other information.
- Helped evaluate and prioritize hazard mitigation and climate adaptation actions.
- Reviewed and provided comments on draft SHMCAP deliverables.
- Approved and endorsed the final MA SHMCAP prior to submission to FEMA.

1.2.2.1.2 Other Key Partners

Members of the RMAT, municipalities, nongovernmental organizations, community partners, and others who participated in the development of the 2023 MA SHMCAP are listed in Chapter 2 (Planning Process).

1.2.3 Legal and Institutional Context

1.2.3.1 Federal Laws and Policies

The 2023 MA SHMCAP was developed in compliance with the Disaster Mitigation Act of 2000, which was established to mitigate the impacts from natural disasters and provide funding for qualifying pre- and post-disaster actions at the state and local level. This document fulfills eligibility requirements for federal disaster recovery and hazard mitigation funding through FEMA and under the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The plan was prepared in accordance with the following federal regulations and guidelines:

- National Flood Insurance Act of 1968, as amended [42 United States Code 4001 et seq.].
- 44 CFR Part 201—Mitigation Planning.
- Prepare a Standard State Mitigation Plan following the criteria in §201.4 as a condition of receiving non-emergency Stafford Act assistance and FEMA mitigation grants.
    - Review and update the Standard State Mitigation Plan every five years from the date of the approval of the previous plan to continue program eligibility.
    - Make available the use of up to 7 percent of Hazard Mitigation Grant Program (HMGP) funding for planning in accordance with §206.434.

    - Provide technical assistance and training to local governments to assist them in applying for HMGP planning grants and in developing local mitigation plans.

- 44 CFR Part 206, Subpart N—Hazard Mitigation Grant Program, Section 206.434 Eligibility.

1.2.3.2 State Laws, Policies, and Planning

In addition to serving as the Commonwealth's hazard mitigation plan, this plan satisfies a key requirement of *Executive Order 569: Establishing an Integrated Climate Change Strategy for the Commonwealth*, which was signed in September 2016 by Governor Charlie Baker and directs the EEA to publish a statewide climate adaptation plan.

1.2.3.3 Local Policies and Planning

Massachusetts has 351 cities and towns and two federally recognized Tribes, each of which develops and enforces local laws and policies related to hazard mitigation and climate adaptation. These local and Tribal governments are key to successful implementation of the identified actions and can directly contribute to risk mitigation efforts through targeted training, technical assistance, and funding supported by the Commonwealth. The 2023 MA SHMCAP considered content from 37 local hazard mitigation plans to inform local conditions, ensure alignment between local and statewide hazards, and ensure congruency through the Risk Assessment and Vulnerability Assessment. When developing the 2023 MA SHMCAP, the Commonwealth held several meetings with local jurisdictions to solicit input on proposed statewide/global actions and evaluate if the proposed actions were likely to reduce risk and increase resilience for local communities.

1.2.4 MA SHMCAP Adoption by the Commonwealth

This MA SHMCAP was adopted by Governor Maura Healey on September 12, 2023, as required by 44 CFR §201.4(c)(6). A signed adoption letter from the governor is included at the beginning of this plan.

1.2.5 Assurances

The Commonwealth of Massachusetts complies (and will continue to do so) with all applicable federal statutes and regulations in effect with respect to the periods for which it receives grant funding, in compliance with Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards in 2 CFR 200 and 2 CFR 3002. Compliance with these regulations includes managing and administering FEMA funding in accordance with applicable federal statutes and regulations. The Commonwealth also assures it will amend the MA SHMCAP in accordance with 44 CFR 13.11(d), including amending the plan whenever necessary to reflect changes in state or federal laws and statutes, as described in Chapter 7 (State Strategy, Actions, and Implementation Plan).

1.2.6 Plan Organization and How to Use the 2023 MA SHMCAP

The 2023 MA SHMCAP is organized into seven chapters, each of which has multiple sections and subsections. Table 1-2 provides a summary of the contents of each chapter in the plan.

Table 1-2. Organization of the 2023 MA SHMCAP, Including Chapters and Brief Descriptions.

Chapter	Brief Description
1. Introduction	Provides an overview of the purpose, vision, approach, and principles of the plan; reviews previous related efforts; and outlines key terms and concepts, assurances, and organization of the plan.
2. Planning Process	Describes the state agencies, their processes, and their roles in developing the plan; describes the Commonwealth's approach to the engagement and participation of state, regional, local, and community entities in the development of the plan and its actions.
3. Profile of Massachusetts Setting and Climate Projections	Provides an overview of the Commonwealth's setting and climate projections, such as geography, demographics, and state assets, to provide critical context.
4. State Capability and Adaptive Capacity Analysis	Describes the capabilities and capacities present within each state agency to implement hazard mitigation and climate adaptation actions to improve resilience and reduce risk in the Commonwealth. Provides key findings and recommendations based on an adaptive capacity analysis, which included a survey.
5. Risk Assessment and Hazard Analysis	Examines the natural hazards that have historically exposed or are likely in the future to expose the Commonwealth; identifies vulnerable populations and community assets, geographic hot spots, critical assets and services, infrastructure, natural and cultural resources, and economic assets that are at risk to current and future hazards based on climate change projections.
6. State Agency Vulnerabilities	Describes state agency physical and non-physical assets and functions of concern, in addition to social and environmental vulnerabilities faced by the Commonwealth.

Chapter	Brief Description
7. State Strategy, Actions, and Implementation Plan	Presents a strategy that includes actions designed to address priority impacts and vulnerabilities to reduce risk across the Commonwealth. The strategy describes the process used to prioritize the actions, as well as the hazard and climate impacts and vulnerabilities that will be addressed by implementing the actions identified in the strategy. This chapter also describes the implementation and maintenance of the plan, the timing, the responsible parties, and the tools that will be used to track actions and measure progress toward risk reduction; as well as describing revisions and updates to be made annually to address emerging concerns.

Chapter 2. Planning Process

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Abbreviations

EOEEA	Executive Office of Energy and Environmental Affairs
FEMA	Federal Emergency Management Agency
MEMA	Massachusetts Emergency Management Agency
MVP	Municipal Vulnerability Preparedness
NGO	Non-Governmental Organization
OCIR	Office of Climate Innovation and Resilience
PMT	Project Management Team
RMAT	Resilient Massachusetts Action Team
SHMCAP	State Hazard Mitigation and Climate Adaptation Plan

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2.1 Introduction and Purpose

This chapter provides an overview of the key agencies and partners involved in the development of the 2023 State Hazard Mitigation and Climate Adaptation Plan (2023 SHMCAP). This chapter also describes the stakeholder outreach, engagement strategy, and coordination with existing state hazard mitigation and planning efforts that were integrated into the 2023 SHMCAP development process. The 2023 SHMCAP is a living document that reflects the Commonwealth's ongoing commitment to comprehensive hazard mitigation and climate adaptation planning. In accordance with Federal Emergency Management Agency (FEMA) regulations, the Commonwealth updates its SHMCAP every five years, monitors and evaluates progress, and conducts limited updates on an annual basis. These updates and annual evaluations are crucial to ensuring the relevance, accuracy, and effectiveness of the plan to protect the state's population and provide a method for aligning, receiving, and utilizing funds appropriated by FEMA.

2.1.1 Overview and Lead Agencies

While the 2023 SHMCAP included robust participation from state agencies, those primarily responsible for developing and coordinating the implementation of the 2023 SHMCAP include the Massachusetts Emergency Management Agency (MEMA) and the Executive Office of Energy and Environmental Affairs (EOEEA). Both MEMA and EOEEA lead the Resilient Massachusetts Action Team (RMAT), an interagency steering committee responsible for the implementing, monitoring, evaluating, and updating the 2023 SHMCAP.

2.2 Key Partners and the 2023 SHMCAP Development Process

The 2023 SHMCAP was created through a collaborative, multi-step planning process involving state agencies, subject matter experts, federal agencies, municipalities, regional planning organizations, community groups, nonprofits, and private entities. The Project Management Team (PMT), including members from MEMA and EOEEA, with their contractors (collectively referred to as project team) built on the 2018 SHMCAP to develop the 2023 SHMCAP and updated the content based on the consideration of additional hazards, a robust risk assessment, input from the 2022 MA Climate Change Assessment (MA Climate Assessment), and input from agencies, local jurisdictions, and partners. The 2023 SHMCAP complies with FEMA requirements, per the following rules, regulations, and guidance:

- Robert T. Stafford Disaster Relief and Emergency Assistance Act (Public Law 93-288), as amended by the Disaster Mitigation Act of 2000.
- Code of Federal Regulations, Title 44, Part 201 (§201.4 Standard State Mitigation Plans).
- FEMA State Mitigation Planning Policy Guide (FP 302-094-2, OMB Collection #1660-0062 2023).

2.2.1 Coordination with State Agencies

In leading the SHMCAP development process, MEMA and EOEEA coordinated closely with agencies across the Commonwealth through the RMAT, which is comprised of representative RMAT Climate Change Coordinators from each Executive Office, as depicted in Figure 2-1, as well as other agencies and organizations representing subject matter expertise (see Appendix 2.B for full list of participants). Specifically, regarding participation of subject matter experts for high hazard dams, the Director of the Flood Control Management and Navigational Operations Section Design and Engineering team participated in the RMAT meetings from January 24, 2023 onward and reviewed the related sections of the Risk Assessment.

Throughout the course of the 2023 SHMCAP development, the project team held six meetings with RMAT; one-on-one meetings between MEMA, EOEEA, and state agencies; meetings with municipalities, regional planning agencies, and non-governmental organizations; in addition to meetings with community focus groups. Summaries and descriptions of the meetings in addition to meeting materials are presented in Appendix 2.A and Appendix 2.C, respectively.

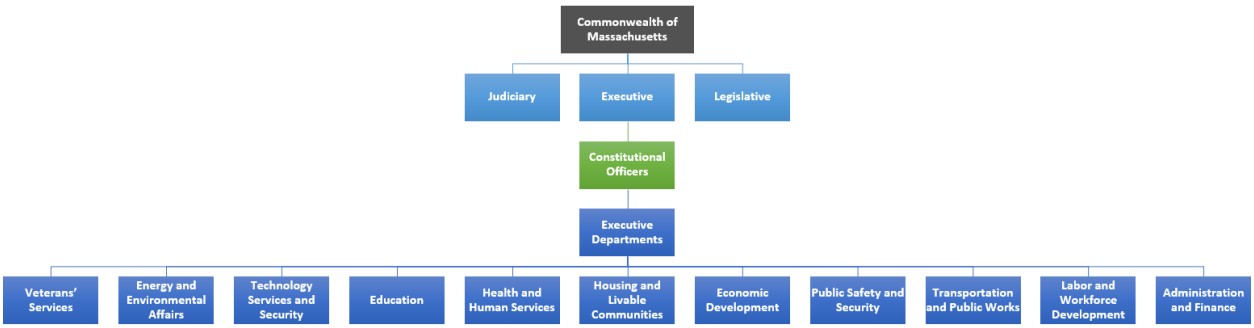


Figure 2-1. Organizational chart of Executive Offices of the Commonwealth.

2.2.2 2023 MA SHMCAP Development Process, Timeline, and Milestones

The Commonwealth's planning activities included completing several key tasks over the course of 18 months from May 2022 to October 2023. Many of the project timelines overlapped and necessitated involvement, collaboration, and input from various participants, including RMAT members, subject matter experts, federal partners, municipalities, community organizations, and others. To demonstrate that the 2023 MA SHMCAP and development processes complies with FEMA requirements, Figure 2-2 presents a high-level summary of the process steps and associated timelines for MA SHMCAP development, while Table 2-1 presents additional detail on related activities and milestones. Summaries and descriptions of the meetings and meeting materials used during development of the 2023 MA SHMCAP are presented in Appendix 2.A and Appendix 2.C, respectively.

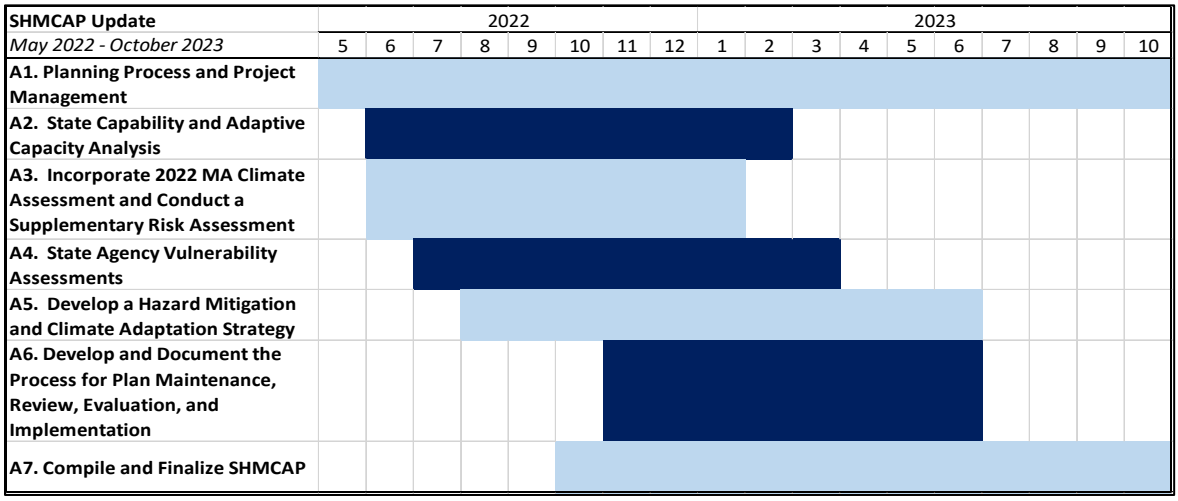


Figure 2-2. Gantt chart depicting timelines and various steps of the 2023 MA SHMCAP

Table 2-1. Summary of Project Activities and Milestones

Activity	Date	Description	Approximate Attendance Count
A.1, Kickoff Meeting	May 23, 2022	Meeting to introduce project team and RMAT, as well as discuss goals, tasks, and timeline.	45–55
A.2, A.3., A.4, RMAT Meeting 1	July 26, 2022	Update on MA SHMCAP progress and overview of engagement approach; report outline and document review framework; and introduction to the Capability, Adaptive Capacity, and Vulnerability Assessment Survey. Requested RMAT input on the Capability, Adaptive Capacity, and Vulnerability Assessment Survey	60–70
A.2, A.3, A.4, RMAT Meeting 2	Sept. 14, 2022	Recap and key findings regarding the Capability, Adaptive Capacity, and Vulnerability Assessment Survey, and discussion of mission statement and goals. Requested RMAT input on mission and goals.	90–100
A.2 and A.4, Office Hours	Oct. 6, 19, & 26, 2022	The project team held two office hours sessions after the RMAT Meeting 2 to answer questions from RMAT regarding completing the Capability, Adaptive Capacity, and Vulnerability Assessment Survey.	10-20
A.2, A.3, A.4, RMAT Meeting 3	Nov. 8, 2022	Survey update; Risk Assessment introduction, including updates since the 2018 MA SHMCAP, new sources of data, findings from the MA Climate Assessment, and next steps. Requested RMAT input on Risk Assessment questions, problem statements, and relevant priority impacts.	60–70

Activity	Date	Description	Approximate Attendance Count
A.2, A.3, A.4, A.5, RMAT Meeting 4	Jan. 24, 2023	Overview of RMAT responsibilities for reviewing chapters, high-level findings from the Risk Assessment, presentation of final goals, overview of connection between priority impacts and actions, and introduction to framework and process for action development and next steps. Requested RMAT review of Capabilities and Capacities chapter and draft Risk Assessment chapter in addition to completing a survey to identify which actions agencies should lead to address specific priority impacts; requested input on Round 1 actions for the 2023 MA SHMCAP.	60–70
A.5, Office Hours	Feb. 9 & 15, 2023	The project team held two office hours sessions after the RMAT Meeting 4 to answer questions from RMAT regarding populating the 2023 MA SHMCAP Action Worksheet during Round 1 of action development.	10–15
A.5 and A.6, **RMAT Meeting 5**	Mar. 14, 2023	Synthesis of 2023 Action Development Worksheet, recap of qualitative findings, review of proposed cross-government actions, and next steps for action development. Requested RMAT input on Round 2 of action development to refine proposed 2023 actions.	50–60
A.5, One-on-One Agency Meetings with MEMA and EOEEA	Mar. 2023	MEMA and EEA held 13 one-on-one meetings with state agencies to support action development with a focus on closing gaps on priority impacts, refining actions, coordinating actions among agencies, increasing the level of detail, and supporting agencies who had questions or needed additional assistance with the process.	13 agencies, approximately 26 individuals

Activity	Date	Description	Approximate Attendance Count
A.5, Office Hours	Mar. 23, 2023	The project team held an office hours session after the RMAT Meeting 5 to answer questions from RMAT regarding populating the 2023 MA SHMCAP Action Worksheet during Round 2 of action development.	5–10
A.5, Series 2 Stakeholder Meetings	April 4 & 6, 2023	The project team held two meetings with municipalities, regional government, and others to provide an overview of the 2023 MA SHMCAP and action development process. The team held interactive sessions with participants to solicit feedback on proposed cross-government actions. Recommendations received at the meetings were shared with the agencies for consideration during Round 3 of action development and in the hazard mitigation and climate adaptation strategy.	45–85
A.5 and A.6, Community Focus Group Meetings	April 2023	The project team held meetings with nine community organizations and non-governmental organizations to obtain feedback on community needs and their alignment with the 2023 MA SHMCAP.	20
A.5, Office Hours	April 14 & 25, 2023	The project team held two office hours sessions to answer questions from RMAT regarding populating the 2023 MA SHMCAP Action Worksheet during Round 3 of action development.	10–15
A.5 and A.6, RMAT Meeting 6	May 31, 2023	Presentation to RMAT members on the final strategy and plan implementation and maintenance, and presentation of next steps for plan approval and adoption.	50-60

2.2.2.1 Development of Mission and Goals

The project team requested input from the RMAT on their mission and goals during the RMAT Meeting 2 on September 14, 2022. The project team went through several rounds of

development for the mission and goals, obtaining input from RMAT members, Office of Climate Innovation and Resilience (OCIR), FEMA, and others. These goals were presented to FEMA during February 2023. The project team updated and finalized the mission and goals based on FEMA's input.

2.2.2.2 State Capability, Adaptive Capacity, and Vunlerability Assessment Survey

The project team developed a state agency survey to evaluate the Commonwealth's capabilities and capacities in responding to hazards, climate change, and associated vulnerabilities given their impacts. The project team requested that a single member from each Executive Office complete the survey. The objectives of the survey included:

- Assist in updating agencies' vulnerability assessments.
- Assess the capability and adaptive capacity of each agency to implement actions to reduce risks from hazards and climate change impacts, which are increasing in intensity, duration, and frequency.
- Determine the vulnerabilities of each agency's physical and nonphysical assets, functions, programs, policies, and other services.

The project team introduced the survey to the RMAT during Meeting 1 on July 26, 2022, including a description of the survey's purpose and a training on the survey. The survey provided definitions of key terms and included two sets of questions: a longer set of questions for agencies that had not recently conducted a vulnerability assessment and a shorter survey that included only the questions related to capacities and capabilities. The Commonwealth utilized the responses to the survey to analyze and inform where Massachusetts has the greatest vulnerabilities to hazards and climate change, actions necessary to improve state capability and adaptive capacity, and innovative and strategic actions to improve coordination and implementation across sectors, agencies, and jurisdictions. The information from the survey informed both Chapter 2 (Capabilities and Capacities) and Chapter 6 (Vulnerability Assessment) of the 2023 SHMCAP.

2.2.2.3 State Capability and Adaptive Capacity Analysis

The State Capability and Adaptive Capacity Analysis chapter for the 2023 SHMCAP was developed based on the findings from the Capability, Adaptive Capacity, and Vulnerability Assessment Survey, interviews with state agency staff and Municipal Vulnerability Preparedness (MVP) grant program representatives, RMAT meetings, analysis of information available in documents including the MA Climate Assessment and the 2018 SHMCAP, and analysis of other existing programs. High-level findings from the survey were shared during RMAT Meeting 3 on November 8, 2022. The chapter identifies existing state capacities, new updates to state-supported climate adaptation and hazard mitigation initiatives since 2018, and an overall capacity rating based on the agencies' capacity and capability to reduce impacts from current and future hazards and future needs. Several

drafts of the State Capability and Adaptive Capacity Analysis chapter were provided to PMT, RMAT, and FEMA for review. Additional information is presented in Chapter 4 (State Capability and Adaptive Capacity Analysis).

2.2.2.4 Vulnerability Assessment

Similar to the Capabilities and Capacities chapter, the Vulnerability Assessment was developed based on the findings from the Capability, Adaptive Capacity, and Vulnerability Assessment Survey. Additional information to inform the Vulnerability Assessment included interviews with state agency staff and MVP program representatives; RMAT meetings; analysis of information available in documents including the MA Climate Assessment, the 2018 SHMCAP, and agency vulnerability assessments; and analysis of other existing programs. The purpose of the Vulnerability Assessment is to identify areas where state agency physical and nonphysical assets and functions are likely to be most vulnerable to the hazard and climate vulnerabilities and consequences identified in the 2023 SHMCAP. The project team provided a high level of findings to RMAT during RMAT Meeting 5 on March 14, 2023. Several drafts of the Vulnerability Assessment were provided to PMT, RMAT, and FEMA for review. Additional information is presented in Chapter 6 (State Agency Vulnerabilities).

2.2.2.5 Risk Assessment

The Risk Assessment is a critical component of the 2023 MA SHMCAP and improves on the information in the 2018 MA SHMCAP Risk Assessment by incorporating new analysis and updated data, expanding vulnerability and consequence findings across all five sectors, and including information from the MA Climate Assessment. The 2023 Risk Assessment identifies risks, consequences, and impacts associated with the hazards and climate change influences that have already affected and will continue to affect Massachusetts. It considers the existing and future long-term climate, land use, and population stressors for each hazard, along with the exposure and vulnerability of populations, geographic areas, assets, and services from each hazard. The information in the Risk Assessment includes the underlying causes of the hazards, the best available data and information for the Commonwealth, the historical context of these hazards in Massachusetts, and the projected impacts of climate change, population projections, and other trends that will influence the risks posed by these hazards. The Risk Assessment provides the empirical basis for the actions and activities prioritized by the 2023 MA SHMCAP.

An introduction to the Risk Assessment was provided during RMAT Meeting 3 on November 8, 2022, and high-level findings from the Risk Assessment were discussed during RMAT Meeting 4 on January 24, 2023. The first draft of the 2023 MA SHMCAP Risk Assessment was shared with FEMA while the initial and final drafts of the Risk Assessment were shared with the RMAT and subject matter experts. The project team incorporated and addressed comments provided by RMAT and FEMA, accordingly.

2.2.2.6 Action Development

The project team worked with RMAT through three rounds of action development, described as follows:

- **Round 1 Action Development.** The project team introduced the RMAT to the action development process and framework during RMAT Meeting 4 on January 24, 2023. During this meeting, the project team asked the agencies to complete a brief survey to identify which priority impacts the agencies would develop actions to address. The project team also introduced the 2023 action development worksheet, which was the primary tool used to develop, coordinate, and refine actions throughout the three rounds of action development.

  The purpose of Round 1 of action development was to review the actions from the 2018 MA SHMCAP Action Tracker and provide an updated status for the action, as well as brainstorm new actions for priority impacts and vulnerabilities identified by the MA Climate Assessment and the 2023 Risk Assessment. Agencies were asked to identify actions as completed, in progress, modified or deferred, or not started, as well as provide an explanation of the reasoning. RMAT members were also asked to review the 2023 MA SHMCAP goals, modify 2018 actions to better align with the 2023 goals, and develop new actions for 2023 to be consistent with the 2023 goals.

- **Round 2 Action Development.** The project team requested that the RMAT review and refine actions presented during Round 1 to specifically incorporate feedback from MEMA and EOEEA and assign a category to the action, in addition to addressing identified priority impacts, concerns with specific assets, and impacts on populations. RMAT members also considered funding, timeline, alignment with FEMA requirements, and barriers to action implementation.

  The project team also reviewed actions that would best be implemented at the statewide level and tagged these as cross-government actions. The project team solicited feedback from RMAT on a series of cross-government actions during RMAT Meeting 5 on March 14, 2023. The project team then revised the cross-government actions and shared them more broadly with stakeholders and community groups. The project team also shared the feedback with RMAT for consideration and refinement.

- **Round 3 Action Development.** The goal of Round 3 of action development was to refine and combine similar actions, identify partners for action collaboration, prioritize actions based on the outputs of the Action Score Card, and remove proposed actions that may no longer be relevant. Round 3 also served as an opportunity to identify lead and partner agencies for proposed cross-government actions and to finalize those actions accordingly.

The project team then asked the RMAT to review the finalized actions with and obtain sign-off from the appropriate Executive Office. Additional detail is available in Chapter 7 (State Strategy, Actions, and Implementation Plan).

2.2.2.7 Strategy Development

The 2023 MA SHMCAP Strategy (as presented in Chapter 7) pulled from all steps in the process, beginning with the updated 2023 mission and goals, which were reviewed by the RMAT in RMAT Meeting 2. The mission and the goals were updated to ensure that the 2023 MA SHMCAP prioritized the following issues:

- Follow a whole community approach emphasizing collaboration among state agencies, regional organizations, and local municipalities.
- Prioritize risk reduction for environmental justice and other priority populations.
- Focus on risks to people and the environment from the highest consequence hazards and impacts.
- Provide best available science and information to support planning and implementation at regional and local levels.
- Consider greenhouse gas effects of hazard mitigation and climate adaptation strategies.

Based on comments received from RMAT members, FEMA, and other participants between RMAT meetings 2 and 4, the 2023 MA SHMCAP mission and goals were revised to simplify the language, ensure consistency with FEMA requirements, and reflect the priorities of the Commonwealth.

The Strategy includes a summary of key themes that were used to guide action development. The themes were identified through the RMAT meetings and a review of existing programs and planning processes. They were based on the priority impacts and vulnerabilities identified in the MA Climate Assessment, the 2023 Risk Assessment, and the 2023 Capability and Capacity Assessment. These themes, which are also reflected in the goals, are:

- Collaboration and support for a whole state approach.
- Focus on flooding and extreme heat.
- Risk assessment and reduction for cultural resources.
- Resilience building through conservation, restoration, and management.

The Strategy also includes the action development process, which is described above and was designed to ensure that actions are responsive to priority impacts and include benefits to people and the environment. The Strategy also considers disproportionate impacts, advances sustainability principles, leverages partnerships, and promotes effectiveness. The actions were developed over RMAT meetings 4 and 5, one-on-one agency meetings with MEMA and EOEEA, and office hours sessions. They were informed by two meetings and nine focus groups designed to obtain municipal, regional, stakeholder, community, non-governmental organization (NGO), and private organization input.

Using three rounds of development for actions was intended to provide a lower bar to entry during the first round and allow for brainstorming and creativity. Providing two more rounds to add detail, consider additional factors, add costs and partners, and rank and prioritize actions provided agencies the ability to refine the actions over time and build upon their initial ideas in the first round.

Both the cross-government actions and the state agency actions were developed through the same process but are organized in the Strategy in two different ways. The cross-government actions are organized by 2023 MA SHMCAP goals and the state agency actions are organized by priority impacts and vulnerabilities. The reason for the difference is that most of the cross-government actions broadly address many of the priority impacts and vulnerabilities, while the state agency actions were designed to address specific priority impacts and vulnerabilities.

During Round 3 of action development, state agencies were responsible for ranking and scoring their actions based on a scorecard developed for the 2023 SHCMAP. The scoring process included the following factors:

- Alignment with 2023 MA SHMCAP goals.
- Engages environmental justice and other priority populations.
- Advances partnerships and supports robust engagement.
- Continuity of critical services.
- Sustainability, conservation, and nature-based approaches.
- Leveraging funding.
- Timing of initiation.

Upon receipt of the final actions from the state agencies, the project team organized the actions by considering the 2023 MA SHMCAP goals, the priority impacts and vulnerabilities, and the key themes to develop the 2023 SHCMAP Strategy. As presented in Chapter 7 (State Strategy, Actions, and Implementation Plan), similar actions are organized together under Action Topics in order to highlight that multiple agencies are intended to coordinate on these actions in order to increase the effectiveness of the individual actions and the strength of state agency partnerships. Examples of Action Topics include assessing and reducing the risks of heat on human health, providing state support for local and regional actions, prioritizing action dams and culverts to reduce risks and improve water quality and habitats, assessing and reducing risks to cultural resources, and undertaking conservation and restoration actions to improve natural and community resilience. Within each of these Action Topics are individual state agency actions that will be implemented by each agency, and that will also be coordinated with the other agencies that have actions under the same Action Topic.

Instead of simply providing a list of individual state actions, the outcome of the Strategy provides a focused approach intended to address the most urgent and consequential priority impacts and vulnerabilities and ensure that the risk reduction and resilience benefits are felt by the people, communities, and resources that are most at risk.

Based on this approach—which was built in collaboration with the RMAT, reflecting the comments received during engagement at the local and regional level, and presented at the final RMAT Meeting 6—the project team developed a hazard mitigation and climate adaptation strategy for the 2023 MA SHMCAP, as presented in Chapter 7 (State Strategy, Actions, and Implementation Plan).

2.2.2.8 Plan Implementation and Maintenance

The 2023 SHMCAP Plan Implementation and Maintenance approach was built on the existing architecture that has been implemented by the Commonwealth since 2018. The process, activities, and schedule for implementing and maintaining the 2023 Strategy was presented to the RMAT at Meeting 6 and is further described in Chapter 7 (State Strategy, Actions, and Implementation Plan).

2.3 Integration and Coordination with Other Planning and Climate Adaptation Efforts

Development of the 2023 MA SHMCAP involved robust engagement and participation that increased awareness and enthusiasm for its implementation, facilitating coordination and integration of related state planning efforts. To further increase effectiveness and efficiency, the 2023 MA SHMCAP planning process considers and is integrated with other planning efforts including but not limited to the MA Climate Assessment, the MVP program, local hazard mitigation plans, the work of regional planning agencies, issues and priorities of community organizations and stakeholders. Some of these efforts are highlighted in the following subsections.

2.3.1 Statewide Assessments, Coordination, and Planning Efforts

Successful adaptation and hazard mitigation planning in Massachusetts depends on intentional and consistent collaboration between state-level leadership and agencies, in addition to federal entities, local jurisdictions, and local communities. Since the 2018 MA SHMCAP, the Commonwealth has undertaken significant efforts to ensure collaborative processes are executed between and among state agencies to increase resilience and develop and implement projects to achieve common goals. The following subsections present summaries of several of these initiatives.

2.3.1.1 Executive Order 604: Establishing the Office of Climate Innovation and Resilience Within the Office of the Governor

Executive Order 604, issued during 2023, created the OCIR, which will direct and advance climate innovation, mitigation, adaptation, and resilience policies. The Executive Order also created the appointment of a Climate Chief to lead this office and serve as a climate officer within the governor's cabinet, providing advice on climate-related policy, regulations, legislation, and initiatives, as well as guidance on potential funding or capital investment opportunities. The establishment of the OCIR and appointment of a Climate Chief are critical to continuing to foster collaboration among agencies and to integrate adaptation and hazard mitigation planning statewide.

2.3.1.2 MA Climate Assessment

The MA Climate Assessment was released during 2022 and involved a statewide analysis detailing how Massachusetts' people, natural environments, economy, infrastructure, and governance may be affected by climate change and its related hazards through the end of the century. The assessment directly informed the 2023 MA SHMCAP update. The MA Climate Assessment includes updated statewide climate change projections to identify climate impacts across the Commonwealth's regions and sectors, as well as data-driven climate risk consequence and urgency ratings. The project was informed by local planning through the Commonwealth's MVP program plans as well as FEMA-approved Local Hazard Mitigation Plans and was guided by a stakeholder working group, an equity advisory group, and a series of regional conversations and workshops.

2.3.1.3 Metropolitan Area Planning Council's Report on Stormwater Flooding in Greater Boston

The Metropolitan Area Planning Council published a report *Water, Water, Everywhere: The Increasing Threat of Stormwater Flooding in Greater Boston* in 2023. This report is the result of an extensive research effort to understand the risks of flooding associated with extreme precipitation events. The Council analyzed 27,000 flood claims that followed a historic series of storms in March 2010. The storms brought 18 inches of rain across Eastern Massachusetts in a short period of time, resulting in $59 million in disaster assistance payouts. This report is one of the first comprehensive reviews of flooding in areas outside FEMA flood zones that have been impacted by flooding from precipitation from storm events.

2.3.1.4 Massachusetts Drought Management Plan

The Massachusetts Drought Management Plan was updated in 2019 and was developed to maximize the Commonwealth's ability to effectively prepare for and respond to drought conditions. The plan aims to minimize drought impacts to the Commonwealth by improving agency coordination; enhancing monitoring and early drought warning

capabilities; and outlining preparedness, response, and recovery activities for various state agencies, local communities, and other entities affected by drought. The plan lays out an integrated, multiagency approach to managing drought, with an emphasis on state-led preparedness and response actions as drought conditions change.

2.3.1.5 Massachusetts Department of Transportation Capital Investment Plan

Released in June 2022, the 2023–2027 Capital Investment Plan includes a plan for investing a total of $14.9 billion in capital improvement projects over the next five years. Approximately 52 percent of investments focus on improving the reliability and resilience of the existing core transportation system, in addition to greenhouse gas mitigation approaches.

2.3.1.6 Model Building Codes

The Commonwealth requires local governments to use a nationally applicable model building code that addresses hazards (including wind, flood, snow, seismic, and other hazards) as a basis for design and construction of new buildings and any state-sponsored mitigation projects. The Ninth Edition of the State Building Code became effective October 20, 2017 and is based on modified versions of the 2015 International Codes, as published by the International Code Council. Under the Ninth Edition, the design and construction of buildings and structures located in flood hazard areas must be in accordance with American Society of Civil Engineers standards, which are consistent with, and in some cases exceed, minimum National Flood Insurance Program requirements. As of November 2022, the Commonwealth is in the process of adopting the 2021 International Code Council model codes as the Massachusetts Tenth Edition, which has further improvements for design and construction requirements for buildings and structures in flood hazard areas.

2.3.1.7 Climate Resilience Design Standards and Guidance Tool

The Climate Resilience Design Standards and Guidance Tool is advancing prioritized cross-agency actions included in the MA SHMCAP. This effort has developed climate resilience design standards and guidance, as well as a Design Standards Tool for state agencies in order to incorporate climate resilience into the Commonwealth's capital planning process and grant-making for local capital projects. The Tool outputs are generated using available climate science data for Massachusetts, and the Tool can be enhanced over time to incorporate new science, additional or changing climate hazards, and ongoing stakeholder feedback.

2.3.1.8 Department of Energy Resources Leading by Example Program

Established by Executive Order 594 in 2021, the Department of Energy Resources Leading by Example Program requires state agencies to prioritize practices and programs that

address resource use at state facilities, including a reduction in energy consumption derived from fossil fuels and emissions associated with such consumption. The Executive Order also mentions the MA SHMCAP: "whereas, the Massachusetts Integrated State Hazard Mitigation and Climate Adaptation Plan directs the Commonwealth to continue to prioritize investments in clean energy resilience infrastructure projects at state facilities."

2.3.1.9 EOEEA's Resilient Lands Initiative

The 2023 Resilient Lands Initiative guides actions that aim to conserve, restore, and care for the land to help nature and people. The initiative planning effort incorporates input from community members, nonprofits, government, and farm and forest residents. The Resilient Lands Initiative recognizes that the economy and human sectors are dependent on the services and products that natural systems offer. It approaches implementation and visioning through (1) justice, equity, diversity, and inclusion, and (2) climate change. The 2023 MA SHMCAP aligns with the goals of the Resilient Lands Initiative in that they both aim to help residents understand, address, and cope with climate change impacts.

2.3.2 Local and Regional Assessments, Coordination, and Planning Efforts

The Commonwealth has assisted municipalities and communities with integrated planning by providing technical assistance and funding for more than 20 years. MEMA also engages with Regional Planning Agencies, which include staff of professional planners and are typically consulted to prepare hazard mitigation plans. MEMA's webpage on Local Hazard Mitigation Planning provides resources for communities and regional planning agencies to consult when developing or updating hazard mitigation plans. MEMA and other state agencies also provide technical assistance to communities through workshops, trainings, site visits, templates, and other resources, and coordinate to ensure that each jurisdiction is provided with new templates, examples, and current information when plans are updated and new plans are developed. The Commonwealth provides funding to eligible communities through the MVP program, in addition to grants awarded by FEMA through the Hazard Mitigation Grant Program, Hazard Mitigation Assistance, and Building Resilient Infrastructure and Communities programs. The Commonwealth also provides funding through several other grant funding opportunities, including the Office of Coastal Zone Management's Resilience Grant Program and Coastal Pollutant Remediation Grant Program, EOEEA's Planning Assistance Grant Program, the Parkland Acquisitions and Renovations for Communities Grant Program, and others presented in the Massachusetts Executive Office of Energy and Environmental Affairs Climate Grant Viewer.

2.3.2.1 Local Hazard Mitigation Planning

As further described in Chapter 5 (Risk Assessment) the analysis used to inform the 2023 SHMCAP included a systematic review of local hazard mitigation plans to evaluate consistency with hazard exposure, vulnerability, damages, and other relevant local

conditions. The effort included a review of 37 local plans selected to provide a range of local characteristics throughout the Commonwealth and to assist with aligning local and statewide efforts in hazard identification, risk assessment, and mitigation strategy development. Refer to Chapter 5 (Risk Assessment), for additional detail and examples regarding specific integration of local hazard mitigation planning and the 2023 MA SHMCAP.

In 2022, EOEEA and MEMA launched a pilot Local Hazard Mitigation Planning Equity Program, which is now administered annually and provides funding to develop or update Local Hazard Mitigation Plans for Massachusetts cities and towns with vulnerabilities and disproportionate impacts to environmental justice and other priority populations. One goal of the program is to demonstrate increased equity in mitigation planning and participation, and to prepare communities to apply for federal Hazard Mitigation Assistance pre- and post-disaster funding allocated to the Commonwealth.

2.3.2.2 MVP Grant Program

The Commonwealth's MVP grant program supports city and town climate change and resilience planning by providing funding for conducting vulnerability assessments and developing resiliency plans using The Nature Conservancy's Community Resilience Building workshop guide. The Community Resilience Building process for completing local hazard mitigation plans also fulfills certain FEMA Local Mitigation Plan Review Guide regulatory checklist requirements, as documented in this crosswalk. After completing the MVP program, communities are MVP certified and therefore have increased standing in state grant programs and are eligible for MVP Action Grant funding, which funds priority action implementation. The Commonwealth has made significant strides in increasing resilience throughout Massachusetts by implementing the MVP Grant Program. Figure 2-3 shows the number of individual communities and regions participating in the MVP program as of 2018. Figure 2-4 shows the updated map as of February 2023, with additional communities and regions (349 total) participating in the MVP program, as significant increase from 2018.

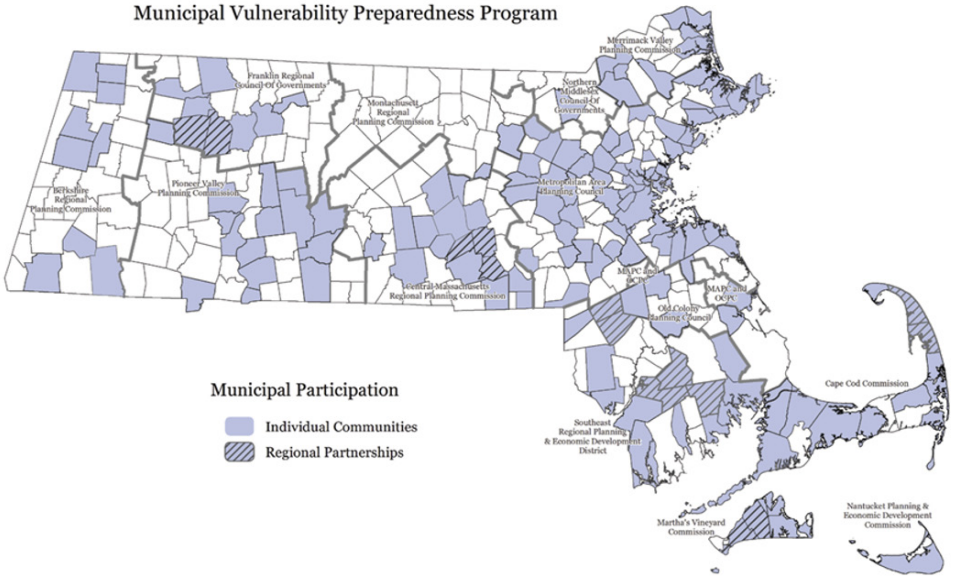
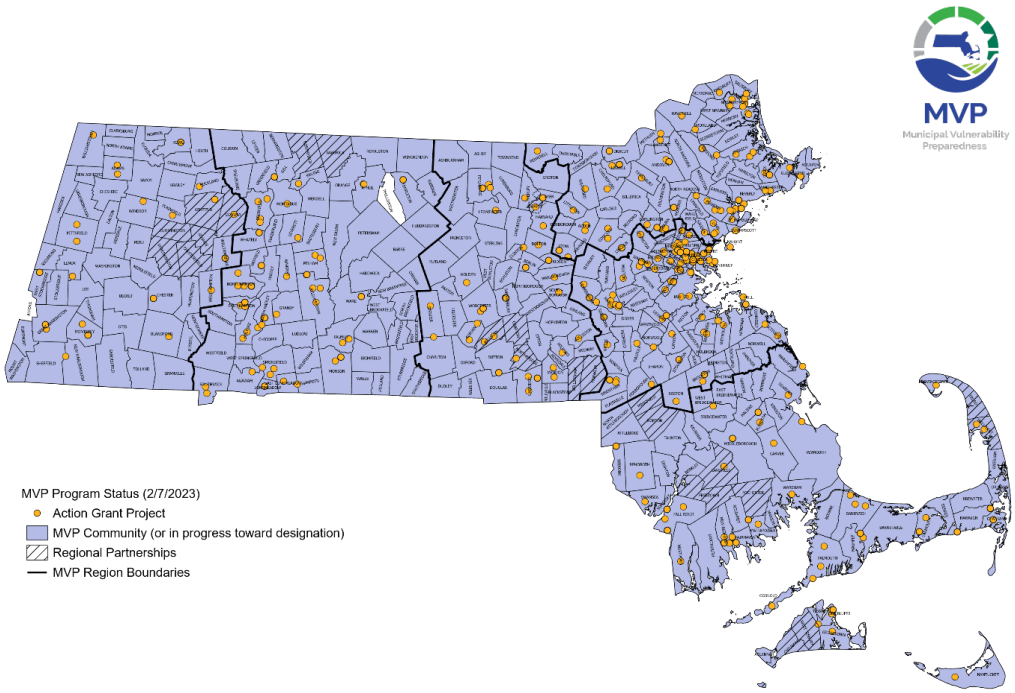


Figure 2-3. MVP Planning Grant Communities and Regional Partnerships (2018).



Source: MA MVP Program.

Figure 2-4. MVP Planning Grant municipalities and MVP Action Grants (2023).

Chapter 3. Profile of Massachusetts' Setting and Climate Projections

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Abbreviations

ACS	American Community Survey
DCAMM	Division of Capital Asset Management and Maintenance
DCR	Department of Conservation and Recreation
EEA	Energy & Environmental Affairs
EOEEA	Executive Office of Energy & Environmental Affairs
EJ	Environmental Justice
FEMA	Federal Emergency Management Agency
RCP	Representative Concentration Pathway
SHMCAP	State Hazard and Climate Adaptation Plan

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3.1 Introduction

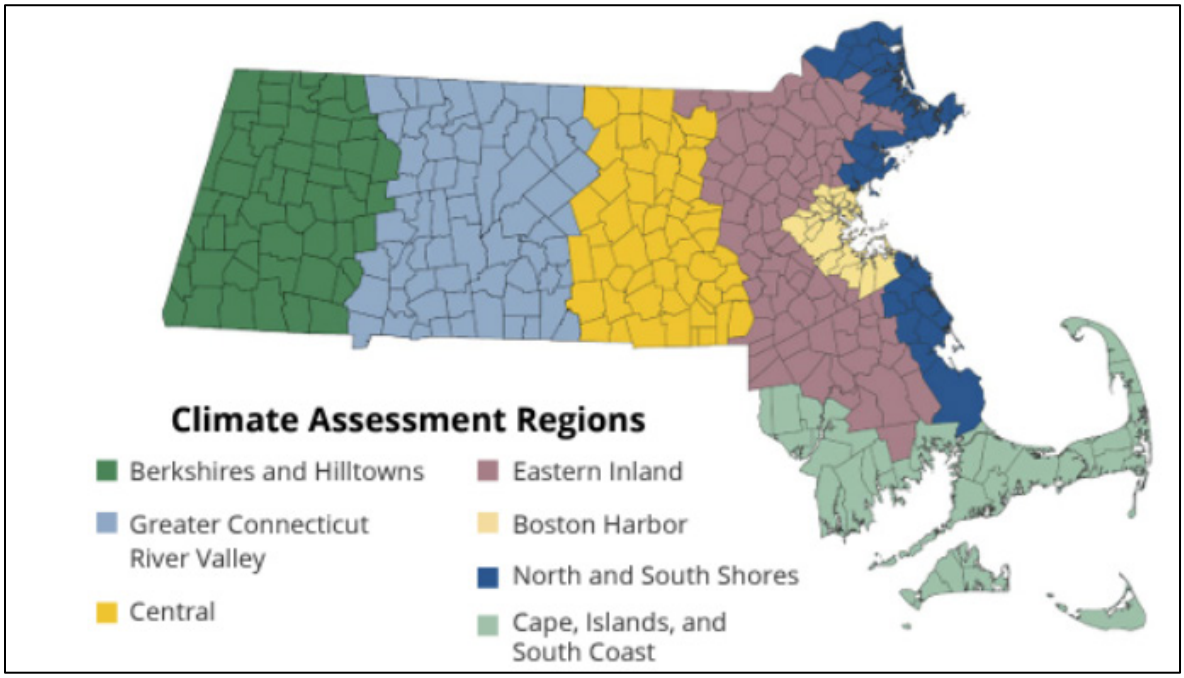
To better understand the hazards that pose the greatest risk to Massachusetts, to identify the changes to those hazards that are occurring and will likely accelerate due to climate change, and to determine the most effective actions to include in the 2023 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (MA SHMCAP), it is necessary to understand the Commonwealth's natural environment, resources, communities and populations, lifelines, and critical assets and services. This chapter describes that setting and the factors that influence current and future risk and resilience in Massachusetts—part of the foundation for an understanding of how to prioritize hazard mitigation and climate adaptation actions to reduce the most urgent risks and most effectively build resilience.

Regional variations such as geography, natural resources, demographics, population density, development patterns, cultural resources, and economy shape the experience of and response to hazards and climate impacts. At a higher level, there are some common factors across the Commonwealth that provide critical context and insights into complexities that should be considered at each level of hazard mitigation and climate adaptation planning. The following subsections provide an overview of the local demographics, geography, climate, economy, transportation, natural resources, land management, and state assets.

3.1.1 Key Resources and Assets

Massachusetts is a small and diverse state with a wealth of natural, historic, and cultural resources. The Commonwealth is home to many communities, economic, and natural

assets that must be protected from hazards—and the increases in frequency, intensity, duration, and areas affected by these hazards due to climate change. Recognizing the diversity of geography and demographic characteristics across the Commonwealth, the *2022 Massachusetts Climate Change Assessment* (MA Climate Assessment) subdivided the state into seven climate regions, as shown in Figure 3-1. The 2023 MA SHMCAP uses these regional designations, where relevant, to describe various populations, demographics, and risks. (In some cases, when describing circumstances at the county or municipal scale would be more informative, the MA SHMCAP uses those scales instead.)



Source: MA Climate Assessment (Commonwealth of Massachusetts, 2022).

Figure 3-1. Map of the seven regions used in the MA Climate Assessment.

3.1.1.1 Demographics and Population Characteristics

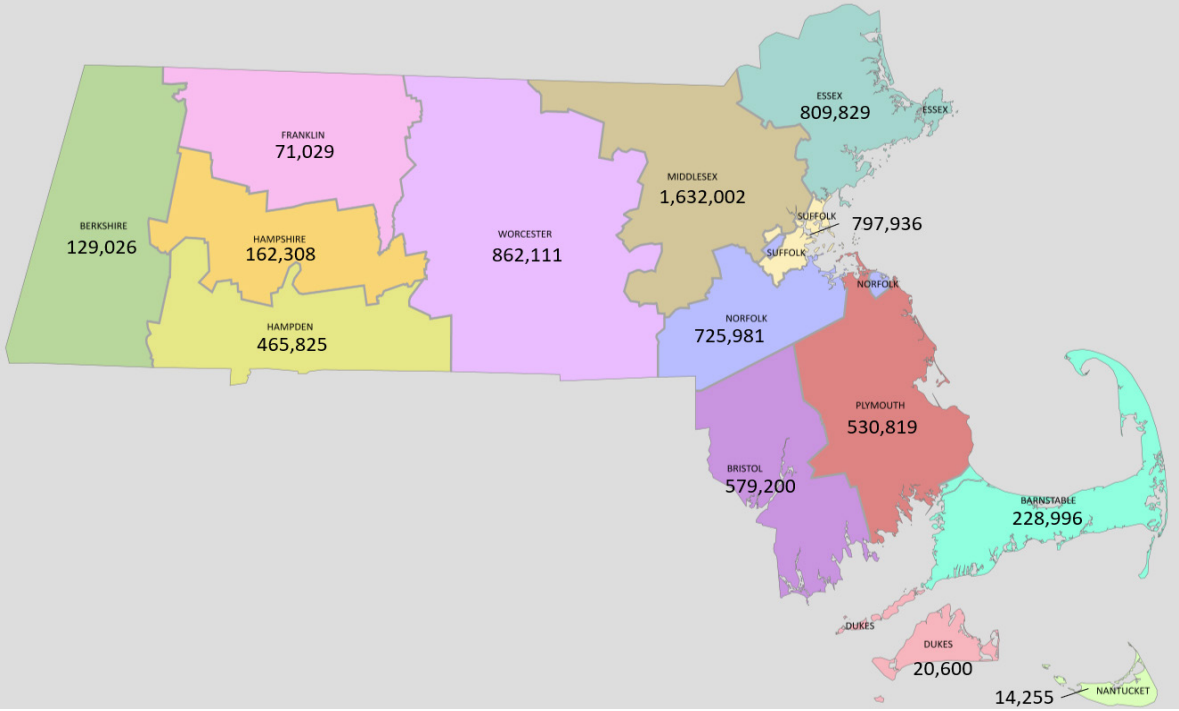
Massachusetts is a relatively small state. It is densely populated, particularly in the eastern regions. The western and island regions are more rural and less populated, with smaller towns of concentrated populations. Demographically, the Commonwealth has a diverse population, with a range of incomes, racial and ethnic backgrounds, and languages spoken in the home. According to information from the 2020 Census, the population is about 7 million, having increased by 7.4 percent between 2010 and 2020 (U.S. Census Bureau, 2021). Table 3-1 (from the MA Climate Assessment) summarizes a subset of demographics for each climate assessment region, as informed by the 2020 U.S. Census for population, the Massachusetts Executive Office of Energy and Environmental Affairs' environmental justice and priority populations data, and the 2019 American Community Survey five-year estimates (provided as part of the Census Bureau's demographic survey). This table confirms that population density and characteristics are diverse across

Massachusetts, with higher densities in the eastern regions and low income and racial and ethnic diversity spread throughout the Commonwealth.

Table 3-1. Summary Demographics Based on Climate Region from the MA Climate Assessment

Region	Total Population (2020)	% Minority	% Low Income	% Household with Limited English Language Proficiency	% of Block Groups with Any Environmental Justice Designation
Berkshires and Hilltowns	156,440	12.7%	24.9%	1.2%	37.7%
Greater Connecticut River Valley	788,189	32.8%	30.9%	4.7%	52.0%
Central	960,236	27.4%	20.4%	4.7%	39.9%
Eastern Inland	2,112,456	31.4%	16.7%	4.9%	37.0%
Boston Harbor	1,623,633	50.7%	27.0%	10.2%	66.5%
North and South Shores	731,000	25.4%	20.1%	4.1%	30.9%
Cape, Islands, and South Coast	657,963	20.4%	25.4%	4.4%	38.6%
Statewide	**7,029,917**	**33.4%**	**22.5%**	**5.9%**	**45.9%**

Source: MA Climate Assessment (Commonwealth of Massachusetts, 2022).



Sources: MassGIS (n.d.); U.S. Census Bureau (2021).

Figure 3-2. Massachusetts population by county.

As shown in Figure 3-2, Massachusetts is divided into 14 counties. Middlesex County is the most populous of these (about 23 percent of the Commonwealth's population lives there, according to 2020 Census data), and Nantucket County is the least populous (housing 0.20 percent of the state's population).

In accordance with the 2020 Census, the racial and ethnic composition of the population across the Commonwealth, in decreasing order, is presented in Table 3-2.

Table 3-2. Racial and Ethnic Composition of Massachusetts' Population in Decreasing Percentage

Ethnicity	Percentage
White	61.6%
Hispanic	18.7%
Black	12.4%
Two or more races	10.2%
Other race	8.4%
Asian	6.0%
American Indian and Alaska Native	1.1%
Native Hawaiian and Other Pacific Islander	0.2%

Source: U.S. Census Bureau (n.d.).

Across the Commonwealth, 75.5 percent of households only speak English, while 9.4 percent speak Spanish, 9.2 percent speak other Indo-European languages, 4.4 percent speak Asian and Pacific Islander languages, and 1.6 percent speak other languages (U.S. Census Bureau, n.d.)

The median household income was reported as $89,645; 10.4 percent of residents live in poverty. For education, 46.6 percent held bachelor's degrees or higher, with 22.8 percent holding a high school or equivalent degree. Sixty-three percent of the population are homeowners and 24.7 percent rent. The Commonwealth's homeownership rates are near the median for the U.S., which is about 65 percent. While this indicates an average rate of home ownership, note that Massachusetts has high housing costs and affordable housing is an issue for its residents. The median age in the Commonwealth was 39.9 years, with 17.4 percent of the population at least 65 years of age (U.S. Census Bureau, n.d.).

3.1.1.2 Environmental Justice and Other Priority Populations

The Massachusetts Executive Office of Energy Environmental Affairs released updated maps of environmental justice populations in 2022. The Environmental Justice Maps Update 2022 is an interactive GIS-based tool that incorporates data from the 2020 U.S. Census on environmental justice populations, which the state defined as those meeting the following criteria:

- "The annual median household income is 65 percent or less of the statewide annual median household income."
- "Minorities make up 40 percent or more of the population."
- "Twenty-five percent or more of households identify as speaking English less than 'very well.'"
- "Minorities make up 25 percent or more of the population and the annual median household income of the municipality in which the neighborhood is located does not exceed 150 percent of the statewide annual median household income."

According to the Environmental Justice Maps Update 2022, 51 percent of U.S. Census block groups in the Commonwealth are classified as environmental justice (based on the definition provided above), representing nearly 3.5 million people; these populations are further classified based on specific "environmental justice criteria" for minority population, income, and English isolation, as presented in Table 3-3.

Table 3-3. Summary of Environmental Justice Populations Based on Minority, Income, and English Isolation Criteria

Environmental Justice Criteria	Number of Municipalities	Total Population	Population in Environmental Justice Block Group	Percent of Population in Environmental Justice Block Group
Minority, income, and English isolation	38	3,196,017	2,652,715	83.0%
Minority and income	46	1,919,050	463,205	38.9%
Income and English isolation	1	15,119	2,3029	15.4%
Minority	41	846,400	260,959	30.8%
Income	60	605,317	107,060	17.7%
English isolation	1	8,460	1,413	16.7%

Source: Massachusetts Executive Office of Energy and Environmental Affairs (n.d.).

The Commonwealth also defines priority populations as:

> *People or communities who are disproportionately impacted 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 EJ 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. This is driven by underlying contributors such as racial discrimination, economic disparities, or accessibility barriers that create vulnerability. The term priority populations acknowledges that the needs of people with these experiences and expertise must take precedence when developing resilience solutions to reduce vulnerability to climate change.*

Throughout the 2023 MA SHMCAP, environmental justice, priority populations, and those that also face social vulnerabilities are referred to as **"environmental justice and other priority populations."** Environmental justice and other priority populations in Massachusetts include communities of color, low-income groups, certain immigrant groups, and people with limited English proficiency. They live in locations that are more prone to climate-related health hazards, including extreme heat, flooding, and pollution from industrial sources. These populations have greater rates of existing medical conditions including poor mental health and physical disabilities. Additionally, they may live in areas with infrastructure that is aging or has not been properly maintained, making them more vulnerable to effects from climate change. Environmental Justice and other priority populations likely have limited financial support and access to resources to help them overcome cultural, linguistic, and other social barriers (U.S. EPA, 2022).

3.1.1.3 Projected Population Growth

Information from the 2020 Census showed that Massachusetts was one of the five Northeastern states that had experienced a decline in population since the 2020 Census (UMass Donahue Institute, 2018). Information from the 2020 Census showing Minor Civil Division lines identifies the Boston Harbor region as experiencing the most population growth in the Commonwealth, while population is expected to decline slightly in rural Massachusetts through 2040. According to data on nationwide trends from the University of Virginia, Massachusetts is expected to have a 10.9 percent increase in population between 2020 and 2040 (Weldon Cooper Center, 2018).

Based on data from the Metropolitan Area Planning Council's public database MassBuilds, which tracks construction and development projects posted by planning commissions from 2013 to 2017, the highest number of construction projects occurred in the eastern area of the state, mostly in the Boston Harbor region in Middlesex and Essex counties. Construction projects between 2018 and 2022 were highest in Middlesex and Essex counties but were also substantial in Norfolk, Hampshire, and Hampden counties. Based on this information and projected population growth across the Commonwealth, development is also likely to occur in Hampshire, Hampden, and Worcester counties between 2023 and 2030.

3.1.1.4 Geography

Massachusetts is a small coastal state bordering the Atlantic Ocean in the New England region of the northeastern U.S. The low-lying coastal plain to the east, which includes the city of Boston and the Cape Cod peninsula, is the most populous area. The more rural interior region features varied elevation, with distinctive rolling hills. Continuing westward, the low-lying Connecticut River Valley watershed bisects the state north to south and is a productive agricultural region. The western border represents the highest elevation of the state, holding the scenic Berkshire and Taconic Mountain ranges (whose highest peak, Mount Greylock, measures 3,491 feet in elevation). About 25 percent of the 10,555-square-mile state is composed of water bodies, including several large reservoirs, lakes, and ponds. Massachusetts is heavily wooded, with forestlands covering a little over 60 percent of the state and distributed throughout the regions. The Commonwealth has a significant coastline for its size—1,500 miles. It also has many rivers and streams, as well as over 25,000 river and stream crossings.

3.1.1.5 Climate

Statewide, Massachusetts has traditionally experienced hot, humid summers and cold winters with significant precipitation. Average annual temperatures vary across the state, with the coast and Greater Boston experiencing the highest temperatures. The Islands and Cape Cod have the highest average winter temperatures and moderate temperatures during the summer months. Central and western Massachusetts have lower average winter and summer temperatures than Greater Boston. The coastal region is classified as

temperate, a slightly warmer climate type characterized by the coldest month between 32°F and 50°F and at least one month averaging above 50°F. Table 3-4 lists average temperatures and precipitation for each Massachusetts county between 1901 and 2000.

Table 3-4. Average Massachusetts Climate Data: 1901–2000

County	Annual Average Precipitation (Inches)	Annual Average Temperature (°F)
Barnstable	35.48	51.0
Berkshire	38.00	46.9
Bristol	36.45	51.5
Dukes	35.11	51.5
Essex	34.84	50.1
Franklin	37.41	48.2
Hampden	38.56	49.6
Hampshire	38.56	49.2
Middlesex	38.12	50.4
Nantucket	35.58	50.4
Norfolk	33.98	50.9
Plymouth	36.79	51.3
Suffolk	36.25	51.1
Worcester	36.75	49.0

Source: NOAA NCEI (2023).

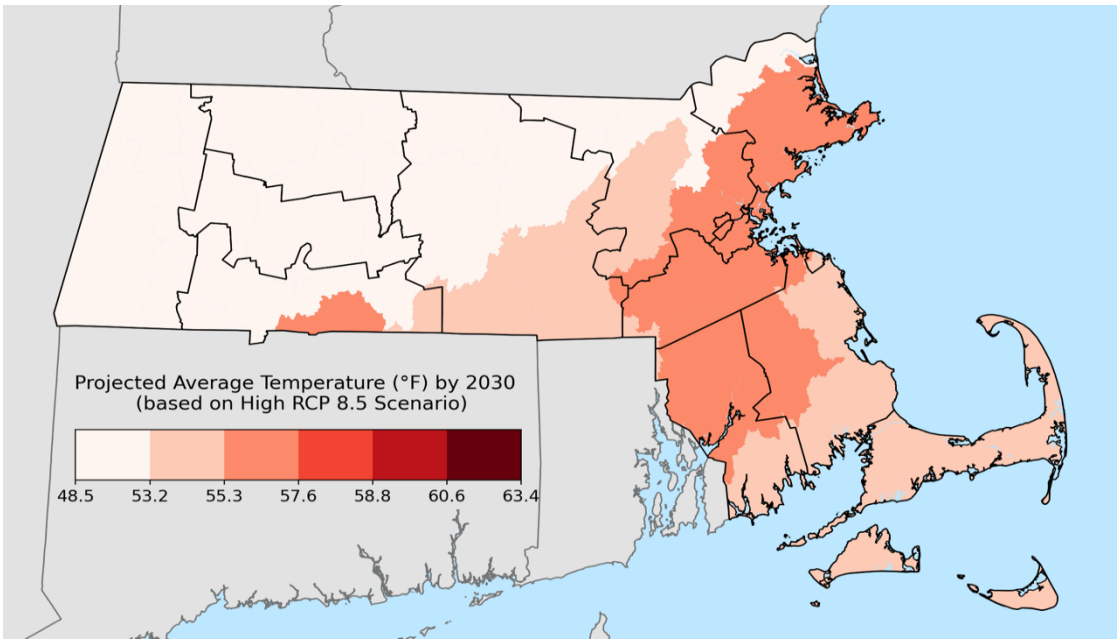
3.1.1.6 Climate Change

The Commonwealth is already experiencing the impacts of climate change, including changes to temperature, precipitation, and water levels due to sea level rise. The following subsections provide an overview of climate change information on temperature, levels of precipitation, and sea level rise. Additional information on these subjects is provided in Chapter 5 (Risk Assessment).

3.1.1.6.1 Temperature

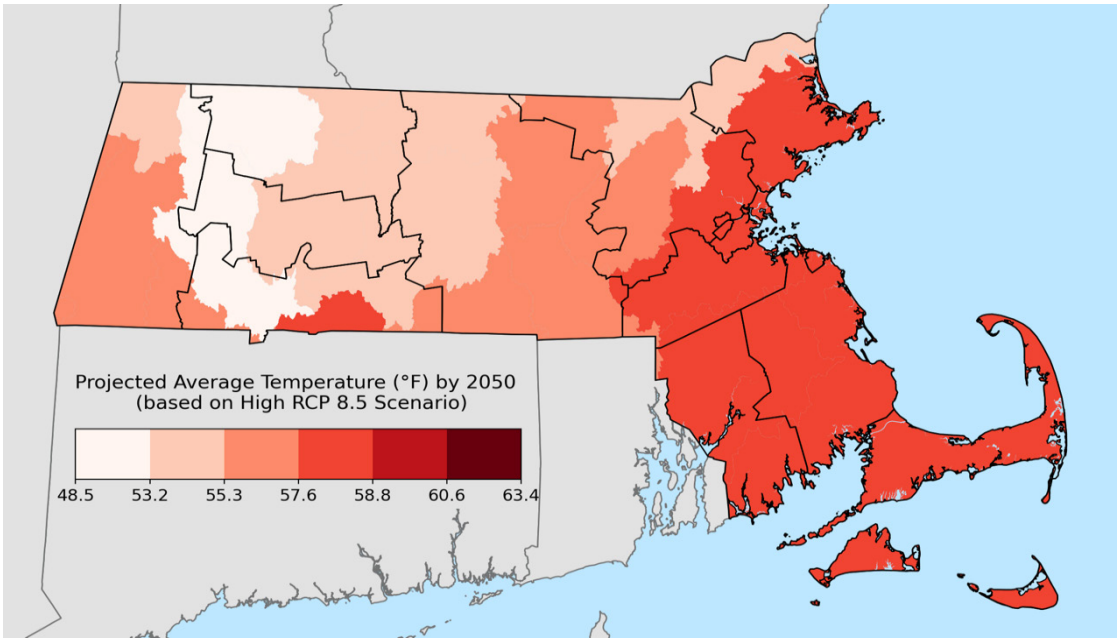
According to the *Resilient MA: Climate Change Clearinghouse for the Commonwealth* website, Massachusetts has experienced a recorded 3.5°F increase in average temperatures since 1900. Average temperatures during the winter are expected to increase more than average summer temperatures, resulting in less snow and ice, increased invasive species, challenging timber harvests, and other issues related to increasing hazard intensity. Also, according to the Resilient MA website, with increased temperatures, extreme heat days (days with temperatures over 90 degrees) will also increase across the state, increasing public health implications such as heat-related illness and mortality. Between 1971 and 2000, the Commonwealth experienced four days with temperatures over 90°F. By mid-century, it is expected to experience between 10 and 28 such days. Figure 3-3 and Figure 3-4 show the areas of the Commonwealth that are expected to experience the

greatest change in projected average temperature assuming a representative concentration pathway (RCP) of 8.5—that is, assuming the amount of greenhouse gases emitted today will be similar to those in the future.



Source: MA Climate Assessment (Commonwealth of Massachusetts, 2022), using Stochastic Weather Generator data.

Figure 3-3. Geospatial distribution of projected annual temperature: 2030.

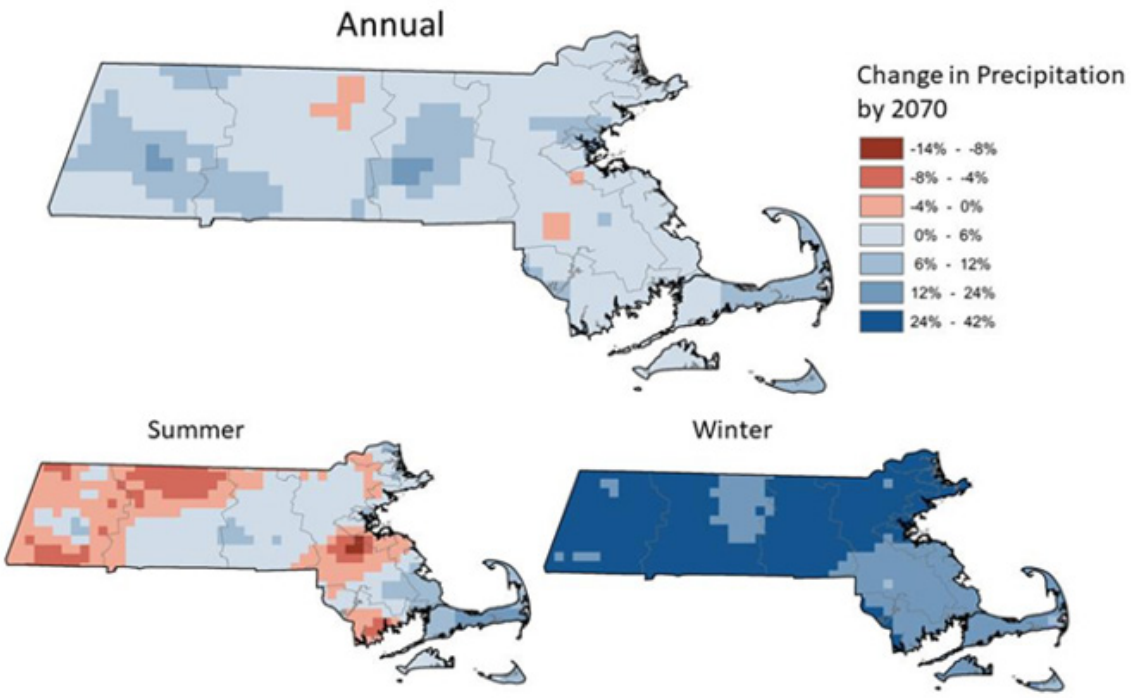


Source: MA Climate Assessment (Commonwealth of Massachusetts, 2022), using Stochastic Weather Generator data.

Figure 3-4. Geospatial distribution of projected annual temperature: 2050.

3.1.1.6.2 Precipitation

Extreme precipitation is contingent on temperature increases and atmospheric capacity to hold water. According to the MA Climate Assessment, annual precipitation is generally expected to increase across Massachusetts overall but occur over fewer days. These trends imply that precipitation events will increase in intensity. Figure 3-5 shows that most areas across the Commonwealth can expect an increase in annual total precipitation, as shown in blue. Most of the changes in precipitation levels are based on seasonal variation, with the most significant changes occurring during winter months.



Source: MA Climate Assessment (Commonwealth of Massachusetts, 2022), using Stochastic Weather Generator data.

Differences between the 50th percentile of projections for 2060–2080 and a baseline of 1986–2005.

Figure 3-5. Change in annual, summer, and winter season precipitation in 2070 compared to current climate.

3.1.1.6.3 Sea Level Rise

Sea level is projected to increase by 0.6 to 1.1 feet above 2000 levels by 2030, and up to 4.2 feet above 2000 levels by 2070 (Massachusetts Department of Public Health, n.d.). The combination of sea level rise and increased levels of precipitation will likely result in the increase of duration, intensity, and frequency of both tidal and storm-related flooding. Additionally, increased frequency of extreme weather could also cause stronger and more frequent storm surges and coastal flooding.

Over half of Massachusetts residents live in coastal communities. Coastal residents, threatened by sea level rise and coastal flooding as well as hurricanes and winter storms, are critically susceptible to the effects of climate change. Both coastal and inland flooding present risks to populations, particularly environmental justice and other priority populations, in addition to infrastructure, assets, economy, and natural resources. Table 3-5 presents the sea level rise projects for 2030, 2050, and 2070 based on the data and scenarios used to inform the MA Climate Assessment.

Table 3-5. Sea Level Rise Projection Relative to the 2008 Present Day Tidal Epoch

Sea Level Rise Projection	2030	2050	2070
Northern coast of Massachusetts	1.2 feet (14.4 inches)	2.4 feet (28.8 inches)	4.2 feet (50.4 inches)
Southern coast of Massachusetts	1.2 feet (14.4 inches)	2.5 feet (30.0 inches)	4.3 feet (51.6 inches)

Source: Woods Hole Group (2022).

3.1.1.6.4 Massachusetts Climate Planning Initiatives

The 2018 MA SHMCAP was the first state hazard mitigation plan to explicitly integrate climate change vulnerabilities and adaptation strategies with hazard mitigation planning. The 2023 MA SHMCAP has continued this integrated planning approach. Historically, the Commonwealth has successfully conducted hazard mitigation planning efforts through a range of programs, research, initiatives, and legislation. Some recent examples include:

Resilient MA: Climate Change Clearinghouse for the Commonwealth

Resilient MA is a repository for data and information relevant to climate change adaptation and mitigation across the Commonwealth. It provides local climate change science and support tools to support decision-making that enhances climate resilience for local planners, practitioners, policymakers, and the public.

- 2023 Resilient Lands Initiative. Guides actions that aim to conserve, restore, and care for the land to help nature and improve the quality of life for residents—especially environmental justice and other priority populations.
- Municipal Vulnerability Preparedness (MVP) Program. Provides funding and technical assistance to localities conducting vulnerability assessments and developing resilience plans.
- 2022 Massachusetts Climate Change Assessment. Describes how residents, the environment, governance, economy, and infrastructure may be affected by climate change and related hazards through the end of the century, informing the 2023 MA SHMCAP.

- 2022 Healthy Soils Action Plan. Assesses soil conditions and provides a blueprint for how to effectively conserve, protect, restore, and manage soils to improve the vitality of nature and the health and quality of life of residents.
- Clean Energy and Climate Plan for 2025 and 2030. Outlines details on actions that the Commonwealth will undertake through the next decade to ensure that 2025 and 2030 emissions limits are met.
- Clean Energy and Climate Plan for 2050. Sets a goal to achieve net zero greenhouse gas emissions in 2050 through a robust set of goals, strategies, policies, and actions.

3.1.1.7 Economy, Key Sectors, and Employment

Massachusetts is home to a range of job sectors, including technology, science, health care, and maritime. The state is also home to, and supported by, over 120 colleges and universities, many of which are the most prestigious in the U.S. Massachusetts' workforce is composed of more than 3.7 million people, with growth in professional/scientific/technical services, leisure and hospitality, and education and health services. Other key sectors in the Commonwealth include professional/scientific/business services, government, manufacturing, and construction (Massachusetts Executive Office of Labor and Workforce Development, 2023b).

The unemployment rate in the Commonwealth was 3.6 percent as of March 2023 (Massachusetts Executive Office of Labor and Workforce Development, 2023a). The Commonwealth gained nearly 682,000 jobs since April 2020, but labor shortages remain concerning. In 2030, it is expected that the number of Massachusetts jobs will increase by 21 percent but the workforce may increase by only 1.5 percent due to earlier retirements and slower population growth (Turken, 2023).

Current and future hazards, as influenced by climate change, have already affected both local and statewide economies across the Commonwealth. Rising temperatures, extreme precipitation, invasive species, drought, extreme weather, and sea level rise have already begun to have direct impacts on the state's economy and those impacts are projected to increase. For example, high heat days could result in workers across the state losing over 10 million hours of work by the end of 2090, equating to over $778 million in lost wages for the time period (Neidell et al., 2021). Similarly in a report released in December 2022, increasing temperatures throughout the Commonwealth will result in a 30 percent increase in per capita annual municipal expenditures from 2090 to 2099. The greatest increases in municipal expenses due to increasing temperatures are related to heating and cooling of buildings and other services including road maintenance and operations (Zhao, 2022).

Damage to the built and natural environment is often costly and has cascading impacts. For example, waterfront damage from a storm could affect anticipated revenue from recreation, tourism, or the maritime industry, as well as affecting access and services if damage includes transportation and utility assets. Meanwhile, the increasing occurrence

of extreme temperatures can also affect people's ability to perform outdoor jobs (e.g., farmworkers, construction) or to get to work if roads, transit, or utilities are damaged and service is disrupted. For details on the costs of past hazard and climate events, as well as consequences of future events, please refer to Chapter 5 (Risk Assessment).

3.1.1.8 Levels of Government and Organization

When the Massachusetts Constitution was ratified in 1780, the state became a commonwealth—defined as a body of people that constitute a state or nation. In Massachusetts, the Commonwealth government consists of Executive, bicameral Legislature, and Judiciary branches.

The Executive Branch is led by the Governor and five other constitutional officers who serve in four-year terms (Table 3-6). The Executive Branch oversees state programs and services (Table 3-7). Its oversight does not extend to constitutional officers or independent agencies and commissioners.

In January 2023, Governor Healey signed Executive Order 604, which established the Office of Climate Innovation and Resilience within the Office of the Governor to coordinate the Commonwealth's climate policy across all state agencies and communities. Melissa Hoffer has been appointed as the first Climate Chief—in fact, Massachusetts is the first state in the U.S. to establish this position at the cabinet level.

Table 3-6. Massachusetts Constitutional Officers (as of March 2023)

Title	Name
Governor	Maura Healey
Lieutenant Governor	Kim Driscoll
Secretary of the Commonwealth	William Francis Galvin
Treasurer and Receiver General	Deborah Goldberg
Attorney General	Andrea Joy Campbell
Auditor	Diana DiZoglio

Table 3-7. Executive Branch Functions

Executive Branch	Role
Executive Office for Administration and Finance	Creates and carries out policies and services for state and local government financial stability, efficiency, and effectiveness.
Executive office of Economic Development	Promotes vibrant communities, growing businesses, and a strong middle class.
Executive Office of Education	Creates opportunities for Massachusetts residents through education. Empowers schools and educators, determines different college and career paths, and facilitates educational reform.
Executive Office of Energy and Environmental Affairs	Aims to protect, preserve, and enhance environmental resources in the Commonwealth and create a clean energy future.

Executive Branch	Role
Executive Office of Health and Human Services	Administers public health programs to improve residents' health, resilience, and independence.
Executive Office of Housing and Livable Communities	Creates more homes and lower housing costs throughout the state. Distributes funding to municipalities, oversees the state-aided public housing portfolio, and operates the state's Emergency Assistance family shelter.
Executive Office of Labor and Workforce Development	Conducts and oversees services to protect the rights, safety, health, and wages of the workforce.
Executive Office of Public Safety and Security	Develops policy and oversees the budget of secretariat agencies, programs, and boards focused on preventing crime, preparing for homeland security, and ensuring resident and visitor safety.
Massachusetts Department of Transportation	Provides reliable, safe, and resilient transportation infrastructure.
Executive Office of Technology Services and Security	Provides secure, quality digital services, tools, and information.
Executive Office of Veterans' Services	Advocates for veterans and provides support for veterans and their families.

Source: Commonwealth of Massachusetts (2023a).

The Legislative Branch makes or changes state laws. Is composed of the Senate (40 members serving two-year terms) and the House of Representatives (160 members, also serving two-year terms). Together, these bodies create the General Court.

The Judicial Branch interprets laws. It is composed of the following:

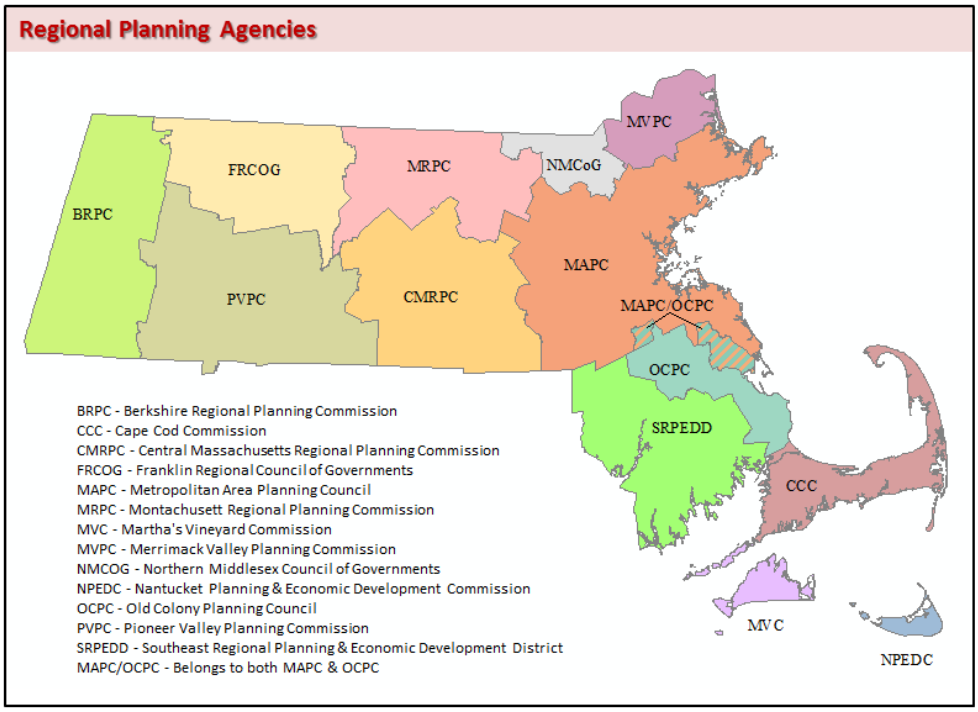
- The Supreme Judicial Court, led by a Chief Justice and six associate, governor-appointed justices
- The Appeals Court
- The Executive Office of the Trial Court
- Seven Trial Court departments
- Massachusetts Probation Services
- The Office of Jury Commissioner

The 2023 MA SHMCAP covers the entirety of the Commonwealth of Massachusetts, which has 14 counties. Some of these have county governments and others rely on localities for government services (see Figure 3-6). County governments exist in Barnstable, Bristol, Dukes, Nantucket, Norfolk, and Plymouth counties.

3.1.1.8.1 Regional

The Massachusetts General Laws established 13 planning regions throughout the Commonwealth. Within each of these, a regional planning agency collaborates with local

municipal governments and organizations to develop and implement comprehensive planning projects relating to populations, jobs and economic development, transportation, and environment (MassGIS, 2022). Regarding regional collaboration, the Commonwealth has established the MVP Program, which provides funding and technical assistance to localities in assessing vulnerabilities and developing resilience plans. These plans, combined with local hazard mitigation plans, fulfill certain regulatory requirements described in the FEMA *Local Mitigation Plan Review Guide*. After completing the MVP program, communities are MVP certified; this gives them increased standing in state grant programs and makes them eligible for MVP Action Grant funding, which funds priority action implementation.



Source: MassGIS (2022).

Figure 3-6. The Commonwealth's 13 planning agencies.

3.1.1.9 Natural Setting and Land Management

Massachusetts has 62 percent forest cover, and 75 percent of its forests are privately owned (UMass Amherst, n.d.). The Commonwealth also has over 1,500 miles of coastal areas and 48,000 acres of wetlands, including tidal and non-tidal wetlands (NOAA, n.d.) The Massachusetts Department of Conservation and Recreation manages over 150 parks across the state, including parks with mountains, freshwater and saltwater beaches, rivers and streams, and other natural features. As of June 2021, over 1.7 million acres of land throughout the Commonwealth were protected or preserved, which encompasses approximately a quarter of the total land in the state (Sutcliffe et al., 2021). Protecting and expanding the state's natural resources is a critical strategy that will increase resilience,

support climate adaptation, provide for the sequestration and storage of greenhouse gas emissions, and protect people and natural assets.

Massachusetts granted home rule authority to municipal governance, allowing towns and cities to adopt ordinances and bylaws to regulate the use of land, buildings, and structures (Commonwealth of Massachusetts, 2023b). Since the Commonwealth does not manage zoning and construction permits, it does not have direct influence over land use decisions within Massachusetts. However, it has the authority to support local municipalities' land use decisions by providing information on hazards and climate change risks; providing technical assistance for risk reduction; and encouraging safe and resilient development through funding support, resilient codes, and other best practices.

3.1.1.10 Statewide Assets

According to information provided by the Division of Capital Asset Management and Maintenance (DCAMM), the Commonwealth owns over 657,891 acres and over 5,000 buildings as of 2022 (Table 3-8). Executive offices within the Commonwealth are responsible managing other infrastructure, including roads, bridges, rails, buildings, culverts, open spaces, parks, beaches, trails, ports, pump stations, and dams. The Division's data set also identifies critical facilities, such as police/fire stations, military facilities, hospitals, residential facilities and housing, and emergency operation centers. The protection, preservation, and resilience of these statewide and critical assets and functions they serve are considered throughout the 2023 MA SHMCAP—as are other state, regional, and local assets, resources, and services as further described in Chapter 5 (Risk Assessment).

Table 3-8. Summary of State-Owned Land and Buildings as of 2022

State Entity	Land (Acres)	Building		Improvements	
		Count	Square Feet	Count	Square Feet
Department of Transportation	6,777	704	3,527,713	290	3,026,096
Executive Office for Administration and Finance	4,077	200	4,487,306	59	100,523
Executive Office of Education	7,602	1,029	46,216	398	12,025,830
Executive Office of Energy and Environmental Affairs	623,715	1,709	6,327,880	2,506	101,771,926
Executive Office of Health and Human Services	2,615	416	8,725,282	63	168,705
Executive Office of Housing and Economic Development	0.33	0	0	0	0
Executive Office of Labor and Workforce Development	1.96	5	67,412	1	0
Executive Office of Public Safety and Security	9,264	774	9,041,916	144	1,644,972

State Entity	Land (Acres)	Building		Improvements	
		Count	Square Feet	Count	Square Feet
Executive Office of Technology Services and Security	2.18	1	146,984	0	0
Independent authorities and quasi-public agencies	2,854	45	1,224,684	28	285,449
Judicial Branch	148	67	5,048	9	60,200
Secretary of the Commonwealth	5.03	1	100,000	0	0
Sheriffs	826	180	4,535,247	37	11,126
Federally owned land with state structures	0	12	4,453	17	5,523,024
Municipality-owned land with state structures	0	18	76,183	22	675,508
Privately owned land with state structures	0	5	28,748	11	10,938
Total	**657,891**	**5,166**	**89,558,816**	**3,585**	**125,304,297**

Source: Massachusetts Division of Capital Asset Management and Maintenance (2022).

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Chapter 4. State Capability and Adaptive Capacity Analysis

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Abbreviations

ASCE	American Society of Civil Engineers
BBRS	Board of Building Regulations and Standards
BEH	Bureau of Environmental Health
BBRS	Board of Building Regulations and Standards
BMPs	best management practices
CECP	Clean Energy and Climate Plan
CERT	Community Emergency Response Teams
CMR	Code of Massachusetts Regulations
CRS	Community Rating System
CZM	Office of Coastal Zone Management
DCAMM	Division of Capital Asset Management and Maintenance
DCR	Department of Conservation and Recreation
DER	Division of Ecological Restoration
DMF	Division of Marine Fisheries
DER	Division of Ecological Restoration
DoD	U.S. Department of Defense
DOER	Department of Energy Resources
EOEEA	Executive Office of Energy and Environmental Affairs
EOHED	Executive Office of Housing and Economic Development
FCPA	Massachusetts Forest Cutting Practices Act
FEMA	Federal Emergency Management Agency
FHMP	Flood Hazard Management Program
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance
FY	fiscal year
GHG	greenhouse gas
GIS	geographic information system
HMA	Hazard Mitigation Assistance

HMGP	Hazard Mitigation Grant Program
ICC	International Code Council
LIDAR	LIght Detection and Ranging
LiMWA	Limit of Moderate Wave Action
MA SHMCAP	State Hazard Mitigation and Climate Adaptation Plan
MAPC	Metropolitan Area Planning Council
MassECAN	Massachusetts Ecosystem Climate Adaptation Network
MassDEP	Massachusetts Department of Environmental Protection
MassDOT	Massachusetts Department of Transportation
MassECAN	Massachusetts Ecosystem Climate Adaptation Network
MBTA	Massachusetts Bay Transportation Authority
MDAR	Massachusetts Department of Agricultural Resources
MEMA	Massachusetts Emergency Management Agency
MEPA	Massachusetts Environmental Policy Act
MGL	Massachusetts General Laws
MSBC	Massachusetts State Building Code
MVP	Municipal Vulnerability Preparedness
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
PDM	Pre-Disaster Mitigation
Risk MAP	Risk Mapping, Assessment, and Planning
RL	repetitive loss
RMAT	Resilient MA Action Team
SFHA	Special Flood Hazard Area
SMART	Solar Massachusetts Renewable Target
SRL	severe repetitive loss
TERT	Telecommunicator Emergency Response Taskforce
WPA	Wetlands Protection Act

4.1 State Capability and Adaptive Capacity Analysis

4.1.1 Introduction and Purpose

The purpose of this state capability and adaptive capacity analysis is to identify the areas in which the Commonwealth of Massachusetts and individual state agencies can take action to reduce risks and increase resilience from the hazard and climate vulnerabilities and consequences identified in the risk assessment. To develop an effective hazard mitigation and climate adaptation strategy that the Commonwealth can implement, Massachusetts has assessed its current and future risk from hazards and climate change and analyzed its current capability and capacity to address risks through existing resources, as well as identify challenges and gaps. The Commonwealth will use this analysis to determine the actions necessary to improve state capability and adaptive capacity to address the risks identified in the MA SHMCAP and can incorporate these actions in the plan. This analysis also allowed the Commonwealth and its state agencies to identify innovative and strategic actions to improve coordination and implementation across sectors, agencies, and jurisdictions.

The capability and adaptive capacity analysis includes two components: (1) a *capability assessment* that evaluates the Commonwealth's existing capabilities to enable and implement hazard mitigation and climate adaptation actions across agencies on a statewide level, and (2) an *adaptive capacity analysis* that includes an analysis of individual state agencies, as well as identifying trends and themes across agencies.

As defined for the purposes of this plan, **state capabilities** include the authorities, laws, policies, programs, staff, funding, and other resources available to the Commonwealth to support hazard mitigation and climate adaptation efforts. **Adaptive capacity** is the ability of state agencies (including their key physical and nonphysical assets and services, functions, missions, and programs) to adjust or modify their operations, policies, or other functions to adapt to changes to the frequency, severity, and extent of hazards, and to consider climate change projections for vulnerabilities and impacts in the near, mid-, and long terms.

In combination with the risk assessment, this analysis:

- **Supports identifying specific actions** to include in the hazard mitigation and climate adaptation strategy to increase the ability of the Commonwealth and its agencies to effectively take action to reduce risks identified in the risk assessment, and the specific capabilities or resources required for implementation.
- **Evaluates existing state capabilities and capacity** that improve or impede resilience and reduce risks across the Commonwealth and within each agency in the near, mid-, and long terms.
- **Identifies the challenges and opportunities** within and between each agency that improve or impede resilience to future natural hazard events and other future conditions, including the effects of climate change.
- **Identifies ways the state's capabilities can support hazard mitigation and climate adaptation efforts** at all scales, with a focus on environmental justice and other priority populations, sustainable approaches, and the leveraging of federal, state, and local partnerships.

4.1.1.1 Major State Capability and Adaptive Capacity Chapter Updates Since 2018

Major updates to the components of the state capability and adaptive capacity analysis since 2018 include the following:

- **Updated Appendix 4.A** on the Commonwealth's primary hazard mitigation and climate adaptation capabilities and approaches, including updates on effectiveness of all MA SHMCAP actions and capabilities since 2018.
- **Highlighted recent examples** of state-supported initiatives and activities, laws and policies, as well as state agency partnerships and initiatives, such as Executive Order 604 (*Establishing the Office of Climate Innovation and Resilience Within the Office of the Governor*), Bill H.5060 (*An Act Driving Clean Energy and Offshore Wind*), the 2022 Climate Law, and the Clean Energy and Climate Plan (CECP) for 2050.
- **Described the adaptive capacity of state agencies**, based on a survey (Appendix 4.B) conducted with agencies in fall 2022, including strengths, capacity ratings, how agencies incorporate hazard mitigation and climate adaptation into existing programs,

current obstacles and challenges, and key opportunities and ways to address resource needs.

- **Updated details** on how the Commonwealth administers the National Flood Insurance Program (NFIP) and Federal Emergency Management Agency (FEMA) mitigation programs.
- **Added a section and Appendix 4.C** on funding sources for hazard mitigation and climate adaptation actions.
- **Updated local capabilities and coordination** details, including roles of local jurisdictions, Tribal governments, and regional planning agencies, as well as current challenges and opportunities of local jurisdictions and Tribal governments.

4.1.2 State Capabilities and Adaptive Capacity

In strengthening capabilities since the 2018 MA SHMCAP to increase capacity to advance effective climate adaptation and hazard mitigation in Massachusetts, the Commonwealth has made many improvements that have contributed to the success of the overall program. The significant progress provides the Commonwealth with a strong foundation to build upon and provides state agencies and others with a lot to leverage as Massachusetts seeks to identify projects and actions that will result in state agencies and others implementing hazard mitigation and climate adaptation actions. Some key highlights include:

- Between the 2018 MA SHMCAP and 2023 MA SHMCAP update, agencies have identified over **180 existing capabilities and approaches** to reducing hazard risk and vulnerability, including strengthening engagement within Department of Conservation and Recreation's (DCR's) Flood Hazard program with FEMA Region 1 and proposed resilience-focused amendments to waterway regulations by the Massachusetts Department of Environmental Protection (MassDEP; see Appendix 4.A for more details).
- **Over 90 new capabilities and approaches** to reducing hazard risk and vulnerability have been added by state agencies to this 2023 MA SHMCAP update, such as developing the Resilient MA Action Team (RMAT) and the Massachusetts Department of Transportation (MassDOT) Rail Division's pilot Cape Main Line project, which identifies hot spots susceptible to embankment failures due to drought conditions (see Appendix 4.A for more details).
- **Updated and new policies, procedures, and standards** have been created by state agencies since 2018 to increase effectiveness for reducing risk and vulnerability across the Commonwealth, such as the current adoption process underway for the 2021 edition of the International Code Council (ICC) model building codes (see the examples highlighted throughout this section for more details).
- **Increased funding, support, technical assistance, outreach, and education to local jurisdictions** that has strengthened community capacity to implement local climate

adaptation and hazard mitigation projects, such as ongoing outreach from the DCR Flood Hazard Management Program (FHMP) to local officials around capacity building, partnerships, risk reduction, and resilience building (see Section 4.1.3, "Local Capabilities and Coordination," for more details).

- **Gaps still exist** in staffing, skills, authority, funding, data and information, and coordination, when it comes to agencies' adaptive capacity to reduce climate risks and improve resilience (see "Current Obstacles, Challenges, and Needs" in Section 4.1.2.2 for more details).
- **Moving forward, key opportunities to address gaps** include coordinating and engaging with the Office of Climate Innovation and Resilience and the Climate Chief (which is the nation's first such position at the cabinet level), building staff technical skills and knowledge areas, prioritizing agency funding to focus on hazard mitigation and climate adaptation gap areas, addressing data and information gaps, and continuing support and engagement in interagency collaborations and partnerships, as well as with local jurisdictions and environmental justice and other priority populations to fully leverage resources and build capacity (see "Opportunities and Ways to Address Resource Needs" in Section 4.1.2.2 for more details).

4.1.2.1 Existing State Capabilities

The Commonwealth of Massachusetts has a diversity and breadth of policies, programs, and other capabilities and approaches to adapt to a changing climate and mitigate hazards and vulnerabilities that are most consequential to its communities, environment, and economy (e.g., coastal erosion, coastal flooding, drought, earthquakes, flooding from precipitation, groundwater rise, hurricanes, invasive species, landslides and mudflows, other severe weather, extreme temperature, tornadoes, tsunamis, wildfires, winter storms). While some of these capabilities and approaches focus exclusively on hazard mitigation and climate adaptation, many provide a range of equitable benefits to communities and environmental justice and other priority populations, the economy, the natural environment, and critical assets and services throughout the Commonwealth. For more information on addressing equity in strategy implementation for hazards, please see Chapter 7 (State Strategy, Actions, and Implementation Plan).

Appendix 4.A summarizes the Commonwealth's hazard mitigation and climate adaptation capabilities and approaches. The appendix has been updated for the 2023 MA SHMCAP with the most current information on hazard mitigation and climate adaptation capabilities and approaches, as well as 2023 update notes, effectiveness, and opportunities for improvement. Existing capabilities and approaches are organized under five categories:

- **Planning and regulatory.** State laws, regulations, Executive Orders, enabling legislation, plans, policies, strategies, and guidelines that support risk reduction for the built environment and natural systems. This category includes hazard-related plans

and policies that improve or impede resilience to future hazard events and other future conditions, including the effects of climate change.

- **Administrative and technical.** State staff and technical resources or programs, including the expertise, data, tools, partnerships, and other capabilities that support institutional capacity building, including the capacity to design and implement actions to reduce risk and build resilience. These actions include land use policies and regulations, buy-outs, community engagement, infrastructure projects, green infrastructure, and climate adaptation for short-, medium- and long-term resilience.
- **Capital projects and asset management.** Capital improvement programs or other investments that support risk reduction, hazard mitigation, and climate adaptation for key state assets or critical infrastructure.
- **Financial.** Grants, capital projects/improvements, land acquisition, and other monetary investments by the Commonwealth that support hazard mitigation and climate adaptation for the built environment (recent and future developments), economy, jobs, communities, and natural systems, with a focus on environmental justice and other priority populations and sustainable approaches.
- **Education, outreach, and capacity building.** Technical assistance, training, education and awareness initiatives, public–private partnerships, Tribal partnerships and engagement, community partnerships and engagement, and nonregulatory incentives that support external capacity building.

Key new or major updates since 2018 on the existing capabilities and approaches are highlighted in the Section 4.1.2.2 below.

4.1.2.1.1 Comprehensive Statewide Program—State Agency Partnerships and Initiatives

The Commonwealth has a long history of demonstrating its commitment to advancing risk reduction and resilience across the state. This work encompasses a broad range of state-supported initiatives and activities that include a combination of outreach, training, technical assistance, funding, partnerships, research, and analysis to advance understanding of specific hazards and climate change influences, regulatory codes and statutes, infrastructure projects, and other activities to increase statewide resilience. Some specific examples that are either new or have major updates since 2018 are listed in Table 4-1; for a full list, see Appendix 4.A.

Table 4-1. Key New or Major Updates to State-Supported Climate Adaptation and Hazard Mitigation Initiatives and Activities Since 2018

Examples	Description
RMAT	The RMAT was launched in 2019 (as required by Executive Order 569) and is led by the Executive Office of Energy and Environmental Affairs (EOEEA) and the Massachusetts Emergency Management Agency (MEMA). An expanded version of its predecessor, the State Hazard Mitigation Interagency Committee, the RMAT is an interagency team composed of representatives from each Secretariat Climate Office, called Climate Change Coordinators, who are supported by agency staff, stakeholders, and subject matter experts. The RMAT is tasked with monitoring and tracking the MA SHMCAP implementation process, supporting and making recommendations on MA SHMCAP plan updates, and facilitating coordination across state government and with stakeholders. The RMAT led initiatives such as the climate communication workgroup, development of the Climate Resilience Design Standards Tool, and the 2022 MA Climate Assessment (see below).
EOEEA 2022 Massachusetts Climate Change Assessment	The 2022 Massachusetts Climate Change Assessment is a statewide analysis detailing how Massachusetts' people, environments, economy, and infrastructure may be affected by climate change and its related hazards through the end of the century. The assessment directly informed the 2023 MA SHMCAP update. The 2022 MA Climate Assessment includes updated statewide climate change projections to identify climate impacts across the Commonwealth's regions and sectors, as well as data-driven climate risk consequence and urgency ratings. The project was informed by Municipal Vulnerability Preparedness (MVP) Program plans and assessments as well as FEMA-approved Local Hazard Mitigation Plans and was guided by a stakeholder working group, an equity advisory group, and a series of regional conversations and workshops.
MassDOT Capital Investment Plan	Released in June 2022, the 2023–2027 Capital Investment Plan reflects the first five-year plan since the fiscal year (FY) 2020–2024 Capital Investment Plan, and the first since the COVID-19 pandemic began. A total of $14.9 billion is committed to investing in the Commonwealth's capital needs over the next five years. Approximately 52 percent of investments focus on improving the reliability and resilience of the existing core transportation system. For example, new highway formula funds from the Bipartisan Infrastructure Law will support climate change mitigation (carbon reduction and electric vehicle charging infrastructure) and address resilience of transportation assets.

Examples	Description
Model Building Code	The Commonwealth requires local governments to use a nationally applicable model building code that addresses hazards (including wind, flood, snow, seismic, and other hazards) as a basis for design and construction of new buildings and any state-sponsored mitigation projects. The Ninth Edition of the State Building Code became effective October 20, 2017, and is based on modified versions of the 2015 International Codes, as published by the ICC. Under the Ninth Edition, the design and construction of buildings and structures located in flood hazard areas must be in accordance with American Society of Civil Engineers (ASCE) standards, which are consistent with, and in some cases exceed, minimum NFIP requirements. As of November 2022, the Commonwealth is in the process of adopting the 2021 ICC model codes as the Massachusetts Tenth Edition, which has further improvements for design and construction requirements for buildings and structures in flood hazard areas. See the "Massachusetts Building Code Update and Enhancement" section below for more details on these upcoming updates.
Climate Resilience Design Standards and Guidance Tool	The Climate Resilience Design Standards and Guidance Tool is advancing prioritized cross-agency actions included in the 2018 MA SHMCAP. In spring 2021, state infrastructure grant programs piloted use of the tool, including the MVP Program and the MassWorks Infrastructure Program, offered though the Community One Stop for Growth. This effort has developed climate resilience design standards and guidance in the form of an online tool for state agencies in order to incorporate climate resilience into the Commonwealth's capital planning process and grant-making for local capital projects. The tool outputs are generated using best available climate science data for Massachusetts and can be enhanced over time to incorporate new science, additional or changing climate hazards, and ongoing stakeholder feedback. In October 2021, initial application of the tool to private and public projects was piloted through the Massachusetts Environmental Policy Act (MEPA) Interim Protocol on Climate Change Adaptation and Resiliency.

Examples	Description
DOER Leading by Example Program	Established by Executive Order 594 in 2021, the Department of Energy Resources' (DOER's) Leading by Example Program requires state agencies to prioritize practices and programs that address resource use at state facilities, including a reduction in energy consumption derived from fossil fuels and emissions associated with such consumption. The Executive Order also mentions the MA SHMCAP: "whereas, the Massachusetts Integrated State Hazard Mitigation and Climate Adaptation Plan directs the Commonwealth to continue to prioritize investments in clean energy resilience infrastructure projects at state facilities."
Local Hazard Mitigation Planning Equity Program	Initially supported by funding from EOEEA and the Emergency Management Grant Program, MEMA launched the Local Hazard Mitigation Planning Pilot Program in FY 2022. The program is now administered annually and provides funding to develop or update Local Hazard Mitigation Plans for Massachusetts cities and towns with environmental justice and other priority populations. One goal of the program is to demonstrate increased equity in mitigation planning and participation, and to prepare communities to apply for federal Hazard Mitigation Assistance (HMA) pre- and post-disaster funding allocated to the Commonwealth.
Massachusetts Drought Management Plan	The Massachusetts Drought Plan was updated in 2019 and was developed to maximize the state's ability to effectively prepare for and respond to drought conditions. The plan aims to minimize drought impacts to the Commonwealth by improving agency coordination; enhancing monitoring and early drought warning capabilities; and outlining preparedness, response, and recovery activities for state agencies, local communities, and other entities affected by drought. The plan lays out an integrated, multiagency approach to managing drought, with an emphasis on state-led preparedness and response actions as drought conditions change.

Examples	Description
Executive Order 604: Establishing the Office of Climate Innovation and Resilience Within the Office of the Governor	To support strategic, integrated action to meet the Commonwealth's climate goals, the Executive Order issued in 2023 directed the creation of an Office of Climate Innovation and Resilience, which will direct and advance climate innovation, mitigation, adaptation, and resilience policies. The Executive Order also created the appointment of a Climate Chief to lead this office and serve as a climate officer within the governor's cabinet, providing advice on climate-related policy, regulations, legislation, and initiatives, as well as guidance on potential funding or capital investment opportunities. In addition, each Cabinet Secretary was required to appoint a Secretariat Climate Officer charged with developing agency-specific climate plans and tracking, coordinating, and managing actions to advance the climate goals and policies laid out in the Executive Order and by the Office of Climate Innovation and Resilience.
Bill S.9: An Act Creating a Next-Generation Roadmap for Massachusetts Climate Policy	Pursuant to the Global Warming Solutions Act, as amended in 2021 by An Act Creating a Next-Generation Roadmap for Massachusetts Climate Policy, the Secretary of EOEEA adopted the interim 2025 statewide greenhouse gas (GHG) emissions limit of 33 percent below 1990 levels and the interim 2030 statewide GHG emissions limit of 50 percent below 1990 levels. In compliance with the new law, EOEEA developed and finalized the CECP for 2025 and 2030 (the 2025/2030 CECP; see more details later in this section).
Bill H.5060: An Act Driving Clean Energy and Offshore Wind	Passed in 2022, this law reinforced the Commonwealth's commitment to reaching emissions reduction targets of 50 percent by 2030. An Act Driving Clean Energy and Offshore Wind directed the further development of clean energy infrastructure, including for offshore wind, and supported measures for transportation electrification and building decarbonization. Interagency collaboration across the Commonwealth is essential to meet the goals outlined in this act.

The Commonwealth continues to take many steps to enhance its hazard mitigation and climate adaptation efforts through direct actions, partnerships, and coordination within and across Massachusetts, as well as with other states in the Northeast. Some state agencies and offices regularly engage in efforts to incorporate hazard mitigation and climate resilience as part of their organizational missions. See Appendix 4.A for descriptions of many of the agencies' functions, including their enabling legislation and current hazard mitigation and climate resilience efforts. Many of the Commonwealth's initiatives to strengthen resilience to hazards and climate change have been accomplished through partnerships and coordination between state agencies, such as the RMAT, which has expanded the Commonwealth's ability to coordinate actions (e.g., cross-government actions) across agencies. These initiatives include efforts to expand planning and

programmatic development, provide funding opportunities, and develop policies and procedures to enhance resilience at a statewide level, including those highlighted in Table 4-1 above. Other examples of these policies, interagency partnerships, and initiatives are described below.

Executive Order 569: Establishing an Integrated Climate Change Strategy for the Commonwealth

In September 2016, building on the Commonwealth's leadership to mitigate and adapt to climate change, former Governor Charlie Baker signed an Executive Order that included a comprehensive approach to further reduce GHG emissions; safeguard residents, municipalities, and businesses from the impacts of climate change; and build a more resilient Commonwealth. Executive Order 569, *Establishing an Integrated Climate Change Strategy for the Commonwealth*, was designed to be a collaboration between the Office of the Governor, EOEEA, the Executive Office of Public Safety and Security, MEMA, and other key state, local, and environmental stakeholders.

The Executive Order ensured Massachusetts will continue to lead state and local officials by example, including through collaborating across state government to reduce GHG emissions and build resilience within government operations and across the Commonwealth. It also directed EOEEA and the Executive Office of Public Safety and Security to lead development and implementation of a statewide comprehensive climate adaptation plan (i.e., the 2018 MA SHMCAP) to provide a blueprint for protecting the built and natural environment of the Commonwealth, based on the best available data on existing and projected climate change impacts. Additionally, each Executive Office was required to designate a Climate Change Coordinator to work to complete a vulnerability assessment for each office and assist with implementing and coordinating adaptation and mitigation efforts across state government. The 2018 MA SHMCAP, along with the separate vulnerability assessment reports created for state agencies as part of the plan development process, were developed pursuant to the Executive Order's framework.

Municipal Vulnerability Preparedness Program

Launched in 2017 in support of Executive Order 569, the MVP Program provides support for cities and towns in Massachusetts to plan for and implement actions to increase local resilience. Under the MVP Program, the Commonwealth awards funding to communities to complete vulnerability assessments and develop and implement resilience plans. The program helps communities: (1) define extreme weather and natural and climate-related hazards, (2) identify existing and future vulnerabilities and strengths, (3) develop and prioritize actions for each community, and (4) identify opportunities to take action to reduce risk and build resilience. A community that completes the MVP process becomes designated as MVP Community and is eligible for MVP Action Grant funding to implement the priority actions identified in its resilience plan.

The sixth round of MVP planning grants was awarded on August 30, 2022, totaling more than $32.8 million. Since the program's 2017 inception, approximately $100 million has been awarded to 349 towns or cities, or 99 percent of communities in the Commonwealth. In addition, more than 360 people have been trained in workshops across the state to provide technical assistance to communities to aid in the developing local assessment and resilience plans. In 2022, of the $32.8 million in grants announced, $32.6 million was awarded to 73 municipal projects that build local resilience to climate change. Additionally, $157,700 was awarded to six towns to pursue a community-led planning process to identify vulnerabilities to climate change and develop priority actions to respond to identified vulnerabilities.

Although administered primarily through EOEEA, the MVP Program is supported by other state agencies/offices that review applications, including MEMA, DCR, MassDEP, the Division of Ecological Restoration (DER) in the Department of Fish and Game, and the Office of Coastal Zone Management (CZM). For example, MEMA mitigation staff work closely with EOEEA to ensure opportunities to leverage existing mitigation planning efforts and resources are effectively coordinated at both the state and municipal levels. This work includes promoting the integration of MVP with existing processes to develop or update local hazard mitigation plans. Other technical assistance providers include representatives from regional planning agencies, local municipalities, nonprofit organizations, community organizations, academia, and private-sector companies.

Silver Jackets Team

The Massachusetts Silver Jackets Team launched in 2016 with the goal of reducing the risk of flooding and other natural disasters by bringing together multiple federal and state agencies. The interagency team facilitates a collaborative process of strategic and integrated mitigation actions to reduce the threat, vulnerability, and consequences of flooding in the Commonwealth of Massachusetts. Through the process of sharing and combining resources, funding, programs, and technical expertise, the team works toward the goal of proactively reducing flood risk.

In 2022, the team re-established legacy high water marks on publicly visible and publicly owned infrastructure in downtown Boston, helping the city engage the public in flood risk awareness and the need to take action to reduce these risks. From 2022 into 2023, the team also collaborated with partners on the Massachusetts Historic Structure Assessment Project to create guidance on floodproofing options and cost estimates that will help preserve historic buildings and properties on Cape Cod.

Floodplain Management Initiatives

Federal Executive Orders 11988 (*Floodplain Management*) and 11990 (*Protection of Wetlands*) require federal agencies to avoid direct or indirect support of development in the floodplain, and work to minimize harm to floodplains and wetlands. State agencies

reviewing federally funded projects or receiving federal grants for projects must take these Executive Orders into consideration.

Federal Executive Order 13690 (January 2015, rescinded in 2017, reinstated in 2021) established a higher level of federal flood risk management, including outlining the establishment of the floodplain, and a set of requirements for enhanced stakeholder engagement in these processes. Executive Order 13690 states, "It is the policy of the United States to improve the resilience of communities and Federal assets against the impacts of flooding. These impacts are anticipated to increase over time due to the effects of climate change and other threats. Losses caused by flooding affect the environment, our economic prosperity, and public health and safety, each of which affects our national security." The Commonwealth adopts the practices outlined in this Executive Order when considering floodplain requirements for projects under federal mitigation grants.

Numerous state agencies within the Commonwealth are involved in reviewing state and federal projects in the floodplain, as well as establishing and implementing the following Massachusetts state laws and policies regarding floodplain management:

- **Massachusetts Executive Order 149.** Enacted in 1978, Massachusetts Executive Order 149, *State Coordination and Participation with the Federal Administration Under the National Flood Insurance Act*, designates the Massachusetts Water Resources Commission as the state agency to implement floodplain management programs in Massachusetts. The Office of Water Resources in DCR provides technical and staff support to the commission, including scientists, hydrogeologists, and water policy specialists who undertake activities of the Commission. In addition to floodplain management technical assistance (per NFIP regulations) offered to local governments, residents, other agencies, nonprofit organizations, and industry professionals, DCR staff also review floodplain development proposals that trigger MEPA review. Since 2018, the number of requested MEPA projects for review have more than tripled, with this work becoming a major component of the work of FHMP staff.
- **Massachusetts Executive Order 181.** Enacted in 1980, Massachusetts Executive Order 181, *Barrier Beaches*, recognized the vulnerability of barrier beaches and the important role natural barriers play in providing storm damage prevention and flood control. To mitigate future loss of life and property, Executive Order 181 prohibited new development in velocity zones or on primary dunes, as well as seawalls and revetments on barrier beaches. It constrains the use of state funds and federal grants for construction projects that could encourage growth and development in barrier beach areas. CZM was tasked with barrier beach policy coordination and continues to provide technical assistance to local and state agencies on barrier beach management.
- **Wetlands Protection Act (WPA).** Massachusetts was one of the first states in the nation to pass wetlands protection laws, in the early 1960s. The WPA, found in Massachusetts General Laws (MGL) Chapter 131, Section 40, was codified as 310 Code of Massachusetts Regulations (CMR) Section 10.00. These regulations protect wetlands,

wetland functions, and public interest in wetlands, including flood control, pollution and storm damage prevention, and protection of water supplies and other natural resources and habitats. Multiple state agencies review actions that may alter wetlands, floodplains, lands under water, waterways, salt ponds, fish runs, and the ocean under the WPA.

- **Massachusetts Rivers Protection Act.** Enacted in 1996, the Massachusetts Rivers Protection Act (Chapter 258 of the Acts of 1996) amended the WPA to provide protection to approximately 9,000 miles of Massachusetts riverbanks. The act created a 200-foot riverfront area that extends on both sides of rivers and streams in the Commonwealth, protecting water quality benefits, preserving habitat, and providing flood risk reduction to surrounding lands.
- **Massachusetts State Building Code (MSBC).** MSBC 780 CMR (further described in the following section) is a statewide mandated construction code that is updated periodically, based on the ICC's recommended codes; it includes most of the federal construction requirements listed in the U.S. Code of Federal Regulations Title 44, Section 60.3 for floodplains as defined by FEMA Flood Insurance Rate Maps (FIRMs) under the NFIP. Other NFIP development requirements are included in the WPA or in the Commonwealth's Title V (310 CMR 15) requirements for sewage treatment and disposal. Finally, remaining NFIP standards can be found in the 2020 state model floodplain ordinance; these standards must be adopted at the community level, typically through municipal zoning bylaws. The Commonwealth monitors changes to the local codes as they pertain to mapped floodplain changes or related local practices.
- **Massachusetts Model Floodplain Bylaws.** Updated in 2020 (version 2), the Massachusetts Model Floodplain Bylaws is used to review local community bylaws or ordinances as part of the local map adoption process. The model helps local communities participating in the NFIP to understand the proper language for compliance with the NFIP.

Additionally, many local jurisdictions throughout the Commonwealth have adopted laws, regulations, and policies to advance hazard mitigation and climate adaptation across Massachusetts.

Massachusetts Building Code Update and Enhancement

The State Board of Building Regulations and Standards (BBRS) administers the MSBC (found at 780 CMR), which consists of a series of international model codes and any state-specific amendments adopted by the BBRS during the promulgation process. The BBRS regularly updates relevant provisions of the MSBC as new information and technology become available.

The Commonwealth requires mandatory enforcement of the statewide building code and does not allow local amendments to this code. The Commonwealth adopts a plumbing and electrical code that provides requirements and certifications for plumbers and

electricians working in Massachusetts. The Commonwealth also has a program in place for building code inspection certification, which includes taking classes prior to examination and certification, requires continuing education, and allows consumers to file complaints against inspectors. Massachusetts also requires licensing of general, plumbing, electrical, and roofing contractors; requires licensing candidates to pass an examination prior to licensing; and requires continuing education.

The current Ninth Edition of the MSBC (issued in 2017; see note below on upcoming Tenth Edition) is based on the 2015 ICC's recommend International Codes. There are currently three tiers of building energy efficiency code options available to municipalities in Massachusetts. While as a baseline, all municipalities must comply with the Base Energy Code; one step beyond these requirements is the Stretch Code. First adopted by Massachusetts in 2009, and updated every few years since, the Stretch Code contains additional amendments that provide for constructing buildings that are more energy efficient than those built to the base specifications. Above the Stretch Code, and available only as of 2023, is the Specialized Energy Code. This code contains all the amendments of the Stretch Code as well as additional requirements to ensure new construction is consistent with state GHG limits. Municipalities must vote to adopt the Stretch and Specialized codes in place of the Base Energy Code. As of February 2023, 296 municipalities in the Commonwealth have adopted the Stretch Code. In addition, four municipalities have adopted the Specialized Energy Code.

The Ninth Edition of the MSBC also contains a series of requirements for flood-resistant design and construction that are in accordance with the ASCE 24 standard, which incorporates—and in certain areas exceeds—FEMA's NFIP construction standards. Highlights of ASCE 24 that complement the NFIP minimum requirements include requirements for building performance; flood damage–resistant materials, utilities and service equipment, and siting considerations. Specific requirements for designing flood elevations and using flood-resistant materials may be found in the ASCE tables included in 780 CMR Section 1612.4. Additional state-specific higher standards for flood-resistant construction in coastal dunes may be found in Appendix G of the MSBC. For example, the state requires the use of pilings in coastal dune areas, even if the areas are not in a mapped velocity flood zone (V Zone) and has higher elevation requirements than the NFIP (the lowest floor must be built to at least 2 feet above a dune). Freeboard requirements are found in all FEMA 1 percent annual chance floodplain areas.

Specific requirements in the Ninth Edition Building Code that affect development and redevelopment in coastal flood zones include: (1) in new or substantially improved buildings in V Zones, utilities may no longer be located below the FEMA base flood (1 percent annual chance) elevation, and (2) new or substantially improved buildings in A Zones (areas inundated by the base flood with no base flood elevations determined) must be elevated so the lowest floor surface is at least 1 foot above the FEMA base flood elevation. New or substantially improved (i.e., 50 percent or more of the market value)

buildings in V Zones must continue to be elevated so the bottom of the lowest horizontal member is at least 2 feet above the FEMA base flood elevation.

As of November 2022, the Commonwealth is in the process of adopting the 2021 edition of the ICC model codes (Tenth Edition of the MSBC), which have further improvements for design and construction requirements for buildings and structures in flood hazard areas. Example improvements include:

- Defined the new Specialized Opt-in Code, which allows municipalities that wish to adopt stricter local building codes to go beyond the Base Energy and Stretch codes.
- Updated the 2021 International Building Code snow map to match ASCE 7-16 snow maps and updated secondary rain loads to be consistent with ASCE 7.
- Added frost protection for egress doors to the foundati
- on requirements.
- Added additional freeboard in all FEMA Special Flood Hazard Areas.
- Included the International Building Code regulations for coastal A Zones.

In addition, in 2023, the Executive Office of Housing and Economic Development (EOHED) plans to conduct a statewide building code study and develop a local floodplain management action guide (see text box to right).

MCBS Study and Local Floodplain Management Action Guide

Starting in 2023, EOHED plans to undertake a building code study that includes:

- Assessing the MSBC for needs and options to improve floodplain management standards, taking into account best available statewide climate change projections
- Developing a guidance document to assist municipalities to take impactful local action to improve floodplain management standards within their geographic jurisdictions

Coastal Management Initiatives

With more than 1,500 miles of coastline in Massachusetts—much of it vulnerable to hazards and climate change—the Commonwealth's coastal management initiatives are critical to consider in the context of risk reduction and climate resilience. CZM is the lead policy, planning, and technical assistance agency on coastal issues in EOEEA. Hazard mitigation and climate change adaptation are fundamental to CZM's mission and program areas, which play a strong role in various risk reduction activities at state, regional, and local levels. Some of the more notable initiatives include:

- **StormSmart Coasts.** This national model launched by CZM in 2008 is designed to help communities and homeowners address coastal erosion, storm damage, flooding, and related issues. The StormSmart Coasts website includes information on assessing the vulnerability of coastal properties to erosion and flooding, tools for local officials to improve coastal floodplain management, options for coastal property owners to

reduce erosion and storm damage while minimizing impacts to shoreline systems, landscaping options for controlling erosion and storm damage, interactive maps of Massachusetts coastal erosion, and available grants.

- **Shoreline Change Project.** CZM developed and maintains the Shoreline Change Project in cooperation with the U.S. Geological Survey to inform vulnerability assessments and planning. Historical shorelines from the mid-1800s to 2018 have been delineated and used to compute long-term (100+ years) and short-term (approximately 30 years) rates of erosion.
- **Sea Level Rise and Coastal Flooding Viewer.** CZM developed this online tool to support the assessment of coastal flooding vulnerability for community facilities and infrastructure, consistent with Executive Order 569. The viewer launched in 2017 with interactive maps of flooding associated with National Oceanic and Atmospheric Administration (NOAA) sea level rise scenarios, FEMA coastal flood zones, and current worst-case hurricane storm surge modeled by the U.S. Army Corps of Engineers. In March 2023, CZM released an updated viewer with future storm surge scenarios produced from the Massachusetts Coast Flood Risk Model. Locations consisting of a wide range of public facilities and infrastructure assist state, regional, and local planners and other stakeholders in conducting vulnerability assessments to these coastal hazards and climate effects.
- **Coastal A Zone Mapping.** To improve coastal flood hazard mapping in Massachusetts, DCR Flood Hazard Management and CZM partnered in 2015 to delineate the Limit of Moderate Wave Action (LiMWA) for 15 coastal communities. FEMA updated these maps in July 2021. LiMWA is the inland limit of the area expected to receive 1.5-foot or greater breaking waves during the 1 percent annual chance flood event. FEMA FIRMs that went into effect in 2009–2013 for Massachusetts coastal counties were based on studies initiated in 2005 and did not include LiMWA lines. The addition of the LiMWA to FIRMs allows communities and individuals to better understand the flood risks to their property. To make the most accessible and accurate information on coastal A Zone boundaries available, DCR and CZM use information on coastal A Zone boundaries for the entire Massachusetts coast from FEMA's published Flood Insurance Studies. Through this initiative, the LiMWA was mapped based on the coastal storm surge and wave modeling data from the most recent FEMA coastal Flood Insurance Studies for coastal communities. The data have since been approved and incorporated into FEMA's National Flood Hazard Layer as of 2021.
- **Increasing Resilience Through Application of Nature-Based Infrastructure.** From 2015–2022, CZM participated in a Northeast Regional Ocean Council effort to increase resilience to sea level rise in New England through the effective use of nature-based infrastructure for reduced erosion and enhanced wave attenuation. The effort included region-specific information on suitable natural infrastructure types (i.e., "living shorelines"), and the council partnered with several communities to implement and monitor a range of nature-based coastal infrastructure projects. The experience and

lessons gained through this project help identify successful approaches and models to reduce coastal erosion and flooding.

- **Metro Boston Coastal Resilience Study.** The Commonwealth received an authorization through the 2020 Water Resources Development Act that allows for a funding agreement with the U.S. Army Corps of Engineers to conduct a planning study to address climate resilience at a regional scale. The study includes a regional vulnerability assessment and identifies recommended regional adaptation strategies and an implementation framework that builds on existing local plans and priorities.

Energy Resilience Initiatives

There are several agencies in the Commonwealth that design, implement, and/or manage programs and initiatives focused on energy resilience. For example, DOER develops and implements policies and programs aimed at ensuring the adequacy, security, diversity, and cost-effectiveness of the Commonwealth's energy supplies to create a clean, affordable, and resilient energy future for all residents, businesses, communities, and institutions. Examples of new or key updates since 2018 to agency efforts to advance energy resilience in Massachusetts are highlighted in Table 4-2.

Table 4-2. Key New or Major Updates to Energy Resilience Initiatives Since 2018

Initiative	Description
Section 40101(d) of the Bipartisan Infrastructure Law: Preventing Outages and Enhancing the Resilience of the Electric Grid Formula Grants to States and Indian Tribes	The Department of Energy will provide grants to states, U.S. territories, and Indian Tribes to improve the resilience of their electric grids. States and Indian Tribes may further allocate funds to "eligible entities," as defined by Section 40101(d). These grants offer a unique opportunity to advance the capabilities of states and Indian Tribes, as well as their communities, to address not only current, but future resilience needs. Applicants shall provide a "Head of Government Letter" documenting their appointment as the sole entity within the state or Indian Tribe to apply for, receive, and administer the award and a "Program Narrative" to define a planning framework for resilience to address all hazards including future climate implications by March 31, 2023, for the first two years of program funding. The Massachusetts Clean Energy Center and DOER hosted a public webinar on potential program design in January 2023.
Clean Energy Results Program and Gap III Energy Grant Program	Led by MassDEP, the Clean Energy Results Program is a partnership with DOER and the Massachusetts Clean Energy Center that reduces regulatory or other barriers to clean and energy-efficient development across the state. The Gap Grant is a streamlined energy grant funding model that has helped municipal water utilities reduce their energy usage and operating costs, as well as improve the environment. In January 2023, an expanded Gap III Energy Grant Program provided $8.1 million of grant awards to 62 organizations, including 40 municipal drinking water and

Initiative	Description
	wastewater facilities, 12 nonprofit affordable multi-family housing organizations, seven agricultural and food-producing nonprofits, and three small businesses. These projects are anticipated to save these organizations up to $1,642,963 in annual energy cost savings and more than 9,000 megawatt hours in annual electricity savings or on-site generation of clean energy, as well as reduce carbon emissions by 3,359 metric tons annually.
Clean Energy and Climate Plan	The 2025/2030 CECP, released in June 2022, provides details on the actions the Commonwealth will undertake through the next decade to ensure the 2025 and 2030 emissions limits are met. The 2025/2030 CECP development is informed by the 2050 Decarbonization Roadmap. Furthermore, the CECP for 2050, released in December 2022, provides details on the actions the Commonwealth will undertake to be on a pathway to achieve net zero GHG emissions by 2050.
Clean Peak Energy Standard	The Clean Peak Energy Standard was established by DOER in 2021 and designed to provide incentives to clean energy technologies that can supply electricity or reduce demand during seasonal peak demand.
Regional Greenhouse Gas Initiative	As a nation-leading energy efficiency program, DOER held hearings in 2018 on proposed amendments to the Regional Greenhouse Gas Initiative program. The overall changes to the program "will cause real reductions in greenhouse gas emissions and, in accordance with the Green Communities Act, the economic proceeds will be invested in programs to promote energy efficiency, conservation and demand response."
Clean Energy Standard	MassDEP finalized amendments to the Clean Energy Standard in November 2022, which "improve consistency with federal requirements, reflect the GHG reporting program's transition to a new electronic platform, and remove requirements that are burdensome to facilities." The Clean Energy Standard requires retail electricity sellers to demonstrate the use of clean energy to generate a specified percentage of their electricity sales on an annual basis.

Other ongoing state agency energy resilience initiatives include:

- **Community Clean Energy Resiliency Initiative.** The Community Clean Energy Resiliency Initiative was designed to help address service interruptions to critical infrastructure caused by hazards and climate change. The $40 million grant program funded technical assistance, as well as project implementation, for police and fire

dispatch, emergency shelters, hospitals, and critical water infrastructure facilities to use clean energy technologies—including combined heat and power, solar photovoltaic, and energy storage technologies—to mitigate and address the impacts of climate change. As of 2023, funding is no longer available from this program, but grant recipients are continuing to implement their funded projects.

- **Energy Storage Initiative.** The Energy Storage Initiative was a $20 million grant program designed to demonstrate how energy storage can improve grid operations, reduce energy costs, provide backup power through storms, and benefit the local economy. The initiative aims to make the Commonwealth a national leader in the emerging energy storage market, requiring a 1,000 megawatt hour energy storage target to be achieved by December 31, 2025.
- **Solar Massachusetts Renewable Target (SMART) Program.** Launched in 2017, the SMART Program provides incentives to advance development of distributed solar photovoltaic electricity generation across the Commonwealth. The DOER regulation in 225 CMR 20.00 sets the regulatory framework for the program. The SMART Program is the nation's first to incorporate an incentive to pair energy storage with solar technology. Incorporating energy storage with distributed solar generation can enable the solar technology and the stored energy to continue serving on-site loads through a power outage, improving a facility's energy resilience.

Transportation Resilience Initiatives

Established in 2018 through Executive Order 579, the Commission on the Future of Transportation in the Commonwealth advises the Administration on future transportation needs and challenges. The commission is focusing on five key areas to improve transportation resilience: climate change and resilience; transportation electrification; autonomous and connected vehicles, including ride-sharing services; transit and mobility services; and analysis of the relationship between transportation and land use and demographic trends, with a focus on technology, climate, and new business models. The commission delivered a report that included, among others, a recommendation to substantially reduce GHG emissions from the transportation sector while accelerating efforts to make transportation infrastructure more resilient. This included a sub-recommendation to complete vulnerability assessments of all publicly owned or funded transportation infrastructure to inform capital planning and disseminate resilience-oriented design standards for transportation infrastructure. By 2020, it recommended no transportation infrastructure should be built that does not conform to these standards.

MassDOT's 2050 Statewide Long-Range Transportation Plan, entitled Beyond Mobility, launched in October 2021 and will articulate a set of priority areas and actions that reflect MassDOT's values, vision for the future of transportation, and existing problems based on public input and data analysis. Other tasks include public engagement, scenario planning, financial planning, needs assessment, and recommendations. MassDOT has intentionally

placed public engagement at the center of the Beyond Mobility planning process with a focus on equitable and inclusive outreach.

The draft priority areas include resilience as an important area for MassDOT to address through potentially identifying uses of new federal resilience funding, as well as future studies that could inform other initiatives. The final plan will also consider electrification across all modes and technological changes as important areas for MassDOT to address through its ongoing work, largely through actions that are aligned with those included in the 2025/2030 CECP.

Annually, MassDOT includes resilience in its Capital Investment Plan by proposing investments that help to mitigate the impacts of climate change and/or improve the resilience of our transportation network to better withstand natural hazards.

Key new MassDOT resilience efforts since 2018 include:

- Announced in 2021, the city of Boston, the Boston Planning & Development Agency, MassDOT, EOEEA, and DCR launched a joint planning effort to **evaluate and recommend transportation and infrastructure improvements** intended to enhance mobility and safety for pedestrians, transit users, cyclists, and motorists, and strengthen climate resilience at Dorchester's Kosciuszko Circle and along Morrissey Boulevard.
- In 2020, MassDOT awarded $806,880 in grants to support **culvert replacement projects that reduce flood risks** to municipal roads and river health in communities across the Commonwealth.
- MassDOT is conducting a **Flood Risk Assessment** to understand inland and coastal vulnerability of critical assets, including National Highway System roads, bridges, and large culverts; railroads; staff and equipment facilities; and public-use airports. It assesses damage and repair costs and time estimates for repairs, in addition to considering the consequences from loss of service.
- In collaboration with the Woods Hole Group, MassDOT developed the Massachusetts Coastal Flood Risk Model in 2019 to help anticipate how climate-related hazards (i.e., sea level rise and coastal storm events) will influence future coastal flood risks in the Commonwealth and assess potential flooding vulnerabilities to transportation infrastructure throughout the coastline.
- Since 2018, the Massachusetts Bay Transportation Authority (MBTA) has completed **climate change vulnerability assessments** and **flood screening reports** of its entire operations and continues to assess its system for vulnerabilities by conducting more detailed assessments (see a complete list of MBTA's vulnerability assessments here). Executed and coordinated by its Environmental Department, MBTA is eager to adopt and operationalize the findings from the most recent assessments, completed between January 2021 and August 2022, and focused on data and decision-making tools, strategic planning, capital planning, asset management, engineering and design,

emergency and risk management, and interagency collaborations. For more details on MBTA's capabilities, see Appendix 4.A.

4.1.2.2 Adaptive Capacity of State Agencies

Following is an analysis of the adaptive capacity of individual state agencies[1] informed by a survey conducted with the agencies in fall 2022, in which 85 of 94 agencies responded (Appendix 4.B).[2] **State agency adaptive capacity** is defined as the ability of state agencies (including their assets, functions, missions, services/programs, and service populations and customers) to adjust or modify their operations, policies, or other functions to adapt to changing hazards and climate change impacts, in the short, medium, and long terms. Example updates of state agency adaptive capacity and MA SHMCAP actions since 2018 are highlighted in Figure 4-1 below.

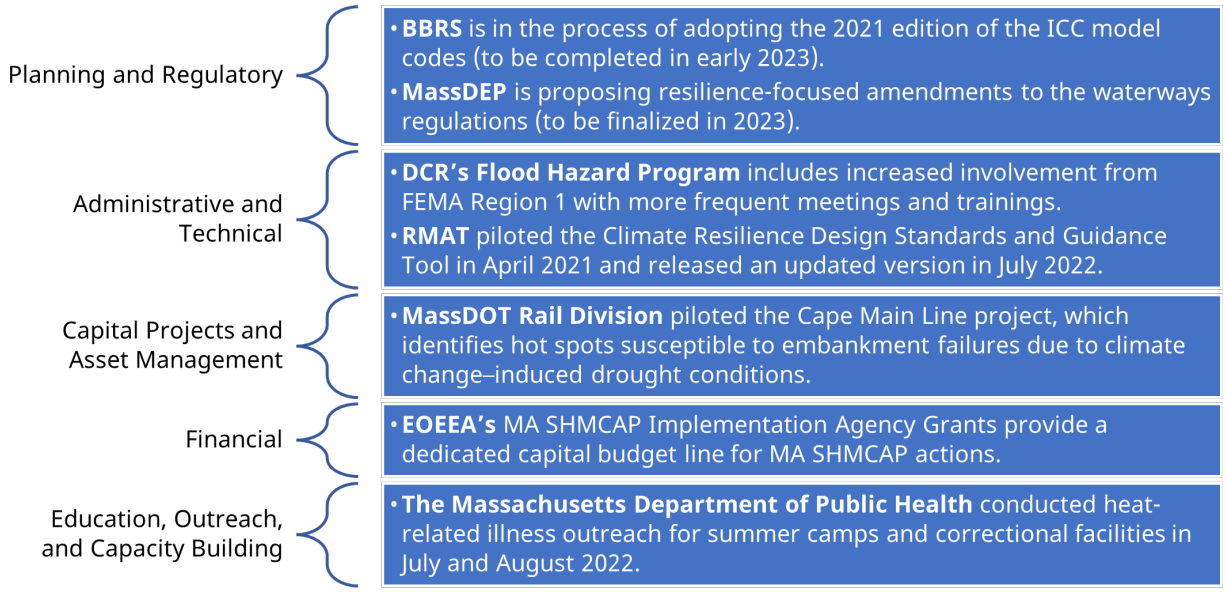


Figure 4-1. Example updates since 2018 on agency actions to increase adaptive capacity.

[1] "Agency" is used here as a term to encompass the various departments, divisions, offices, boards, bureaus, committees, and commissions surveyed.

[2] Given nine agencies did not respond, some results may be skewed. Additional agency data collected as part of the state agency survey include information related to the continuity of agency operations and functions during a hazard event that result in damage, disruption, or loss of state agency physical and nonphysical assets and service, as well as restoration times, and other strategies to reduce state agency vulnerabilities. Since these responses relate more directly to the vulnerability and resilience of state assets and functions, this information is included in Chapter 6 (State Agency Vulnerabilities).

Key findings from document review and agency survey responses are highlighted below. Notable examples or additional comments on specific agency capabilities, plans, policies, or other available resources to support agencies' adaptive capacity to reduce risk and increase climate and hazard resilience are highlighted in text boxes.

Spotlight: Massachusetts Telecommunicator Emergency Response Taskforce (TERT) Program

The Massachusetts Executive Office of Public Safety and Security and State 911 Department plan to implement the TERT Program on December 1, 2022. Developed in partnership with the Statewide Office of Public Safety Interoperability and the Massachusetts Chapter of National Emergency Number Association, the program is a team of certified and credentialed public safety telecommunicators who respond, relieve, assist, and/or augment public safety answering points affected by human-made or natural disasters.

4.1.2.2.1 Current Strengths

Based on agency survey responses, the following strengths represent key themes around agency abilities to address current hazard risks that are increasing in frequency, intensity, duration, and/or geographic location due to climate change.

Agencies' existing available resources to reduce hazard and climate risks are mainly directed toward emergency preparedness and response. However, agencies that are prepared for and mitigate hazard risks subsequently reduce overall risk impacts and costs. In order to manage repeated hazards, agencies regularly monitor their assets and unique vulnerabilities. For example, they may regularly test emergency power sources, survey properties for potential sources of damage, and ensure communication modes are functional. Many also have backup power sources and secure online file storage to be prepared for emergency situations. Another key strategy is utilizing technology to build capacity for remote work and creating plans to shift to remote operations when needed. Some agencies currently conduct a significant portion of their work remotely, while others ensure the option is available for emergency situations. Agencies also frequently reported that they have plans for how to respond in an emergency, and some have additional plans for how to adapt to overall changing conditions. These plans include support for keeping Continuity of Operations and/or Emergency Response Plans in place and up to date to direct operations during emergency response actions. In cases when hazards are likely to occur repeatedly, agencies often review and update these plans to address the most current conditions. While the majority of these resources are focused on emergency response, they are important building blocks to increasing hazard mitigation and climate adaptation implementation in Massachusetts.

Furthermore, there are ongoing state interagency collaborations and partnerships designed to advance hazard mitigation and climate adaptation understanding, funding, and actions. Some of these interagency partnerships support the reduction of risk from hazards and climate change through managing ecosystems. Other partnerships coordinate responses to emergencies and ensure the timely recovery of essential services.

Example Interagency Collaborations and Partnerships

- 2022 MA Climate Assessment
- Drought Management Task Force
- Massachusetts Silver Jackets, New England District
- MEMA State Emergency Response Commission
- Resilient Lands Initiative
- RMAT
- HMA Interagency Review Panel
- Coordinated Statewide Emergency Preparedness in Massachusetts

For more information on challenges and opportunities of interagency collaborations and partnerships, see the subsections below.

The Commonwealth's whole-of-government approach to climate action is exemplified by the establishment, in 2023 through Executive Order 604, of the Office of Climate Innovation and Resilience within the Governor's Office. The Office is led by the Climate Chief, who advises the governor on climate-related matters and coordinates policies across state agencies and communities. Additionally, there are collaborations that focus on drought, reducing flood risk, increasing community resilience, protecting public health, and obtaining federal hazard mitigation grants, among other topics. One example is the Drought Management Task Force (DMTF) chaired by EOEEA and MEMA. The DMTF consists of officials from state and federal agencies and professional organizations with responsibility for geographic areas and social and environmental issues likely to be affected by drought conditions. The drought task force also includes representatives with technical expertise, drought response roles, public health agencies, and public safety responsibilities. The DMTF collects information and makes recommendations for drought management in the Commonwealth.

In addition to partnerships and collaborations, some state agencies have added full-time staff positions, contractor support, or part-time roles to support and advance hazard mitigation and climate adaptation work. For example, DER has added 10 new positions since 2018 to increase capacity to address current risks and respond to and plan for climate change, as well as provide enough capacity to support building capacity in external partner organizations and agencies.

4.1.2.2.2 Overall Capacity Rating

The overall capacity rating is a self-assessment rating of the agency's overall capacity and capability to reduce impacts from current and future hazards. Ratings were identified in response to a closed-ended survey question with the following potential ratings:

- **Adequate.** The resource is available and accessible to my agency; my agency is not constrained in its implementation of climate adaptation and hazard mitigation actions,

strategies, and projects based on a lack of this resource or the ability and authority to use it.

- **Limited.** The resource is available and accessible in a limited way to my agency; my agency has some limits regarding availability, access, or capacity related to this resource. These limits have an effect on my agency's ability to implement climate adaptation and hazard mitigation actions, strategies, and projects.
- **Constrained.** This resource is not available and/or accessible to my agency; my agency is constrained in its implementation of climate adaptation and hazard mitigation actions, strategies, and projects based on the lack of this resource and/or the ability and authority to use it.

Agencies self-assess the rating of their overall capacity and capability to reduce impacts from current and future hazards in the resource categories of funding, staff, data/information, expertise/skills, authority, and infrastructure/hardware. Agencies identified specific resource types in each of these categories to rate whether their capacity and capability is adequate, limited, or constrained (see definitions above). Table 4-3 below highlights the high-level resource category ratings, where funding and staff are most constrained (and a significant challenge to acquire), and infrastructure/hardware and authority are adequate (and a less significant challenge to acquire).

Table 4-3. Overview on Ratings of Agencies' Self-Assessed Capacity and Capability in General Resource Categories (Out of 85 Participants)

Resource Category	Does your agency have the resource?	My agency has capacity and capability to reduce impacts from current/ future hazards	This is a significant challenge for our agency
Funding (e.g., hazard mitigation planning funds, operating budget, capital budget, grants, bonds)	Y = 39% N = 61%	Adequate = 35% Limited = 42% Constrained = 23%	31%
Staff (e.g., skilled staff, dedicated staff, hazard mitigation staff, data analysts, emergency response coordinator)	Y = 40% N = 60%	Adequate = 36% Limited = 34% Constrained = 30%	29%
Data/information (e.g., monitoring data, data sharing, vulnerability and hazard response data, climate-based emergency/climate modeling, climate communications)	Y = 29% N = 71%	Adequate = 43% Limited = 34% Constrained = 23%	25%

Resource Category	Does your agency have the resource?	My agency has capacity and capability to reduce impacts from current/ future hazards	This is a significant challenge for our agency
Expertise/skills (e.g., climate science/adaptation/ mitigation, project management, grant writing, LIDAR)	Y = 25% N = 75%	Adequate = 43% Limited = 25% Constrained = 32%	22%
Infrastructure/hardware (e.g., backup generator, portable heating/cooling units, hatchery retrofits, email firewall and security infrastructure, drones/sensors, sandbags)	Y = 23% N = 77%	Adequate = 58% Limited = 25% Constrained = 17%	21%
Authority (e.g., Continuity of Operations Plan, policy, laws, programs)	Y = 17% N = 83%	Adequate = 55% Limited = 23% Constrained = 22%	19%

4.1.2.2.3 Incorporating Hazard Mitigation and Climate Adaptation into Existing Programs

This section describes current agency efforts to incorporate hazard mitigation and climate change adaptation into existing programs.

Agencies consider hazards and climate change impacts in their work in a variety of ways, depending on the services they provide, their assets and functions, their service populations, and their customers, as well as what each agency relies upon to function, and who and what relies on them. The most frequent ways agencies reported incorporating hazard mitigation and climate adaptation include:

- Developing specific policies, plans, or programs or integrating hazard and climate into existing policies, plans, or programs.
- Planning for and responding to hazard events through preparation, response, and recovery.
- Providing maintenance, operation, and repair for their assets and services to reduce current and future risk and considering replacement schedules and lifecycle with hazards and climate change in mind.
- Providing funding for hazard mitigation and adaptation efforts, either internally to advance agency mitigation actions or externally through grant programs.

In addition to the bulleted actions described above, some agencies conduct work that, by definition, addresses hazard mitigation and climate adaptation. For example, DER's primary role is to plan and implement ecological restoration projects, many of which deal with aquatic environments. These restored ecosystems can mitigate climate risks such as flooding and sea level rise, as well as provide additional ecological benefits. Similarly, DCR enforces the Massachusetts Forest Cutting Practices Act (FCPA; MGL Chapter 132). The FCPA was created to ensure the continuation of long-term public benefits provided by forests, which requires rehabilitating, maintaining, and protecting forestlands for a multitude of purposes (e.g., conserving water, preventing floods and soil erosion, improving conditions for wildlife and recreation, ensuring a continuous supply of wood). The FCPA ensures these services continue to be provided and upheld through a required permitting process, which is applicable to commercial timber harvests on both public and private forestland.

Spotlight: MBTA Climate Change Vulnerability Assessments

MBTA conducts assessments to understand the risks posed by climate change to its transportation system assets. The findings of these assessments inform a variety of MBTA's plans and projects, including its five-year Capital Investment Plan, infrastructure design and construction standards, and emergency management activities.

For other agencies, considering future risks and climate resilience is essential for planning future projects or improvements. For instance, when scoring long-term infrastructure project proposals, EOHED includes climate resilience as a consideration to ensure their investments will be worthwhile. Similarly, the Department of Housing and Community Development assists Local Housing Authorities with ensuring they identify potential hazards to new developments and that structures are sited and designed to minimize these risks.

Examples of Federal, State, Regional, and Local Efforts to Support Hazard Mitigation and Climate Adaptation in Massachusetts

Below are examples of efforts being conducted by the Commonwealth and others that support the state's efforts on hazard mitigation and climate adaptation (as identified by survey respondents and document review). For a more comprehensive list, see Appendix 4.A.

- BEH Environmental Toxicology Program Statewide Survey of Local Health Department Capacity to Address the Health Impacts of Climate Change
- Bureau of the State House Hazards and Vulnerabilities Assessment
- Cape Cod Climate Action Plan
- Community Wildfire Protection Plans
- DCAMM Climate Resilience Checklist and the Asset Risk Ratings
- DCR Charles River Vegetation Management Plan
- DCR Forest Action Plan
- DCR Forest Cutting Practices Act
- DCR Land Protection Strategy
- DCR Office of Cultural Resources Cultural Resources Inventory
- DCR Standards for Trail Crossings
- DCR Watershed Protection Plan
- DER Restoration Potential Model tool
- DMF Boating Infrastructure Grants
- DMF Clean Vessel Act
- DoD Climate Assessment Tool
- DOER State Energy Security Plan
- EOEEA 2022 MA Climate Assessment
- EOEEA 2025/2030 Clean Energy and Climate Plan
- EOEEA 2050 Clean Energy and Climate Plan
- EOEEA Healthy Soils Action Plan
- EOEEA Resilient Land Initiative
- EOEEA Statewide Comprehensive Outdoor Recreation Plan Massachusetts Coast Flood Risk Model
- Massachusetts Local Food Action Plan
- Massachusetts Silver Jackets Team
- Massachusetts Threat Hazard Identification and Risk Assessment
- MassDEP Asset Management Planning Grant Program
- MassDEP Climate and Hydrologic Risk Project
- MassDOT & DEP Statewide River Hydraulic Model
- MassDOT Aeronautics Drone Program
- MassDOT fluvial geomorphology training program
- MassDOT Pilot Deerfield Watershed Vulnerability Assessment
- MassDOT Transportation Asset Vulnerability Assessment
- MassECAN Coldwater Habitat Working Group
- MassECAN Salt Marsh Working Group
- MassWildlife Prescribed Fire Plans
- MassWildlife Project Screening Tool
- MassWildlife State Wildlife Action Plan
- MDAR Farmland Action Plan
- MEMA Comprehensive Emergency Management Plan
- MEMA Local Hazard Mitigation Planning Program
- MEMA Massachusetts State Hazard Mitigation and Climate Adaptation Plan
- MEPA Interim Climate Adaptation and Resiliency Policy
- National Fish, Wildlife, and Plants Climate Adaptation Network
- National Wildlife Federation's Climate Adaptation for DoD Natural Resource Managers Guide
- Northeast Climate Change Working Group
- Special Legislative Commission on Ocean Acidification's Report

4.1.2.2.4 Current Obstacles, Challenges, and Needs

Below are existing barriers to an agency's ability to reduce risks to agency assets, functions, missions, services and programs, and service populations and customers

through hazard mitigation and climate adaptation actions designed to increase climate and hazard resilience.

The key challenges state agencies face to effectively address hazard mitigation and climate adaptation are:

- **Funding.** Agencies have limited capital and operating budgets to address hazard mitigation and climate adaptation. Agencies need more funding from all sources, including federal, state, and grant funding to support specific projects and programs, as well as broader hiring, planning, research, and implementation.
- **Staff.** Many agencies do not have adequate staff to address hazard mitigation and climate adaptation. Difficulties include limited financial resources to support additional staff, challenges hiring and retaining qualified staff, and general staffing shortages. For those staff that do work on hazard mitigation and climate adaptation, often this is not their full-time responsibility but rather one of many priorities they must fit into an already significant workload.
- **Expertise and skills.** Agencies need additional hazard and climate expertise in topics including information technology, climate adaptation, resilience assessments, LIght Detection and Ranging (LIDAR) analysis, disaster recovery planning, water resources and hydrology, flooding and droughts, water use and efficiency across multiple sectors, nexus between land use development and water, stormwater management, and marine fisheries and aquaculture.
- **Data and information.** Agencies lack climate-specific information including climate modeling data, climate science and resilience data and metrics, and communication and engagement strategies about climate change and adaptation, as well as current and future risk. Additionally, agencies need to conduct assessments such as surveys, risk analyses, and vulnerability assessments to generate information on the specific hazards they face and impacts on environmental justice and other priority populations, such as developing overlays on increased flooding vulnerabilities across the Commonwealth and, in particular, where vulnerabilities intersect with at-risk populations. Agencies also need to create and update data repositories, such as statewide databases on water use and management in multiple sectors (e.g., municipal, district, commercial, institutional, industrial, public sector). Data for strategic planning that integrates considerations of hazard mitigation and climate adaptation is also lacking, including data for master planning, budgets and grants, geographic information systems (GIS), and asset management.

Similarly, the top challenges of current interagency collaborations and partnerships (as identified by surveyed agency representatives) included staffing/skills, authority/ bureaucracy, funding, data (including data communication), and coordination.

In addition to the obstacles, challenges, and needs described above, it is important to consider the effects that constrained state agency resources have on environmental

justice and other priority populations. Many communities that have faced past discrimination, environmental and social injustice, and a lack of investment are at greater risk from hazards and climate change at both a community and individual level. With limited resources to reduce risks and increase resilience, these communities will continue to face disproportionate risks, which will increase with climate change. This issue must be assessed when evaluating the resources available to advance hazard mitigation and climate adaptation, including where to prioritize any available resources.

4.1.2.2.5 Funding Sources for Hazard Mitigation and Climate Adaptation Actions

Given the hazards that are most consequential for Massachusetts and the geographies and physical and non-physical assets at risk, the Commonwealth should focus on funding sources available to reduce coastal and inland flood risk, address invasive species, provide resources to prepare for extreme heat and wildfire risks, and build resilience for coastal resources. Federal funding programs and agencies that support these issues include NOAA and U.S. Environmental Protection Agency funds for coastal and wetland resilience, as well as green infrastructure strategies. The U.S. Department of Agriculture has federal programs to address invasive species through its National Invasive Species Information Center. In addition, urban heat island funding is available through the Inflation Reduction Act's Neighborhood Access and Equity Grants, which include funding for transportation improvements and heat mitigation projects, and the U.S. Forest Service's Urban and Community Forestry Program, which is also receiving substantial funding from the Inflation Reduction. With a significant amount of infrastructure at risk, the Commonwealth should prioritize funding sources for transportation projects, such as the U.S. Department of Transportation's Rebuilding American Infrastructure with Sustainability and Equity program and its Infrastructure for Rebuilding America program. Some funding sources that can be used to address inland flood risk include U.S. Housing and Urban Development grants, as well as grants available through the U.S. Environmental Protection Agency.

For a more comprehensive view of funding options, Appendix 4.C showcases a funding database for the 2023 MA SHMCAP that builds on a federal resilience funding study conducted by EOEEA in 2021. This funding database provides an inventory of existing federal, state, local, and private funding sources that could support climate adaptation and hazard mitigation). The inventory includes information for each funding source, including the funding source focus (climate adaptation, hazard mitigation, or both), a brief description, the administering body, relevant sectors, and if the funding source includes a focus on social vulnerabilities.

4.1.2.2.6 Opportunities and Ways to Address Resource Needs

This section highlights identified opportunities or ways to address resource needs to increase the adaptive capacity of an agency or an interagency collaboration or partnership to reduce risks and increase resilience.

To help address the challenges above, agency representatives that answered the survey identified ways the Commonwealth can increase capacity and capabilities to support risk reduction and increase resilience. Agencies and interagency collaborations or partnerships can leverage some available resources to reduce climate risks and direct existing capabilities toward updated approaches. In addition, opportunities exist across multiple focus areas to increase the capacity of agencies and interagency collaborations or partnerships to reduce climate risks and improve resilience. See Table 4-4 for more details.

Table 4-4. Summary of Key Opportunities

Key Opportunities
Staff, Skills, and Expertise
Ensure hazard mitigation and climate adaptation staff positions are competitive; write job announcements to attract skills and experience that is currently limited or lacking (rather than general environmental science or policy); develop positions with higher salary caps to attract and maintain qualified full-time employees; ensure that funding is available for ongoing training, conferences, and learning opportunities that provide knowledge transfer and information on best practices and best available data and professional development with others in similar positions across the country. **Invest in full-time, dedicated staff with expertise in key knowledge areas, technical skills, and/or competencies** in hazard mitigation and climate adaptation, as well as contractor and consultant support where necessary to increase capacity for major projects or technical and scientific expertise. Staff expertise in areas identified by state agencies as current gaps (e.g., GIS data and mapping, information technology, climate adaptation, resilience assessments, LIDAR analysis, disaster recovery planning, water resources and hydrology, flooding and droughts, water use and efficiency across multiple sectors, the nexus between land use development and water, stormwater management, and marine fisheries and aquaculture) can be further developed through trainings, seminars, partnerships with nonprofits and academic institutions, as well as peer-to-peer learning with other agencies, states, and federal partners to address capacity limitations and increase staff capabilities over time. **Add more full-time staff with hazard mitigation and climate resilience expertise within agencies responsible for critical physical and non-physical assets and functions** in order to support assessments; planning; program development; funding strategies; operations and maintenance changes; repair and replacement strategies; development of regulations, policies, and design and construction standards; and other efforts to increase resilience within and across agencies in Massachusetts. Bringing hazard mitigation and climate adaptation experience in house will allow these agencies to integrate risk reduction into all parts of their planning, funding, maintenance and operations, staffing, and decision-making, as well as provide resources that enable informed engagement and collaboration on these issues across state agencies and with local and regional organizations.
Authority and Bureaucracy
Building on Executive Order 604, coordinate with the Office of Climate Innovation and Resilience and the Climate Chief to set long-range goals, objectives, and priorities for hazard

Key Opportunities

mitigation and climate adaptation for the Commonwealth to provide guidance across and within state agencies. Engage with the Office of Climate Innovation and Resilience to focus on advancing global actions that will unlock state, regional, and local capacity to reduce risks from the most urgent and consequential impacts and vulnerabilities. Based on the findings regarding Massachusetts vulnerabilities, consequences, and needs, there are several areas that would benefit from focus and support from the Office of Climate Innovation and Resilience. These areas include:

- Advancing the science and research on the effects of sea level rise and climate change on coastal erosion rates and the impact of drought and sea level rise on groundwater, in addition to building off recent research to better understand inland flood risk.
- Providing technical support and capacity building to state agencies that lack the resources to integrate hazard mitigation and climate adaptation into their core responsibilities, particularly those with roles in public health and social and child services, as well as public safety.
- Based on the cultural and economic importance of Massachusetts' natural resources, including agriculture and fisheries, initiate a statewide natural and working lands and waters plan to develop system-scale climate resilience for these resources.
- Work with state agencies to develop and adopt resilient codes and standards for new buildings and infrastructure and for retrofits and lifecycle replacements that would reduce system- and network-scale risks from coastal and inland flooding, high winds, extreme temperatures, and other likely and consequential hazards.
- Develop a prioritization approach for state funding and support that ensures that funds go to agencies, municipalities, and other organizations that are factoring social vulnerability and environmental justice objectives into hazard mitigation and climate adaptation programs, policies, funding, regulations, and other efforts.
- Consider developing a response plan for geographic areas, critical assets, or lifeline networks and systems that are at high risk for damage, disruption, or loss to provide a clear roadmap for rebuilding and repairs to critical assets.

Continue cross-agency participation and engage with the Office of Climate Innovation and Resilience in developing new or amending existing regulatory, policy, and design and construction standards; zoning and code requirements; and other efforts that could significantly increase hazard and climate resilience in the Commonwealth, especially environmental justice and other priority populations. Building on an increased understanding of climate change impacts from the 2022 MA Climate Assessment and improved collaboration of state agencies through the development of the RMAT, identify actions agencies can take together to reduce risks to critical systems and assets such as affordable housing, transportation, energy, and flood management infrastructure. Move beyond agency strengths in emergency response and preparedness and focus on actions to advance pre-disaster resilience and adaptation to increasing risks due to climate change, which will reduce the costs, risks to public safety, and time that it takes to recover from a disaster or climate impact.

Work with the Office of Climate Innovation and Resilience to write new legislative language that supports agency coordination and partnership, including sharing assets (e.g., equipment to maintain or restore access to critical roads, emergency lifelines, and community facilities; management of natural resources; other specialized equipment), sharing resources (e.g., outreach and education best practices, staff resources, contracting capacity, technical expertise, federal relationships), and leveraging funding and phasing work to increase the associated benefits (e.g.,

Key Opportunities
engaging community and interested parties together, conducting mutually beneficial projects together such as wetlands restoration efforts in combination with transportation resilience projects, designing research to benefit multiple agencies) in an efficient, easy, and cost-effective manner. **Continue emphasizing the need to track and quantify the impact of past, current and projected impacts of hazards** and climate change and the outcomes of hazard mitigation and climate adaptation efforts through the Office of Climate Innovation and Resilience. Develop a tool that provides a way to track impacts of hazards to state assets and services in a post-hazard evaluation of extent of damage, length of disruptions, and amount and type of loss. Include progress toward reducing risks through pre-disaster actions led by state agencies, and support and identify the assets, populations, services, geographies, and additional benefits of each pre-disaster action. Use this tool to provide critical post-disaster data and metrics, identify pre-disaster benefits, and track progress on reducing risks to the Commonwealth across physical, social, and economic dimensions using the 2022 MA Climate Assessment priority impacts and vulnerabilities to inform key objectives. Some examples of such tools include Scotland's use of indicators and trends to assess progress on how well the country is measuring the impacts of climate change, C40s Monitoring, Evaluation, and Reporting Framework, or simpler frameworks that focus on tracking progress toward the 2022 MA Climate Assessment priority impacts and the 2023 MA SHMCAP goals.
Funding
Prioritize annual agency funding to support staffing, operations, and programming needs focused on hazard mitigation and climate adaptation efforts, including for specific projects and programs, hiring, planning, research, implementation, and capacity strengthening of local jurisdictions. While harder to plan around and count on, agencies can use federal, state, and private grants to support hazards and climate work. **Create a state-appropriated funding source** that eliminates restrictions or barriers to agency actions on hazard mitigation and climate adaptation. Leverage, facilitate, and implement effective hazard mitigation and climate adaptation strategies at local, regional, and state scales (e.g., implementation of the $14.9 billion committed to investing in the Commonwealth's capital needs over the next five years from the 2023–2027 Capital Investment Plan, the 2021 amending of An Act Creating a Next-Generation Roadmap for Massachusetts Climate Policy).
Data and Communication
Encourage consistent collection and use of data. Effective data management and information technology structures are essential to assess, evaluate, adopt, implement, monitor, and track hazard mitigation and climate adaptation efforts and actions. Existing tools, such as the MA SHMCAP, the 2022 MA Climate Assessment, and the Climate Resilience Design Standards and Guidance Tool, can be used for consistent direction and guidance across diverse agencies. Many agencies are already conducting studies or developing plans on hazard mitigation and climate adaptation, which will generate data, information, and findings that will be useful to the agencies across state and local governments in the Commonwealth. **Conduct a statewide loss avoidance study** to help quantify the losses avoided (e.g., damage prevented, benefits) due to the implementation of the Commonwealth's hazard mitigation and climate adaptation projects, as well as to help run scenarios of the different risks and vulnerabilities

Key Opportunities
associated with varying implementation strategies. For example, given that most agencies do not currently analyze the social and economic costs avoided by reducing risk, conducting these analyses can provide key information to support operational change and make it more compelling. As of January 2023, MEMA is currently in the early stages of designing a loss avoidance study for HMA projects; however, the Commonwealth could benefit from a statewide loss avoidance study. **Address data and information gaps by investing and supporting studies to collect and assess climate-specific information,** including climate modeling data, climate science and resilience data and metrics, and communication and engagement strategies about climate change and adaptation, as well as current and future risk. Conduct assessments such as surveys, risk analyses, and vulnerability assessments to generate information on the specific hazards agencies face and the impacts on environmental justice and other priority populations. **Create and update data repositories,** such as statewide databases on water use and management in multiple sectors (e.g., municipal, district, commercial, institutional, industrial, public). Ensure data are available and accessible for strategic planning that integrates considerations of hazard mitigation and climate adaptation, including for master planning, budgets and grants, GIS, and asset management. **Increase use of Climate Resilience Design Standards and Guidance Tool** to facilitate consistency across state agencies and incorporate climate resilience into capital planning processes and grant-making for local capital projects, as well as overall project design and implementation.
Coordination and Capacity-Building
Ensure at least one full-time, permanent staff position for all state agencies, such as a climate resilience officer, dedicated to interagency coordination of hazard mitigation and climate adaptation for each state agency and among partners, as well as setting formalized and routine meetings. **Build local capabilities by providing tools and technical support** to local jurisdictions, Tribal Nations, and Indigenous communities. Opportunities for the state's capabilities to support hazard mitigation and climate adaptation efforts more holistically and comprehensively in these communities include: • Promote using the 2022 MA Climate Assessment to understand the priority risks and impacts within these communities. • Leverage the Commonwealth's MVP Program and its technical assistance, training, and other resources. • Increase awareness and accessibility of guidance, grant funding, and technical assistance to local communities where it is needed most. • Share adequate and reliable information about hazards and climate projections, as well as best practices and tools on interpreting and translating the data for local agencies.

4.1.2.3 The National Flood Insurance Program in Massachusetts

The Water Resources Commission staff at the DCR Office of Water Resources' FHMP is the state coordinating office for the NFIP. The NFIP is a federal program that makes flood

insurance available in communities that agree to adopt floodplain management regulations that will reduce future flood damage. The program is intended to be a partnership between the federal government, states, and participating local jurisdictions. Congress created the NFIP in 1968 through the National Flood Insurance Act, which was passed to address the fact that homeowner's insurance did not usually cover flood damage, leaving much of the burden of flood recovery to taxpayers and individual homeowners through federal disaster relief programs. NFIP flood insurance is available virtually anywhere, with limited exceptions (e.g., buildings entirely underground or entirely over water are not insurable), in an NFIP participating community, regardless of the flood risk zone. Federal law requires that flood insurance be purchased as a condition of federally insured financing used for purchasing buildings in an identified Special Flood Hazard Area (SFHA), which is the area subject to inundation from the 1 percent annual chance flood (also known as the base flood or the 100-year flood).

Currently, 341 out of 351 Massachusetts communities participate in the NFIP. As of December 2022, there were more than 53,000 NFIP policies in place, with $14,352,713,100 in total insurance coverage and $69.6 million in annual premiums paid. From 1978 to 2021, there have been more than 34,500 total claims, and more than $422.7 million has been paid for insured flood losses. For the sake of comparison, Louisiana has the most claims with the program, at 478,779 between 1978 and 2021.

FHMP staff work with FEMA and officials from NFIP-participating local communities to implement the NFIP in Massachusetts. The FHMP is a technical assistance program and has no regulatory authority, but staff provide a range of assistance to local communities in support of their floodplain management efforts. This assistance includes, but is not limited to, the following activities:

- Conducting Community Assistance Visits and Community Assistance Contacts in coordination with FEMA, as well as supporting the FEMA Region 1 Risk Analysis Branch with mapping updates.
- Supporting FEMA in local compliance matters.
- Providing support to local governments for bylaw compliance and adoption processes.
- Conducting and/or supporting technical workshops and training events for local officials and supporting communities participating in the Community Rating System (CRS) program with the program's higher standards and with CRS compliance documentation.
- Providing on-call and as-needed assistance to all interested parties on issues such as the NFIP, floodplain management, floodplain building requirements, floodplain mapping, flood mitigation, and flood insurance.
- Reviewing floodplain development proposals through MEPA and supporting partners with other state agency grantors such as MEMA, CZM, DER, and EOEEA (e.g., the MVP Program).

- Coordinating with other state and federal agencies on floodplain development issues.
- Supporting MEMA and local governments during post-flood activities.

FHMP staff also support and work with state agencies on revisions or improvements to applicable state regulations, such as the MSBC and WPA. FHMP staff also offer expert testimony at Building Code Advisory Board hearings regarding floodplain variance requests. Program staff are also heavily engaged with state hazard mitigation and climate adaptation planning and project activities in concert with MEMA. In addition to working within the Commonwealth to advance best floodplain management practices, the FHMP looks for opportunities to coordinate with federal agencies such as the U.S. Geological Survey and U.S. Army Corps of Engineers for effective floodplain and flood event work.

Snapshot of Structures at High Risk of Flooding (Repetitive Loss Structures)

FEMA defines a repetitive loss (RL) structure as "any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any 10-year rolling period since 1978". As of July 2022, there are 3,529 structures designated as RL structures in Massachusetts, and 499 of these are severe repetitive loss (SRL) structures[3] (see Table 4-5 for the top 10 communities with RL and SRL structures). Other than Billerica, all top 10 communities are in the coastal zone. An example of an effort underway to reduce the number of these structures is a MEMA effort to conduct a structure-level analysis of buildings impacted by flooding using the Massachusetts Coast Flood Risk Model.

Table 4-5. Top 10 MA Communities with RL and SRL Structures (as of December 2022)

Community	Number of RL Structures
1. Scituate	553
2. Revere	303
3. Hull	262
4. Marshfield	207
5. Quincy	206
6. Winthrop	156
7. Nantucket	79
8. Duxbury	66
9. Billerica	50
10. Nahant	49
Community	**Number of SRL Structures**

[3] As defined by the Flood Insurance Reform Act of 2004, an SRLs is a one- to four-family residence that has had four or more claims of more than $5,000 or at least two claims that cumulatively exceed the building's value.

Community	Number of RL Structures
1. Scituate	159
2. Marshfield	43
3. Revere	36
4. Hull	33
5. Quincy	22
6. Peabody	17
7. Nahant	13
8. Nantucket	11
9. Duxbury	11
10. Winthrop	11

Source: Massachusetts Emergency Management Agency—Mike Enko, personal communication, January 24, 2023.

4.1.2.3.1 Flood Insurance Rate Maps

FEMA produces FIRMs based on technical studies that identify and map the SFHAs where development is regulated in order to reduce flood risk. As mentioned above, the SFHA determines where flood insurance is required as a condition of a federally insured loan through the NFIP mandatory purchase requirement. The geographic boundaries of the SFHA determine where NFIP floodplain management requirements must be enforced by jurisdictions and governments that participate in the program. These requirements include design and construction standards as codified in state regulations and per local flood damage prevention ordinances in compliance with minimum NFIP standards.

FIRMs are made available to view through online mapping viewers or downloadable files provided through municipal websites, publicly accessible computer stations, and/or links from FEMA's Map Service Center website. FIRM maps can be amended or revised through a process (e.g., letter of map amendment, letter of map revision, letter of map change) intended to reflect existing topography or changes in flood characteristics.

4.1.2.3.2 Risk Mapping, Assessment, and Planning

Risk Mapping, Assessment, and Planning (Risk MAP) is a FEMA program that builds on the products of the Flood Map Modernization Program that was created in 2004 to update, modernize, and digitize the nation's flood maps. FEMA's Risk MAP products are nonregulatory resources that supplement the flood hazard information produced by the regulatory FIRMs, the Flood Insurance Study, and FIRM database products.

Examples of FEMA's Risk MAP efforts in the Commonwealth include:

- Development of a discovery report for the Middle Connecticut watershed (i.e., the Connecticut River and surrounding Massachusetts counties of Franklin, Hampden, Hampshire, and Worcester), completed in March 2020. Discovery is the first step in a Risk MAP process and during this phase, FEMA works with local jurisdictions, communities, and other interested parties to collect community knowledge, apply the best scientific knowledge for the area, and identify areas where the risks and consequences from flooding may be greatest. Discovery meetings for the Middle Connecticut watershed took place in November 2018, and a discovery report was issued in March 2020.
- Discovery meetings took place in January 2019 for the Deerfield River watershed. In December 2020, FEMA provided notification of the Deerfield River Watershed study, and in November 2022 held Study Work Map meetings.
- FEMA has created a Coastal Erosion Hazard Map for Region 1, including coastal communities in Massachusetts such as Barnstable, Dukes, Nantucket, Plymouth, Essex, Suffolk, and Norfolk counties. The nonregulatory study included projections of the extent of coastal erosion by the years 2030, 2050, and 2100 along the coast of New England, including Massachusetts. FEMA completed a coastal erosion hazard mapping pilot study in Nantucket in 2019, as well as in Rockingham County, New Hampshire, in 2022. FEMA also conducted community outreach on June 26, 2018, to discuss the coastal erosion hazard mapping in Nantucket.
- FEMA is updating flood hazard determinations for communities of the Quinebaug River watershed across counties in Massachusetts, Connecticut, and Rhode Island. FEMA completed its field survey and hydrologic analysis at the end of 2017. Hydraulic analysis was completed in late 2018 and floodplain mapping commenced shortly after. On December 21, 2021, a notice in the Federal Register was published indicating the preliminary FIRMs and Flood Insurance Studies have been issued for communities in the Quinebaug watershed. FEMA collected comments on the proposed flood hazard determinations by March 2022. The 90-day appeal period ran from April 21 till July 20, 2022.
- The Charles River watershed community work map review meeting occurred on July 9 and 10, 2018. The comment period ended on August 10, 2018. Several communities have requested and were granted extensions for providing comments. FEMA released preliminary revised FIRMs for the Charles watershed in June 2020. FEMA collected feedback during the 90-day appeal period from March 2021 to June 2021.
- For the Merrimack River watershed, FEMA conducted analysis of draft maps throughout 2017 and 2018. Draft work maps were reviewed by FEMA, Massachusetts, and New Hampshire in late fall 2018. Community outreach for the work map review meeting proceeded approximately six weeks later. Community meetings to review work map changes were held in July 2019.
- FEMA issued revised Cape Cod watershed FIRMs in July 2021.

- FEMA completed a discovery project for the Nashua River watershed in 2016. Surveying and base-level engineering are completed. Hydrology and hydraulics were completed in fall 2018. Updated flood analyses were completed in spring 2019, and community meetings to review work maps were held in November 2019.

4.1.2.3.3 Community Rating System

CRS is a voluntary FEMA program within the NFIP that encourages floodplain management activities that exceed minimum NFIP requirements. Flood insurance premiums are discounted to reflect the reduced flood risk resulting from community actions to meet the following CRS goals:

- Reduce and avoid flood damage to insurable property.
- Strengthen and support the insurance aspects of the NFIP.
- Foster comprehensive floodplain management.

For participating communities, flood insurance premium rates are discounted in increments of 5 percent. The discount given depends on a community's designated CRS Class, determined by credit points awarded for flood management activities, with greater discounts given to communities conducting more activities. For example, a Class 1 community receives a 45 percent premium discount, while a Class 9 community receives a 5 percent discount. Class 10 communities are those that were once in the CRS program but have not continued to provide documentation to remain in the program; they receive no discount. The CRS classes are based on 19 activities in the following categories:

- Public information activities
- Mapping and regulations
- Flood damage reduction activities
- Warning and response

As of October 1, 2022, there are 22 Massachusetts communities actively participating in the CRS program, as listed in Table 4-6. The CRS classifications in Massachusetts currently range from Class 9 (5 percent discount) to Class 7 (15 percent discount). FEMA updates these classifications semiannually in May and October of each year.

Table 4-6. Participating CRS Communities in Massachusetts (as of 10/1/22)

NFIP #	Community	CRS Entry Date	Current Effective Date	Current Class	% Discount for SFHA	% Discount for Non-SFHA
250233	Braintree	10/1/92	05/1/18	7	15	5
250003	Brewster	05/1/18	05/1/18	9	5	5
250186	Cambridge	10/1/15	10/1/15	9	5	5

NFIP #	Community	CRS Entry Date	Current Effective Date	Current Class	% Discount for SFHA	% Discount for Non-SFHA
250004	Chatham	10/1/92	10/1/2022	7	15	5
250006	Eastham	10/1/17	10/1/17	8	10	5
250008	Harwich	10/1/95	05/1/20	7	15	5
250085	Haverhill	10/1/92	10/1/92	9	5	5
250269	Hull	05/1/08	10/1/18	7	15	5
250273	Marshfield	10/1/15	10/1/20	7	15	5
250009	Mashpee	10/1/17	10/1/17	8	10	5
250167	Northampton	05/1/17	05/1/17	8	10	5
250060	Norton	10/1/91	10/1/91	9	5	5
250010	Orleans	10/1/93	10/1/18	7	15	5
250278	Plymouth	10/1/91	10/1/91	9	5	5
255218	Provincetown	10/1/11	04/1/21	8	10	5
255219	Quincy	10/1/93	05/1/19	7	15	5
250103	Salisbury	05/1/16	05/1/16	8	10	5
250012	Sandwich	05/1/19	05/1/19	7	15	5
250282	Scituate	10/1/91	05/1/17	7	15	5
250014	Wellfleet	05/1/17	05/1/17	8	10	5
250228	Winchester	10/1/13	05/1/18	7	15	5
250349	Worcester	10/1/95	10/1/20	7	15	5

4.1.2.3.4 CRS Credit for Local Higher Standards Activities and Requirements

The CRS program provides credit to communities that enforce certain state laws, regulations, and standards regarding local floodplain management within the state that have proven effective in reducing flood damage. State-based credit is awarded to communities for activities that are implemented and enforced by the local community (e.g., freeboard standards in the MSBC). This type of CRS credit is verified by Insurance Services Office, Inc., annually.

4.1.2.4 Administering FEMA Mitigation Programs

4.1.2.4.1 Hazard Mitigation Assistance

Currently, there are four HMA programs available to states through FEMA that provide funding for eligible mitigation planning and projects that reduce disaster losses and protect life and property from future disaster damages. The four programs are:

- **Hazard Mitigation Grant Program (HMGP).** Assists in implementing long-term hazard mitigation planning and projects following a major Presidentially Declared Disaster. **HMGP Post-Fire** assistance is available to communities that have been impacted specifically by wildfire disasters. HMGP funding is generally 15 percent of the total amount of federal assistance provided to a state, territory, or federally recognized Tribe following a major disaster declaration.
- **Building Resilient Infrastructure and Communities (BRIC) program.** Prioritizes proactive investments in community resilience through public infrastructure projects, nature-based solutions, the adoption of modern building codes, as well as projects that support essential government and business services. BRIC is currently funded as a 6 percent set-aside taken from federal post-disaster grant funds.
- **Flood Mitigation Assistance (FMA) programs.** Provide funds for mitigation planning and projects on an annual basis, with a focus on reducing flood hazard risks to buildings that are insured under the NFIP. FMA funding depends on the amount Congress appropriates each year to the program.
- **Pre-Disaster Mitigation (PDM) program.** Was effectively replaced by BRIC in FY 2020, though PDM grants made during FY 2019 and earlier continue to be managed under this program. However, the Consolidated Appropriations Act of 2022 authorized $154 million in federal funding for 68 PDM projects designed to reduce risks from natural disasters.

Although FEMA's HMA programs are federally funded and managed, they must be administered by the state (i.e., Recipient), which in turn coordinates with eligible sub-applicants (i.e., Subrecipients). FEMA must regularly certify that a state has demonstrated it has the capability to effectively manage FEMA-funded HMA grant programs.

Since 1991, Massachusetts has supported more than 465 hazard mitigation projects and plans with more than $128 million in federal funding from pre-disaster and post-disaster hazard mitigation grant programs, as summarized in Table 4-7 and Table 4-8 below. Since 2018, nearly three-quarters of projects related to FEMA-assigned disaster numbers 4372, 4379, and 4496 were focused on new or updated local hazard mitigation plans, with a few projects focused on critical facility updates (e.g., replacement generators), infrastructure retrofits to build resilience, and localized flood risk reduction (e.g., culvert replacements). A statewide losses avoided study (as mentioned under "Opportunities and Ways to Address Resource Needs" in Section 4.1.2.2 above) can help highlight how much the Commonwealth saved from implementing these projects.

Table 4-7. Summary of Mitigation Projects Funded Through Post-Disaster Grant Programs

Disaster Event	Disaster Number	Federal Fundinga	# of Projects
Hazard Mitigation Grant Program			
Hurricane Bob, August 1991	914	$651,881	16
Winter Storm, October 1991	920	$621,066	10
Winter Storm, December 1992	975	$322,963	7
Flooding, October 1996	1142	$11,891,758	35
Flooding, June 1998	1224	$1,669,157	18
Flooding, April 2001	1364	$1,615,134	14
Flooding, April 2004	1512	$8,570	1
Flooding, October 2005	1614	$556,944	4
Flooding, May 2006	1642	$1,880,803	12
Nor'easter, April 2007	1701	$439,397	5
Ice Storm, December 2008	1813	$5,612,828	24
Flooding, March 2010	1895	$11,151,438	28
Snowstorm, March 2011	1959	$1,524,502	10
Tornadoes, June 2011	1994	$7,260,627	10
Tropical Storm Irene, September 2011	4028	$4,495,094	7
Snowstorm, January 2012	4051	$9,112,075	20
Hurricane Sandy, October 2012	4097	$1,766,463	5
Snowstorm, February 2013	4110	$3,554,386	21
Snowstorm, January 2015	4214	$9,530,860	22
Nor'easter, March 2018	4372	$2,384,567	7
Nor'easter, March 2018	4379	$1,827,435	11
COVID-19 pandemic, January 2020	4496	$2,841,446	6

Source: Federal Emergency Management Agency (2022).

[a] Federal funding includes project-specific funding as well as obligated administrative costs and management costs.

Table 4-8. Summary of Mitigation Projects Funded Through Non-Disaster Grant Programs

Grant Type	Fiscal Year (FY)	Federal Funding[a]	# of Projects
Flood Mitigation Assistance (FMA)	FY 97	$276,798	4
FMA	FY 98	$310,700	3
FMA	FY 99	$407,501	4
FMA	FY 00	$358,075	8
FMA	FY 01	$110,304	5
FMA	FY 03	$407,277	3
FMA	FY 04	$325,589	3
FMA	FY 05	$321,246	3
FMA	FY 06	$1,300,225	3
FMA	FY 07	$1,070,205	6
FMA	FY 08	$225,720	2
FMA	FY 09	$263,051	2
FMA	FY 10	$51,560	1
FMA	FY 13	$2,155,932	2
FMA	FY 15	$675,410	2
FMA	FY 16	$360,501	2
FMA	FY 17	$185,323	2
FMA	FY 18	$269,918	3
FMA	FY 19	$212,839	2
Pre-Disaster Mitigation (PDM)	FY 00	$400,195	5
PDM	FY 03	$1,125,344	5
PDM	FY 05	$5,297,305	15
PDM	FY 06	$281,325	3
PDM	FY 07	$212,310	4
PDM	FY 08	$4,433,023	7
PDM	FY 09	$678,325	7
PDM	FY 10	$1,449,584	5
PDM	FY 11	$335,764	5

Grant Type	Fiscal Year (FY)	Federal Funding[a]	# of Projects
PDM	FY 13	$288,095	6
PDM	FY 14	$959,377	8
PDM	FY 15	$183,406	6
PDM	FY 16	$651,691	5
PDM	FY 17	$469,885	3
PDM	FY 18	$1,388,069	6
PDM	FY 22	$7,927,196	9
Severe Repetitive Loss (SRL) Program	FY 08	$714,993	2
SRL	FY 12	$301,197	1
Building Resilient Infrastructure and Communities (BRIC)	FY 19	$11,688,944	10

Source: Federal Emergency Management Agency (2022).

[a] Federal funding includes project-specific funding as well as obligated administrative costs and management costs.

Note: This data set contains data from the HMA grant programs that were eliminated by the Disaster Recovery Reform Act of 2018 (i.e., PDM grant program) and by the Biggert Water Flood Insurance Reform Act of 2012 (i.e., the Repetitive Flood Claims grant program and SRL grant program). PDM numbers include PDM and Legislative Pre-Disaster Mitigation grants.

The Commonwealth typically receives applications for amounts far in excess of the amount of available FEMA funding and grants and works closely with applicants to ensure requests are consistent with state and local priorities and that applicants are a good match for the grant. The Commonwealth selects and recommends funding for only the most cost-effective projects.

The Commonwealth has had a FEMA-approved Administrative Plan for HMGP since the federal program was authorized in 1988. Most recently updated in August 2022, the plan was prepared in response to Federal-State Agreement Number FEMA-4651-DR-MA (January 2022 snowstorms) and details the process and criteria for prioritizing post-disaster mitigation funding of local mitigation projects. Massachusetts uses similar criteria to prioritize pre-disaster grant applications (e.g., BRIC, PDM, FMA).

To facilitate effective administration of these hazard mitigation grant programs, MEMA staff provide technical assistance to state agencies, local jurisdictions, and Tribes for

mitigation planning and project applications. The staff generally provide any assistance requested by sub-applicants to complete a successful application.

Since 1997, the Commonwealth has been providing grant funding for local mitigation plans, formerly flood mitigation plans, along with technical support and assistance. Today (as updated in the 2022 HMGP Administration Plan), the State Hazard Mitigation Officer and other members of MEMA help communities working on developing or updating hazard mitigation plans that may be funded through any of FEMA's mitigation grant programs.

In 1999, MEMA developed a comprehensive database to track and monitor all open and completed hazard mitigation project and planning grants funded under the HMGP, FMA, PDM, and U.S. Department of Housing and Urban Development programs. This database has allowed the Commonwealth to track and monitor project and plan timelines and completion dates, as well as track projects and plans by a specific grant program, community, project type, project cost balance, and other related data. For instance, the database allows tracking by project type, such as dam improvements, stormwater management, and elevation.

4.1.2.4.2 Mitigation in Post-Disaster Recovery Operations

Hazard mitigation is an integral part of the Commonwealth's post-disaster recovery operations. Following Presidential Disaster Declarations, staff from the MEMA Mitigation and Recovery Unit co-locate with mitigation staff from FEMA at joint field offices, in addition to staff from other state agencies that may have an interest or jurisdiction in recovery operations. State and FEMA staff work to identify mitigation opportunities that can be leveraged through the Individual Assistance program or through Section 406 of the Public Assistance program, in addition to the subsequent HMGP program.

During post-disaster recovery operations, program staff members often provide mitigation information to disaster survivors. State and federal mitigation staff work together to identify public education needs or opportunities. Public Assistance program staff encourage applicants seeking to repair or rebuild damaged structures and buildings to identify mitigation elements in their projects, including through Public Assistance Section 406. Mitigation and Public Assistance program staff often jointly conduct applicant briefings to discuss mitigation opportunities through both Public Assistance program grants and the HMGP. State mitigation staff quickly disseminate letters of intent and information on the grant opportunities to potential applicants and provide technical assistance for the grant application process.

MEMA's Grant Support Unit ensures all disaster and non-disaster FEMA funding is obligated and disbursed in accordance with all federal, state, and local regulations. Having a singular contracting and fiscal approval process ensures proper fiscal management. The Assistant Director for Mitigation and Recovery also oversees the Grant Support Unit and leads contracting and disbursement, providing seamless coordination with the

implementation of the FEMA Public Assistance, Individual Assistance, and mitigation programs (Public Assistance coordinators review all expenditures).

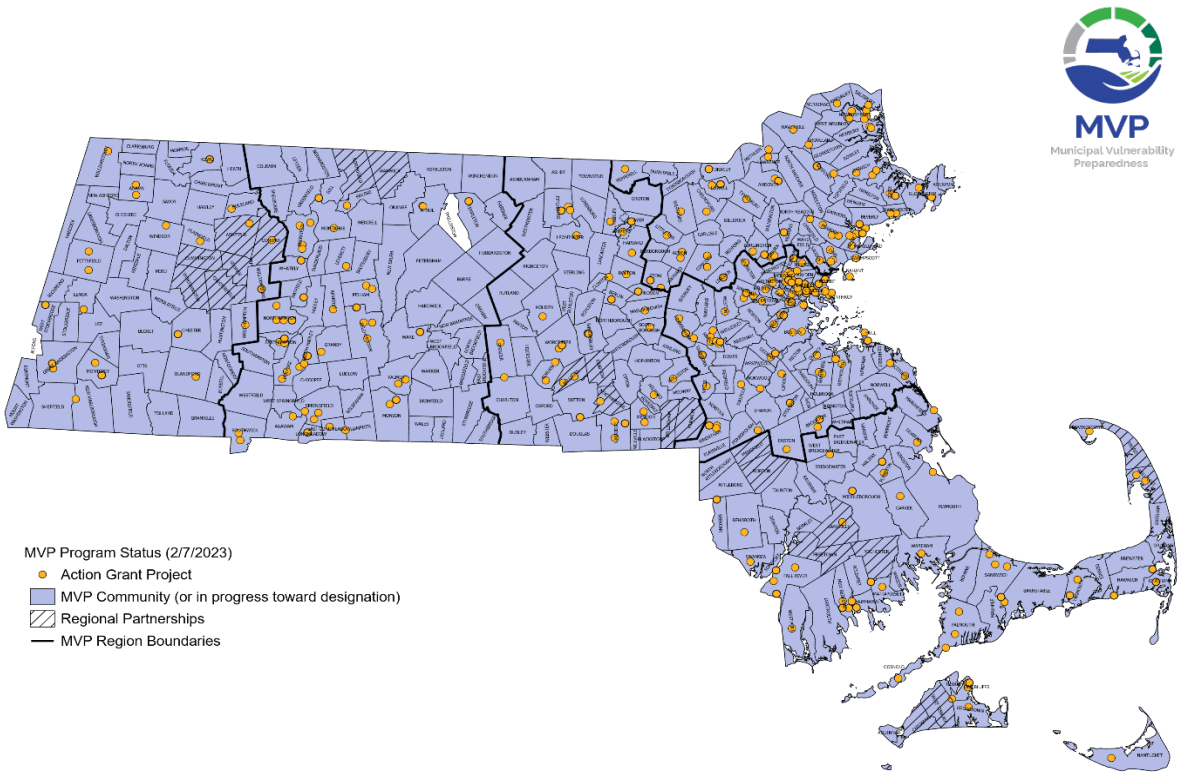
4.1.3 Local Capabilities and Coordination

The local capability assessment is an opportunity for the Commonwealth to examine the effectiveness of local and Tribal governments in hazard mitigation and climate adaptation to reduce risks and build resilience. As a home rule state, Massachusetts cities and towns self-govern and enact their own legislation on many subjects (as long as they align with federal and state law). Even with home rule, some local actions still require state legislature approval, while other local actions are allowed only if the local jurisdictions accept of state statutes. States regularly support local and Tribal governments with reducing risks from hazards and climate change by providing research, modeling, statewide plans and programs to guide mitigation and adaptation action development, training, technical assistance, and funding. This section aims to provide a view of local capabilities across the state.

Overview of Local Jurisdiction Status

The below list highlights the number of jurisdictions that have (1) enrolled in the MVP program as of February 7, 2023; (2) approved local hazard mitigation plans as of December 31, 2022; and (3) have a combined approved local hazard mitigation plan as of December 31, 2022, and are enrolled in the MVP program as of February 7, 2023. The number of jurisdictions meeting these criteria include:

- **349** jurisdictions (99 percent) enrolled in the MVP program. Figure 4-2 below identifies all communities that have achieved MVP designation and the communities in progress of achieving designation in the MVP program as of February 7, 2023.
- **212** jurisdictions (60 percent) have approved local hazard mitigation plans (and/or multijurisdictional hazard mitigation plans).
- **54** jurisdictions (15 percent) have a combined approved local hazard mitigation plan and are enrolled in the MVP program.



Source: MA MVP Program.

Figure 4-2. Map of MVP communities.

Roles of Local Jurisdictions and Tribal Governments

Massachusetts has 351 cities and towns, three federally recognized Tribal Nations, and eight Indigenous communities, each of which develop and enforce local laws and policies related to hazard mitigation and climate adaptation and/or conduct their own local hazard mitigation planning efforts. MGL Title VII: Cities, Towns, and Districts outlines the powers and duties of cities and towns. Included in MGL Chapter 40 are powers related to public authority for construction of public works, growth and development policy committees, public safety mutual aid agreements, municipal waterway improvement and maintenance funds, prevention of forest fires, land purchase conditions and limitations, protection of the water supply, and building permit restrictions.

At the statewide level, Massachusetts created the Commission on Indian Affairs in 1974 to "assist Native American individuals, tribes, and organizations in their relationship with state and local government agencies and to advise the Commonwealth in matters pertaining to Native Americans." In addition, the North American Indian Center of Boston was created in 1969 "to empower the Native American community with the goal of improving the quality of life of Indigenous peoples." The Tribal Nations that are federally recognized by the U.S. Bureau of Indian Affairs have jurisdiction over their reservation lands, meaning the right to self-govern, as well as certain benefits that include funding and services from the bureau and other federal agencies, either directly or through contracts, grants, or compacts. Tribes can develop and organize hazard mitigation plans that best capture their own history, culture, hazards, and mitigation efforts and what works within their governance and tradition.

Indigenous Communities and Federally Recognized Tribal Nations in Massachusetts

- Abenaki Communities
- Chappaquiddick Tribe of the Wampanoag Nation
- Chappaquiddick Tribe of the Wampanoag Nation, Whale Clan
- Chaubunagungamaug Nipmuc Indian Council
- Hassanamisco Nipmuc
- Herring Pond Wampanoag Tribe
- Mashpee Wampanoag Tribe*
- Massachusetts Tribe at Ponkapoag
- Pocasset Wampanoag Tribe
- Stockbridge-Munsee Community Band of Mohican Indians*
- Wampanoag Tribe of Gay Head (Aquinnah)*

*Denotes federally recognized Tribe.

In addition, regional planning agencies frequently support communities with hazard mitigation, climate adaptation, land use, transportation, environmental, water, and utilities planning, and many agencies have extensive GIS capabilities. For example, the Metropolitan Area Planning Council (MAPC) has worked extensively with the 101 cities and towns in the greater Boston area to mitigate risk and adapt to climate change. MAPC's Technical Assistance and District Local Technical Assistance programs provide technical expertise to cities and towns for planning and implementing community-based projects,

which can help advance climate resilience goals. MAPC has supported its communities with developing master plans, hazard mitigation plans, open space plans, and zoning and land use regulations. MAPC conducts research and analysis on hazards and climate change that can support more robust vulnerability and risk assessments at the local level. In 2021, MAPC developed the Municipal Net Zero Playbook, which provides local communities with actionable strategies, tools, and training to achieve their climate goals and reduce carbon emissions efficiently and equitably.

Additionally, metropolitan planning organizations are regional transportation policy-making organizations that help with land use and transportation planning, ensure planning processes are in compliance with federal requirements, and conduct research

and studies. The 13 metropolitan planning organizations in Massachusetts help engage local jurisdictions and other partners and stakeholders in regional decision-making. For example, the Cape Cod Commission, which coordinates transportation planning activities under the Cape Cod Metropolitan Planning Organization, engaged with community stakeholders and partners to update the Regional Policy Plan in 2021 with goals, objectives, and actions that address climate change.

Tribal Mitigation Plan Spotlight: Mashpee Wampanoag Tribe Multi-Hazard Mitigation Plan

In 2019, the Mashpee Wampanoag Tribe developed a multi-hazard mitigation plan that includes the following topics:

- Introduction (including what hazard mitigation can do for the Mashpee Wampanoag Tribe)
- Risk assessment
- Capability assessment
- Mitigation strategy
- Plan implementation and maintenance

In preparing local hazard mitigation plans, many local governments use the following four categories to assess their capabilities, strengths, and challenges: (1) planning and regulatory, (2) administrative and technical, (3) financial, and (4) education and outreach (see Table 4-9). For the purposes of the 2023 MA SHMCAP, the Commonwealth has examined local capabilities in terms of these four categories. The NFIP is included in planning and regulatory. Currently, based on the FEMA 2023 Local Mitigation Planning Policy Guide, plans "must describe the effects of future conditions, including climate change, for the identified hazards, as it relates to location, extent, and probability of future hazard occurrences."

Table 4-9. Categories of Local Capability

Category	Description
Planning and regulatory	Includes capabilities based on the jurisdiction's implementation of ordinances, policies, local laws and state statutes, and plans and programs that relate to guiding and managing growth and development. Also includes plans and policies related to hazards that improve or impede resilience to future hazard events and other future conditions, including the effects of climate change.
Administrative and technical	Includes capabilities associated with the jurisdiction's staff and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions. Also includes processes and tools to support local and Tribal climate mitigation and adaptation plans.
Financial	Refers to the fiscal resources that a jurisdiction has access to or is eligible for in order to fund mitigation actions. Includes public (i.e., federal, state, and local) funding capabilities for hazard mitigation actions and projects.
Education and outreach	Refers to education and outreach programs and methods already in place that jurisdictions could use to implement mitigation activities and communicate hazard-related information.

4.1.3.1 Planning and Regulatory

A local jurisdiction's planning and regulatory policies related to growth and development generally include land use, zoning, utilities, infrastructure, community development, open space and recreation, natural environment and resource management, coastal planning and management, and hazard and risk zoning. Jurisdictions often have many plans that guide the above, including a comprehensive plan, general plan, master plan, specific or community plan, open space and recreation plan, harbor plan, economic development plan, stormwater management plan, historic preservation plan, coastal zone management plan, climate change adaptation plan, and others.

Linking Local and Tribal Mitigation Plans with the MA SHMCAP: Process and Timeframe

Below are the key process steps to receive approval on local and tribal mitigation plans. A full planning process typically takes a year, with up to six months required for FEMA approval and any revisions. Local and tribal communities should look to the MA SHMCAP in the planning and development process of their mitigation plan to align on any relevant mutual goals and objectives. In addition, communities should consider incorporating Traditional Ecological Knowledge when planning for and applying nature-based solutions and management of the natural environment. The steps are:

1. Submit local/tribal plan to MEMA for review, including a completed plan review tool checklist from FEMA.
2. If the local/tribal plan is found to satisfactorily meet all requirement elements, MEMA will send it to FEMA for review. Otherwise, revisions will be required at this step.
3. If FEMA finds the plan satisfactorily meets all required elements, FEMA will issue an Approvable Pending Adoption notice. Otherwise, revisions will be required at this step.
4. Local and tribal communities adopt plans and submit resolutions.
5. FEMA issues approval letter and final review tool to the MEMA. MEMA completes the process by emailing both documents to communities.

Jurisdictions can use planning and zoning along with other regulations and policies to effectively advance hazard mitigation and climate adaptation. For example, the town of Scituate updated its zoning bylaws in 2019 (approved by the Attorney General in 2020) allowing elevation of existing structures to a maximum height of 50 feet to achieve base flood elevation as determined by the current national FIRMs.

Planning boards typically oversee the preparation of comprehensive plans or master plans. They also often coordinate the hazard mitigation and climate adaptation planning process and the implementation of hazard mitigation and/or climate adaptation plans. These boards provide professional expertise in plan development, bylaw drafting, and grant application. A review of local hazard mitigation plans (74 were updated from February 2018 through July 2022) received by the state indicates most local governments minimally include hazards and hazard mitigation in their local comprehensive or master plan. In recent years, communities have begun developing coastal resilience and climate

adaptation plans, as well as incorporating more details on pandemics (e.g., COVID-19) and recent extreme temperatures. For instance, in 2021, the town of Nantucket developed a coastal resilience plan to provide an implementation roadmap for flood control and adaptation approaches. In 2022, the city of Boston prepared a report titled Heat Resilience Solutions for Boston to help prepare the city for hotter summers. It also announced *Coastal Resilience Solutions for East Boston and Charlestown (Phase II),* a framework to understand coastal flood risk, resilience solutions, and implementation timelines for parts of the East Boston and Charlestown coastlines.

A planning board is the primary local vehicle to ensure new development incorporates federal and state best management practices (BMPs). Planning boards maintain floodplain bylaws and ordinances to address current floodplain issues and update them to ensure compliance with state and federal regulations. Planning boards may propose, review, make recommendations, or hold hearings on zoning ordinances and zoning changes. Regulations may be included in building codes, zoning bylaws, subdivision regulations, floodplain regulations, open space preservation, and wetlands regulations.

To encourage communities to adopt BMPs for hazard mitigation and climate adaptation, state agency programs provide technical assistance and funding to municipalities, including the previously mentioned FHMP. Examples include:

- The MVP Program, which provides municipalities with planning and action grants to implement adaptation and resilience strategies.
- CZM's Coastal Resilience Grant Program, which provides grants and technical assistance for local and regional efforts to increase community understanding of coastal storm and climate impacts, evaluate vulnerabilities, conduct adaptation planning, redesign and retrofit vulnerable public facilities and infrastructure, and restore shorelines to enhance natural resources and provide storm damage protection.
- The Community Compact Program, in which communities agree to adopt and implement BMPs in a wide range of municipal services and receive state assistance.
- DOER's Green Community Designation and Grant Program (previously the Green Communities Program), which provides municipalities with funding and technical assistance for energy conservation and efficiency projects to reduce the energy demand of municipal facilities and require communities to adopt ordinances and bylaws for renewable energy siting and the Stretch Code.

Local Planning and Regulatory Support from DCR's FHMP

Examples of FHMP offerings include:

- Substantial damage training/ messaging post-disaster
- 1206 training and assistance
- Training for CRS user groups
- Ordinance or bylaws assistance for floodplain districts
- Technical assistance for floodplain management questions
- Liaison between community and FEMA on mapping activities
- MEPA (and other) project review

- DCR's Floodplain Management Program, which provides multiple types of assistance for local communities. In terms of substantial damage[4] administration, the Massachusetts Local Guidance for NFIP Substantial Damage Planning is a comprehensive guide and tool for communities to assure that certain practices and a post-disaster plan will be in place to implement the substantial improvement/ substantial damage requirements of NFIP and as stated in the MSBC.

Completed in June 2020, the town of Concord's climate action and resilience plan, titled *Sustainable Concord*, maps out a five-year action plan for climate mitigation and adaptation. With $100,095 in supporting grant funds from the MVP Program, the resulting plan includes 22 priority actions organized into five plan elements with goals for each, as well as three leadership priorities. This effort ensured that previous town planning efforts and reports—such as Envision Concord, which is the town's most recent long-range plan, as well as regional studies to identify climate actions and risks—were fully integrated and aligned with the final plan.

Zoning regulations under MGL Chapter 40A give cities and towns the authority to adopt ordinances and bylaws to regulate the use of land, buildings, and structures. Planning boards may recommend land use regulations to protect public health, safety, and welfare, including measures for hazard mitigation and climate adaptation.

Spotlight: Town of Barnstable

The town of Barnstable, the largest town on Cape Cod, is highly susceptible to coastal flooding and erosion. The town has conducted several recent projects to assess the risks posed by flooding and other hazards. In 2019, the Commonwealth designated the town as an MVP Community for its efforts in building community resilience. In 2022, the town completed and formally adopted an updated hazard mitigation plan to replace its 2010 plan. The 2022 plan includes updated vulnerability assessments and plans for mitigation projects to address a variety of climate hazards. Current actions in progress to mitigate flooding include developing additional Coastal Resources Management Plans and pursuing actions to qualify the town for NFIP's CRS. In addition, Barnstable's 2023 coastal resilience project focuses on designing and permitting a preferred alternative solution that uses nature-based measures and reconfigures the Sandy Neck Beach Facility to enhance storm damage protection to infrastructure and natural resources.

MGL 40R encourages "smart growth" to preserve open space, while increasing affordable housing. A smart growth zone must be located either near a transit station, in an area of already-concentrated development, or in another area that—due to transit, infrastructure, or other utilizable resources—is able to support additional growth. A planning board can

[4] As defined by FEMA, substantial damage "applies to a structure in a Special Flood Hazard Area—or floodplain—for which the total cost of repairs is 50 percent or more of the structure's market value before the disaster occurred, regardless of the cause of damage."

adopt its own subdivision rules and regulations without an action at the town meeting. Cities and towns may not adopt higher standards than the Ninth Edition of the MSBC, to help avoid any potential unintended consequences and ensure consistency in standards across the state and competitive advantages in attracting development and investment to the Commonwealth.[5]

Cities and towns in Massachusetts have local boards of health and municipal conservation commissions that take on planning and regulatory responsibilities, as well as administrative and technical responsibilities. Each local community determines the roles of its board of health; some may manage school health programs or assist with community-based health improvement planning, policy and program development, or prevention activities. The local board of health implements the State Environmental Code, including Title 5 relating to sewage disposal. Title 5 protects public health and mitigates losses due to adverse effects of improper sewage treatment in high hazard areas.

Town of Plymouth's Open Space and Recreation Plan: Climate Change Resiliency Addendum

In 2020, the town of Plymouth recognized the need to address potential climate change impacts and created recommendations for increasing resilience and adaptability in the town through a climate change resilience addendum. The town examined the relationships between open space and climate resilience and identified strategies to fulfill the linkages in building and promoting resilience.

Local conservation commissions are required to review development that may impact rivers, streams, ponds, and wetlands. These commissions play a role in enforcing regulations that minimize flood impacts and have primary responsibility for implementing the Massachusetts Rivers Protection Act (MGL Chapter 258; 310 CMR 10.58) and the WPA (MGL Chapter 131, Section 40; 310 CMR 10.00). A conservation commission reviews, approves, or denies applications for any project in the regulatory 100-year floodplain, in the floodplain of a small water body not covered by a FEMA study, or within 100 feet of any wetland or 200 feet of any river or stream (except in the case of densely developed urban areas, where buffers may extend only 25 feet from a river or stream). The Massachusetts Association of Conservation Commissions has guidebooks and model bylaws for local governments to use when enforcing or strengthening their adherence to the WPA.

[5] Massachusetts is in the process of adopting the 2021 edition of the ICC model codes, which is intended to be complete in early 2023.

The Green Communities Act, Chapter 169, signed into law July 2, 2008, increases opportunities for energy efficiency and renewable energy generation, aligns the MSBC with the International Energy Conservation Code, and provides new programs for municipal clean energy development. The Massachusetts Department of Energy's Green Communities Division provides grants, technical assistance, and local support from Regional Coordinators to help municipalities reduce energy use and costs by implementing clean energy projects in municipal buildings, facilities, and schools.

Massachusetts Community Preservation Act

This act encourages cities and towns to undertake the purchase of open space to preserve natural resources. The Commonwealth continues to provide technical assistance to participating communities and other communities interested in adopting the Community Preservation Act. Currently, EOEEA is working with the city of Holyoke's Conservation Commission to ensure any new EOEEA construction does not interfere or impact any of the wetlands on or near the property.

4.1.3.1.1 Current Challenges and Opportunities

Many of the local governments that have submitted FEMA-approved hazard mitigation plans have adequate capacity to implement and monitor the actions in those plans. However, many of the smaller jurisdictions have limited staff or staff who serve multiple roles, meaning they have little capacity to carry out planning activities to build resilience.

Local hazard mitigation plans include a list of mitigation projects or activities for the community to pursue. For instance, the 2021 City of Attleboro Hazard Mitigation Plan Update identifies 47 mitigation actions, and the city of Revere identifies 54 mitigation actions in order of priority. However, many communities struggle with implementing these proposed mitigation measures due to limited administrative or financial capabilities, as further described in this section.

Communities also have a need for regulations and codes that address risk at the local level and a need to direct development away from current and future risk zones. The Commonwealth could play a role in moving this opportunity forward, such as developing incentives, providing funding, designing codes that make local action implementation safer, and conducting further analyses on current regulations and how to improve them. Note that, as mentioned earlier in a Section 4.1.2.1 textbox, starting in 2023, EOHED is implementing a BRIC-funded Massachusetts Building Code Study and Local Floodplain Management Action Guide building code study that will assess the state building codes and develop a guidance document to assist municipalities in taking impactful local action to improve floodplain management standards within their geographic jurisdictions.

Assessing all local planning boards could also be an opportunity to learn, in more detail, the full extent of local jurisdictions' capabilities across the Commonwealth. The responsibility of local conservation commissions, public health boards, and planning boards to mitigate risk provides an opportunity for the Commonwealth to support these

boards with funding, partnership opportunities, access to technical experts and scientific support, peer-to-peer learning opportunities, and other direct and sustained support.

An example of support at the state level is the development of the 2022 MA Climate Assessment, which communities throughout the Commonwealth can use to understand the priority risks and impacts within their communities. There is also an opportunity to foster engagement with environmental justice and other priority populations from the beginning of planning processes. The Commonwealth could help local communities with strategies, best practices, financial support, technical support, maps, data, and communication tools to engage in meaningful ways with socially vulnerable communities (see Section 4.1.3.4, Education and Outreach," for more details).

Example Planning Challenges Identified by Grantees in MVP 2.0 Planning to Action Survey (2021)

The MVP 2.0 Planning to Action process was designed for MVP certified communities to update their previously developed MVP plans (and new communities to develop their first MVP plan). A survey question focused on what support communities need (and related challenges) to be more efficient to move from planning to action.

- Lack of long-term funding and resources for projects from the planning and design stage through to implementation
- Too many planning efforts and not enough on-the-ground action (e.g., plans "sit on a shelf") and feeling of "planning fatigue"
- Limited support to assist local communities from planning to design to action, as well as complex application processes
- Limited engagement with environmental justice and other priority populations in planning processes

4.1.3.2 Administrative and Technical

A local government's ability to mitigate risk and adapt to climate change is affected by the capabilities and capacity of its staff and technical resources. In recognition of that, each Massachusetts community is required to appoint an emergency manager (Chapter 639 of the Acts of 1950) who is primarily responsible for local preparedness, mitigation, response, and recovery, as well as mutual aid for natural and human-caused hazards. Emergency managers play a primary role in developing local comprehensive emergency management plans required by Massachusetts state law, as well as other plans required by MEMA and FEMA. The Commonwealth frequently looks to the local emergency management director as the key point of contact for MEMA- or FEMA-related business. This role is critical for effective outreach and involvement in mitigation planning and grants. One challenge in many communities is that the role of an emergency management director is frequently assigned to an existing full-time employee who has a range of other responsibilities, rather than a separate full-time position. An additional factor related to this responsibility is which department hosts the emergency manager role and how well-integrated that department is with other critical functions such as land use and planning, sustainability,

coastal management, infrastructure, and utilities. These other functions are described below. Integration among all critical functions is important to effective planning, implementation, and monitoring of hazard mitigation and climate adaptation efforts.

Public works departments or water and sewer departments, which are primarily responsible for municipal drainage and stormwater management systems, take the lead in ensuring communities' compliance with the U.S. Environmental Protection Agency's Phase II Stormwater Regulations that relate to the National Pollutant Discharge Elimination System. Because stormwater is one of the major flood hazards in Massachusetts, ongoing maintenance and upgrading of local stormwater systems by public works departments is important to reducing flood risks. Public works staff are integral in implementing local hazard mitigation plans, especially in identifying and implementing local hazard mitigation projects related to infrastructure. Communities have varying degrees of capabilities, although many do maintain a significant level of engineering or public works capability through their own municipal staff, master services agreements, and/or other contractual arrangements with service providers.

Building inspectors implement and enforce the MSBC (specifically, Section 3107, "Flood Resistant Construction"), which incorporates NFIP construction standards. The MSBC includes sections on wind, snow, structural loads, and seismic retrofitting, as well as GHG mitigation via the Stretch Code. It also ensures NFIP standards and other mitigation standards are applied uniformly statewide. Building inspectors also enforce local bylaws, especially to prevent floods. For instance, building inspectors are responsible for administering municipal zoning ordinances, including those that apply to floodplains. Building inspectors also find problems or violations of the MSBC related to hazards other than flooding. Depending on local mitigation plans, administering the NFIP may fall to building inspectors, but also conservation commissions, public works staff, or local planning departments.

When drafting hazard mitigation plans, most communities request a list of RL and SRL properties from MEMA. Communities are then able to include these structures, or their general vicinities, in local risk assessments, as well as identify flood mitigation actions to prevent future losses. Some communities identify and evaluate the need to acquire, elevate, or otherwise floodproof these structures, and many communities will encourage residents to retrofit structures that suffer repeated flood damages.

City of Woburn Local Hazard Mitigation Plan

In 2021, the city of Woburn updated its hazard mitigation plan, prioritizing goals and strategies for dealing with hazards and providing a blueprint for the city to use in prioritizing grant applications and public infrastructure projects. In the summary of RL structures from 1978 to 2020, there were a total of seven properties, 17 losses, and $634,454 in claims.

The Northeast States Emergency Consortium offers no-cost technical assistance to communities to understand and mitigate their risk from hazards. Using programs such as HAZUS (updated in 2022), the consortium can

model impacts of earthquakes, hurricanes, floods, and coastal storm surge. Agencies or organizations interested in obtaining the consortium's assistance with multi-hazard risk mapping can find an application online.

Universities in Massachusetts and across the Northeast are also partners in hazard mitigation and climate adaptation by conducting research on hazards, climate change, and other areas of study, as well as providing technical expertise and scientific studies. For example, the University of Massachusetts system has developed hazard mitigation plans for each of its campuses. It has also participated in the planning process for the communities in which those campuses are located.

4.1.3.2.1 Current Challenges and Opportunities

Example Administrative and Technical Challenges Identified by MVP Grantees

- Lack of necessary staff capabilities to undertake effective grants and projects
- Limited in-house grant writing expertise and technical support around climate projections
- Lack of skilled staff to help with outreach and engagement with environmental justice and other priority populations and the general public

Municipalities in Massachusetts have a high degree of technical and administrative capability, with many local governments supported by experienced staff, citizen volunteers, and external service providers such as regional planning agencies, nonprofit organizations, academic organizations, and private sector businesses. However, many local communities, and especially environmental justice and other priority populations, lack the overall capacity to fully engage in hazard mitigation and climate adaptation planning and implementation due to a lack of time and experience, as well as a lack of access to adequate resources. The Commonwealth's MVP Program is one of the solutions to these challenges and supports local governments by providing technical assistance, training, and other resources concerning new hazard mitigation measures, as well as encouraging and increasing the local enforcement of sound building practices. Additionally, MAPC's technical assistance programming provides communities and municipalities with tools and resources they can use to conduct climate vulnerability assessments, update hazard mitigation plans, and develop climate-resilient land use and zoning regulations. For coastal communities, the CZM Coastal Resilience Grant Program can help support plans, assessments, and analyses that bolster coastal resilience and mitigate hazards such as erosion, storm damage, and flooding.

4.1.3.3 Financial

"Financial capabilities" generally refers to the monetary resources available to local governments to help fund hazard mitigation and climate adaptation actions, including changing existing processes and plans, acquiring land, redesigning a significant segment of shoreline, reconstructing a bridge to make it stronger or higher, and increasing the

capacity of a stormwater system. The costs associated with implementing these actions vary greatly.

Massachusetts municipalities have access to recurring sources of revenue through local property taxes, and some municipalities may have sources beyond that, such as local option taxes (e.g., meals tax; utility, special purpose, or development fees). The municipal budget process is the means by which local government decides on how and where available municipal funds shall be spent. For many communities in Massachusetts, all appropriations for the upcoming fiscal year must be voted on and approved in a town meeting in advance of setting a tax rate.

Example Funding Criteria for Prioritizing Jurisdictions to Receive Grants

Below are some priority criteria for the eligibility, selection, and prioritization of local jurisdictions to receive planning and project grants for the Commonwealth and agencies to consider, based on other existing federal and nonfederal programs (e.g., FEMA and Massachusetts HMA programs, the MVP Program, MassWorks). Jurisdictions should:

- ✓ Include capability- and-capacity-building activities to enhance the knowledge, skills, and expertise of the current workforce to expand or improve the administration of climate mitigation and adaptation efforts.
- ✓ Have cost-effective projects designed to increase resilience and public safety, reduce injuries and loss of life, and reduce damage and destruction to property or high-risk property, critical services, facilities, and infrastructure from severe impacts from climate change and intense development pressures.
- ✓ Determine the degree to which benefits are maximized.
- ✓ Have reasonable indirect costs, direct administrative costs, and other administrative expenses associated with the project.
- ✓ Have a FEMA-approved local hazard mitigation plan and keep it up to date.
- ✓ Include climate adaptation in the local hazard mitigation plan.
- ✓ Ensure the local hazard mitigation plan aligns with local, regional, and state priority protection and priority development areas.
- ✓ Conduct social vulnerability analyses and determine communities at the highest risk with the highest vulnerability, including environmental justice and other priority populations. Consider non-monetary benefits.
- ✓ Utilize and report from the Climate Resilience Design Standards and Guidance Tool, if the project is focused on a specific site and includes physical assets.
- ✓ Incorporate nature-based solutions (i.e., solutions that protect, restore, or manage ecological systems) into the overall project vision.
- ✓ Conduct engagement, especially with environmental justice and other priority populations.
- ✓ Demonstrate positive impacts to the community and have community support (vetted locally).

Although the communities' annual budget focuses mainly on operating expenses, most communities can use general municipal funds to support local hazard mitigation and climate adaptation efforts independently, or as the local match or cost-share often required for external grant funding. However, in most communities, there are also constant and competing demands for new or expanded services. The MVP Program and local hazard mitigation grants attempt to address some of these funding challenges by providing direct funding to communities, as well as guidance on how to make a stronger case to include these priorities in the overall municipal budgeting process, and how to do so.

Spotlight: Rural and Small Town Development Fund

This program, administered by the Division of Community Services within the Department of Housing and Community Development, provides funding for community planning projects in small towns and rural areas that may lack municipal funding to support this work. Grant projects may include infrastructure updates, public housing developments, or planning and zoning changes. Proposals that will serve Black, Latino, and/or environmental justice and other priority populations are scored favorably. Project proposals that address climate change and resilience, as well as other identified priorities for rural communities, are also scored favorably. The Division of Community Services also administers the Housing Choice Grant and the Community Planning Grant Program, both of which similarly prioritize projects that advance environmental justice.

In addition to general funds, many municipalities in Massachusetts have developed a capital improvement program to address major costs that have a multi-year impact on the finances of the municipality. A capital item is usually something that has a high acquisition cost, but also has an economic life of many years. Buildings, infrastructure, some utility replacements and upgrades, fire engines, and dump trucks are common examples of capital items—as are larger infrastructure developments or improvements such as schools or roadways. Structural hazard mitigation or climate adaptation projects such as dam repair, seawall construction, open space acquisition, stormwater system improvements, or other measures to reduce risk are also often included as capital items. Most capital improvement programs plan for five or six years into the future and schedule the acquisition of capital items sequentially to be least disruptive to any given annual budget.

For large capital expenses, many communities will seek to leverage external grant funding and/or borrow money through debt financing to pay over multiple years. Municipalities wishing to borrow money for extended periods of time issue bonds to investors, which are repaid over time with interest. State laws regulate the purposes for which municipalities may borrow, and how long such loans may last. Some cities and towns in Massachusetts typically use debt service for only a small percentage of their budgeting process, opting to maintain a structurally balanced budget where operating revenues meet or exceed operating expenses.

Example Existing Funding Sources for Hazard Mitigation and Climate Adaptation

The following state and federal funding sources/programs support Tribes, local/municipal government, communities, and/or regional partnerships:

State

- Community One Stop for Growth
- CZM Coastal Resilience Grant Program
- DER Culvert Replacement Municipal Assistance Grants
- District Local Technical Assistance
- Food Security Infrastructure Grant Program
- Gap Energy Grant Program
- MassWorks Infrastructure Program
- MEMA Emergency Management Performance Grant
- MVP Program
- Regional Restoration Partnerships Program
- State Transportation Improvement Program
- Water Utility Resilience Program

Federal

- America the Beautiful Challenge
- American Rescue Plan Act Funds
- Community Development Block Grants
- Department of Energy Low-Income Weatherization Assistance Program
- FEMA HMGP
- FEMA BRIC
- FEMA FMA
- Landscape Scale Restoration Program
- National Coastal Resilience Fund

State and federal grants, private funding, and other community resources are also available to communities for specific types of hazard mitigation and climate adaptation projects, depending on various eligibility requirements. The most common sources of state and federal grant funding for these projects in Massachusetts are identified in Appendix 4.A ("Financial" category) and Appendix 4.C ("Funding Sources for Hazard Mitigation and Climate Adaptation Actions"). Sources include, but are not limited to, the MassWorks Infrastructure Program administered by EOHED, the Commonwealth's MVP Program administered by EOEEA, the Coastal Resilience Grant Program administered by CZM, and FEMA's HMA programs administered by MEMA. Although not specifically listed in the inventory on funding sources for hazard mitigation and climate adaptation actions, funding sources and mechanisms may be available for certain local jurisdictions, such as bonds, special benefit districts, local taxes, and development fees. These funding sources and resources can be important for resilience building at the local level.

In addition to coordinating with state agencies, local communities in Massachusetts seek funding cooperatively with their regional planning agencies, neighboring municipalities, or other partners. This work often includes the application for and use of financial sources that can be leveraged to implement projects or activities that provide the benefit of hazard risk reduction and climate adaptation on a regional or multijurisdictional scale.

4.1.3.3.1 Current Challenges and Opportunities

Although most communities in Massachusetts have participated—and continue to participate—in hazard mitigation and climate adaptation efforts, many still rely heavily on external funding sources for assessments, planning, and implementation of hazard mitigation or climate adaptation projects. Communities the capacity to develop and submit competitive applications for grant programs can be successful in accessing limited funds over a specific time frame, but there are many municipalities with limited staff or other resources to compete for these grants that require additional support. For example, a new statewide program that helps build the capabilities and capacities of local planning departments could be beneficial to help increase local community access to and leverage other existing hazard mitigation, climate adaptation, and resilience funding resources, such as FEMA's HMA programs, the MVP Program, MassWorks, and CZM's grant programs. There is also the annual MA SHMCAP implementation funding and technical and policy support (e.g., grant writing through contracted vendors) that could be leveraged. The Commonwealth continues to work to increase awareness and accessibility of guidance, grant funding, and technical assistance to local communities where it is needed most.

Example Financial Challenges Identified by MVP Grantees

- Lack of funding for projects from the planning and design stage through implementation
- High construction and engineering costs for projects that cannot be covered by grants
- Lack of incentives for community members to participate in planning workshops (e.g., town halls)

4.1.3.4 Education and Outreach

Education and outreach includes programs in local communities to communicate and engage on issues related to hazard mitigation, climate adaptation, and emergency preparedness. These programs may be community groups focused on sustainability, climate adaptation, or emergency preparedness, or they may be ongoing public education campaigns or school-related safety programs. For example, the Food Security Infrastructure Grant Program invests in local food providers and supports educational programs and community gardens, which in turn engages

Spotlight: MassWorks Infrastructure Program

Administered by EOHED, this program is a significant source of funding for community infrastructure projects, especially those that support housing development. Considerations for climate resilience are incorporated into project reviews. Proposals are required to include their project's report from the Climate Resilience Design Standards and Guidance Tool and respond to relevant climate resilience questions.

residents in their local food systems. Education and outreach also includes public participation in projects such as the MassWorks Infrastructure Program, FHMP, and the MVP Program. FHMP regularly sends out messages to local officials around capacity-building, partnerships, risk reduction, and resilience building, especially messages related to floodplain development, training opportunities, funding and grants, best practices and case studies, new tools and reports, websites that offer helpful data, and more. In FY 2021, the FHMP sent out 80 such messages across the Commonwealth. As of February 2, 2023, 349 communities have participated in the MVP Program, as identified earlier in this chapter, and 60 communities were awarded MassWorks support in 2022 alone.

Many communities in Massachusetts have Community Emergency Response Teams (CERTs). The CERT program "educates volunteers about disaster preparedness for the hazards that may impact their area and trains them in basic disaster response skills, such as fire safety, light search and rescue, team organization, and disaster medical operations. CERT offers a consistent, nationwide approach to volunteer training and organization that professional responders can rely on during disaster situations, which allows them to focus on more complex tasks. Through CERT, the capabilities to prepare for, respond to, and recover from disasters is built and enhanced."

Two national programs that offer local communities the opportunity to prepare for and mitigate risk are the StormReady program and the Firewise USA program. The StormReady program operates as part of the Weather-Ready Nation program of NOAA's National Weather Service (NWS). The program prepares communities for increased exposure to extreme weather and water events. To date, 21 cities and towns in Massachusetts have the StormReady designation. In addition, six universities have this designation: Boston College, Boston University, Harvard University, Milton Academy, Tufts University, and the University of Massachusetts Amherst.

Firewise USA is a program of the National Fire Protection Association that teaches communities how to adapt to living with wildfires and encourages neighbors to work together and take mitigation actions to prevent losses. As of October 2022, two communities in Massachusetts have received the Firewise USA designation: Six Ponds Improvement Association in 2021 and Hopps Farm Road Association in 2010.

StormReady Communities: Spotlight on Town of Hanover

In September 2022, the town of Hanover received the StormReady Community designation from NWS. To become StormReady, a community must meet or exceed established criteria in six areas:

1. Communications
2. NWS information reception
3. Weather and water monitoring systems
4. Local warning dissemination (including NOAA Weather Radios in local city- or government-owned buildings with public access)
5. Community preparedness (safety/spotter talks and public education).
6. Administrative tools/ recordkeeping

4.1.3.4.1 Current Challenges and Opportunities

There is an opportunity for the Commonwealth to support and increase the availability of outreach and education programs by building upon those that have been successful in the past or are currently successful. Current programs such as the MVP Program, MAPC's technical assistance programs, and CZM's Coastal Resilience Grant Program provide funding, technical support, educational materials, supplemental webinars, outreach, and education, and are good examples of programs led by state agencies that go beyond grant funding alone to boost overall municipal capacity.

In addition, the Commonwealth or other neighboring local communities could provide training and guidance to local communities on best practices to engage, educate, and provide outreach to environmental justice and other priority populations. Conducting community outreach and education can be complex and local communities need support on how to design an equitable and justice-informed approach, which includes working with community-based organizations that have existing relationships within their communities. It is important to build participation into the process—such as by inviting input on prioritizing actions that can be driven by community members, partners, and other stakeholders, not just municipal staff—to ensure diverse perspectives and community needs are being met.

People-Focused Design: City of Springfield

In 2022, the city of Springfield, an MVP grantee, presented its project on building trust in community partnerships, called People-Focused Resilient Redesign and Retrofits for Community and Civic Infrastructure. The main project objectives included improving (1) trust between community members and local agencies, (2) knowledge and understanding of city resilience initiatives, and (3) city communications and outreach. The city worked with a Resident Advisor Board, which consisted of paying stipends to resident advisors who brought their input on various issues aimed at improving communication with residents, particularly the city's most vulnerable residents.

4.1.4 Conclusions

The Commonwealth has a long history of demonstrating its commitment to advancing risk reduction and climate and hazard resilience through a variety of policies, programs, and other capabilities. In recent years, it has advanced that commitment through innovative programs, coordination, and actions that have advanced the understanding of risks from hazards and climate change.

Massachusetts continues to be a leader in the nation on its commitments to climate mitigation and adaptation, including the first-in-nation Clean Peak Standard (established by DOER and designed to provide incentives to clean energy technologies that can supply electricity or reduce demand during seasonal peak demand), the MVP Program, the 2022 MA Climate Assessment, the updated SMART solar program (DOER's incentive program established to support the development of solar energy in Massachusetts), participation in

the Regional Greenhouse Gas Initiative, nation-leading energy efficiency programs, and its Clean Energy Standard. Since 2018, the Commonwealth continues to conduct studies or develop plans and programs on hazard mitigation and climate adaptation, which generate data, information, and findings that are useful to other local and state agencies, as well as nonprofits, academia, and community-based organizations.

The Commonwealth also maintains a strong institutional capacity to reduce hazard and climate risks, especially resources directed towards emergency preparedness and response. Most agencies surveyed in Massachusetts have adequate infrastructure and hardware (e.g., backup generators, software) as well as authority (e.g., policies, laws) to deliver their services or programs in the face of increasing threats from hazards and climate change. For some state agencies, these threats are significant, but for others, they do not pose any major risks or vulnerabilities of concern. Regardless, the MA SHMCAP provides a framework for state and local governments to continue to evaluate risk, assess vulnerability, and work across all agencies to adapt, maintain, and increase their resilience to changing hazards and the impacts of climate change.

To ensure it addresses the top challenges surrounding the capacity and capability of funding, staffing, skills/expertise, and data and information, the Commonwealth will continue to invest in and advance the key opportunity areas highlighted in Section 4.1.2.2 and Table 4-4.

By being proactive in building the Commonwealth's resilience and adapting to hazard and climate vulnerabilities and consequences, in addition to being prepared for emergency response, Massachusetts can be more innovative and strategic when it comes to coordination and implementation across sectors, agencies, and jurisdictions. It will take collaborative planning and teamwork to build capacity and effectiveness across the Commonwealth and across sectors. This extraordinary commitment promotes hazard mitigation, climate adaptation, and overall resilience and recognizes the importance of investing now for the future resilience of the Commonwealth.

Chapter 5. Risk Assessment and Hazard Analysis

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5.1 Risk Assessment Introduction

The 2023 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (2023 MA SHMCAP) Risk Assessment identifies risks, consequences, and impacts associated with the hazards and climate change influences that could affect Massachusetts. It considers the existing and future long-term stressors for each hazard, along with the exposure and vulnerability of populations, geographic areas, assets, and services from each hazard. The information in the Risk Assessment includes the underlying causes of the hazards, the best available data and information for the Commonwealth, the historical context of these hazards in Massachusetts, and the projected impacts that climate change, population projections, and other trends will have on the risks posed by these hazards. The Risk Assessment provides the empirical basis for the actions and activities prioritized by the 2023 MA SHMCAP.

This introduction provides:

- An overview of the changes in the 2023 Risk Assessment compared to the 2018 Risk Assessment.
- A discussion of historical disaster occurrences in Massachusetts.
- An explanation of the approach used in each hazard section.
- A review of methodology.
- **Hazard snapshots**. These are analytical tools for comparing hazards to each other based on results of the Risk Assessment. This analysis uses information from analysis of risk and vulnerability, such as warning time and extent, to rank each hazard. Together with problem statements, hazard snapshots are a form of hazard overview:

an analysis that summarizes and allows for the comparison of vulnerabilities and consequences across hazards and provides a better understanding of Massachusetts' priorities related to addressing these hazards.

- A brief discussion of technological and human-caused hazards.

The introduction is followed by hazard profiles: two-page executive summaries that describe each hazard and provide a high-level overview of the impacts associated with it.

5.1.1 Significant Changes to the MA 2023 SHMCAP Risk Assessment

The 2023 Risk Assessment updates the 2018 Risk Assessment to advance the understanding of risk and the impact of climate change in the Commonwealth. The changes to the Risk Assessment compared to 2018 are described in the subsections below.

5.1.1.1 Integrating Analysis to Consider Future Conditions

Understanding future conditions is essential to understanding how long-term risks in Massachusetts will evolve over time. To address this, the Risk Assessment integrated new sections, analysis, and components to contribute to an improved understanding of future conditions. The Risk Assessment expanded on the 2018 analysis in the following ways:

- **Adding new hazards.** The Risk Assessment added an assessment of groundwater and includes a hazard section to profile and document risks from changes in groundwater. The inclusion of this new section required expert consultation and significant research and will support communities experiencing challenges associated with reduction, rise, and changing characteristics of groundwater.
- **Expanded assessment of existing hazards.** All hazard sections include geospatial and data analysis that had not been conducted in 2018. The analysis of invasive species includes extensive new work and research into a hazard that was flagged as a concern for multiple municipalities. To improve the understanding of earthquake risk, the Risk Assessment team used an updated Hazus analysis that included new soils data. The following hazards also incorporated recent research and data: extreme temperature, hurricanes, tsunamis, and drought.
- **Leveraging the Massachusetts Climate Change Assessment.** To leverage the findings from the 2022 Massachusetts Climate Change Assessment (MA Climate Assessment), the Risk Assessment integrated priority impacts into all hazard analysis. Projections, analysis, and findings from the MA Assessment heavily contributed to Risk Assessment sections on coastal flooding, flooding from precipitation, and extreme temperature. Section 5.1.5.1 provides detail on integration with the MA Climate Assessment.
- **Local and statewide analysis of changes in development.** To advance its understanding of future conditions, this analysis also took discrete steps to

understand changes in development. To achieve this, the team incorporated information from population projections, data that identified the location and type of planned and recently completed construction, and a review of local hazard mitigation plans and reports from the Municipal Vulnerability Preparedness program.

- **Systematically reviewing and integrating local hazard mitigation plans.** The team systematically reviewed local hazard mitigation plans chosen to be geographically representative of conditions throughout the Commonwealth. Each plan was thoroughly reviewed, analyzed, and integrated into all hazard sections, with a focus on using information from the plans to understand the local context and experience of the hazards and climate change influences, as well as mitigation and adaptation actions used at the local level to reduce risks.

Involving State Agencies Throughout the Planning Process

In addition to formal review of the Risk Assessment, state agencies and members of the Resilient MA Action Team (RMAT) had the opportunity to inform and contribute to the Risk Assessment at all periods of the analysis. Through two RMAT Working Group meetings, state agencies were invited to contribute their understanding of risk through comments, participation, and a worksheet. In connection with working group meetings, state agencies and select subject matter experts were invited to contribute with reviews and feedback to the problem statement, hazard profiles, and a preliminary version (Draft 0) of the Risk Assessment. The RMAT Working Group was also provided each section to allow for their review, comment, and recommendations.

Integrating Environmental Justice and Other Priority Populations in the Analysis

The Risk Assessment advanced the way vulnerability and risk were discussed for all hazards. For each hazard, the analysis includes a section on the understanding of environmental justice and other priority populations through multiple dimensions using both 2022 Massachusetts Environmental Justice Population data and the 2020 Census data. In evaluating vulnerability for environmental justice and other priority populations, the team drew in complementary data sources when needed and made connections to consider long-term stressors when relevant. The Risk Assessment also carried over the MA Climate Assessment's evaluation of the disproportionate distribution of impacts from climate change into all hazard analysis.

Integrating the Latest Scientific Knowledge

The 2023 Risk Assessment took steps to ensure that hazard analysis reflected the latest scientific knowledge. To understand recent and projected impacts, the team referenced papers published on or after 2018 and used the latest version of Hazus, new geospatial analysis, and updates to every hazard based on new data and information on population and growth, as well as latest science and research for each hazard.

Advancing Scientific Rigor and Replicability

The Risk Assessment includes new methodologies and approaches, applied systematically to all hazard sections, and documents methods used to increase transparency and replicability. Steps taken to advance replicability allow technical readers and municipal governments to reproduce findings and adapt methods for different contexts. Because data sources and methods are clearly listed, the transparency allows readers to use new and updated resources between SHMCAP updates. Examples of ways the Risk Assessment advances replicability include the following:

- All hazards describe the methodology used to develop maps and tables.
- Hazus information, assumptions, and inputs are clearly documented in the introduction and hazard sections.
- Citations included in text-citations are linked to reference list.

5.1.2 Identifying Hazards

In choosing hazards for inclusion in the 2023 Risk Assessment, the Commonwealth reviewed and retained all hazards from the 2018 MA SHMCAP Risk Assessment. The Commonwealth also analyzed a new hazard for 2023—groundwater changes—after reviewing anticipated future conditions and the projected impacts of climate change and determining that these changes present conditions that could result in significant hazard to the Commonwealth. Table 5.1-1 lists the 15 hazards analyzed in the Risk Assessment.

For the 2023 MA SHMCAP, the focus is on natural hazards that are influenced by anthropogenic actions such as climate change, development, pollution, environmental injustice, and other factors that are described in more detail for each hazard. While many of the phenomena discussed in the Risk Assessment are naturally occurring and, in some cases, could be beneficial in many contexts, climate change impacts, development patterns, and other human actions have increased the exposure, vulnerability, and risks associated with these hazards. The Risk Assessment also evaluated and incorporated the results of the 2019 Massachusetts *Hazard Identification and Risk Assessment* (Commonwealth of Massachusetts, 2019).

The Commonwealth assessed each hazard to determine how climate change may affect exposure, frequency, intensity, duration, vulnerability, and risks to the Commonwealth of Massachusetts. The analysis acknowledges that all hazards analyzed in the Risk Assessment have a historical and current risk component and that climate change is changing many of these hazards, expanding the extent of the geography exposed to the hazards, and increasing frequency, duration, and/or intensity.

Where climate change is known to be an influence, the hazard section includes climate projections, data, and analysis at the most downscaled geography available. A significant source of climate data and information was the *2022 Massachusetts Climate Change Assessment*, or MA Climate Assessment (Commonwealth of Massachusetts, 2022).

The MA Climate Assessment report identifies impacts from climate change to people, environments, infrastructure, economy, and governance in Massachusetts through the end of the century. Table 5.1-1 identifies the sections in the Risk Assessment that drew heavily from the analysis and results of the MA Climate Assessment.

Table 5.1-1. Hazards Included in the 2023 MA SHMCAP Risk Assessment

• Flooding from precipitation (with appendix on dam overtopping)[a] • Coastal flooding and storm surge [a] • Average and extreme temperatures [a] • Coastal Erosion • Changes in groundwater (new to 2023) • Earthquakes • Tsunamis • Landslides and mudflow	• Tornadoes • Hurricanes and tropical cyclones • Severe winter storms/nor'easters • Other severe weather • Wildfires • Invasive species • Drought (including impacts to groundwater)

[a] Draws heavily on analysis from the MA Climate Assessment

5.1.3 Historical Disaster Occurrences in Massachusetts

The 2023 MA SHMCAP identifies the frequency and historical occurrence of each hazard between 2018 and March 2023. It also includes information on the historical frequency of occurrence and the magnitude (severity and intensity) of these events before 2018, as documented in the 2018 MA SHMCAP. To identify past occurrences, the 2023 Risk Assessment considered events that resulted in federal or state disaster declarations. The historical information also includes events with notable magnitudes and impacts. Information from past events, including trends, can be used to understand future likelihood and vulnerability, and to identify areas and assets at greatest risk.

Massachusetts has experienced all the hazards included in the 2023 MA SHMCAP, some more often and some with more significant consequences to the Commonwealth. The hazards that have historically occurred more frequently and affected the greatest number of assets and populations include inland and coastal flooding, extreme temperatures, invasive species, and severe winter weather and nor'easters. Some hazards have been reported or occurred less often but have had significant localized impacts, such as coastal erosion, tornadoes, and landslides. There are also hazards that—due to climate change—are emerging and may become more significant in Massachusetts, including wildfires, drought, groundwater rise, and potential changes in hurricane exposure. Finally, there are several hazards that have occurred very infrequently in the Commonwealth, such as large earthquakes and tsunamis.

There have been four events that led to Presidentially Declared Disasters since 2018: three severe winter storm and flooding events (two in 2018 and one in 2022) and the COVID-19 pandemic. In 2011, a magnitude 5.8 earthquake centered in Mineral, Virginia, was felt

throughout Massachusetts but caused no damage. This was the most significant earthquake in recent history. No new dam failures or major landslides were recorded, although these have historically occurred in Massachusetts. 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

In February 2023, an arctic front moved through the region with a dangerously cold airmass that stayed in place on February 3–4. The cold temperatures broke the records for the lowest recorded minimum temperature and resulted in several deaths.

Each of the Risk Assessment's hazard sections discusses the historical occurrence of the hazard and provides context on how climate change is affecting extent, frequency, duration, and severity and intensity. Appendix 5.A includes more detail on the historical hazard occurrences mentioned here, as well as significant hazards documented by the 2018 MA SHMCAP.

5.1.4 Risk Assessment Organization and Approach

The Risk Assessment is organized into hazard sections. These sections differ slightly in structure, depending on the nature of each hazard, but each section has three major components designed to convey the risk posed to the Commonwealth's populations, assets, services, and geographies. These three components are described below.

5.1.4.1 Hazard Profile

The hazard profile is an abbreviated, two-page summary of the hazard risk assessment, with information on the vulnerabilities and consequences of the hazard on all five sectors. Its goal is to provide a high-level summary of the hazard analysis—one that can be a stand-alone document, communicating the vulnerabilities and risks associated with the hazard and projected changes due to climate change. Each hazard profile identifies the most at-risk areas, the historical trends and occurrence, the secondary effects, and the projected effects of climate change. The 15 hazard profiles appear at the end of this introduction, before the 15 hazard sections.

5.1.4.2 Problem Statement

The Federal Emergency Management Agency (FEMA) defines Problem Statements as summaries that identify the location of the problem, cause and contributing factors to the problem, significance of impacts, and populations and assets most vulnerable and consequential when exposed to the hazard. A problem statement summarizes the

problem that a hazard poses to Massachusetts in terms of exposure, vulnerability, and consequences. The problem statements in this Risk Assessment aim to:

- Present salient information from the analysis on assets, services, populations, and geographies most at risk
- Describe the factors that make the hazard more significant, including climate change, land use, and sensitive assets and services

5.1.4.3 Hazard Risk Assessment

This content includes an analysis and technical description of each hazard, including the probability of occurrence, the geographic extent and area exposed, assets, services and populations most affected, vulnerable characteristics of populations, and analysis of vulnerabilities and consequences for each of the five sectors—human, governance, infrastructure, natural environment, and economy. Each hazard section has several sub-categories, which are listed and described below.

5.1.4.3.1 General Background

The general background describes the hazard and its subcomponents, its severity and intensity, typical warning time, and secondary hazards caused by the hazard. When available, the general background includes examples of notable historical occurrences and broad consequences of the hazard. It contains several subsections as described below.

5.1.4.3.2 Hazard Description

Introduces the hazard, including a definition of the hazard and an overview of its historical occurrence in Massachusetts and sometimes the northeastern U.S. For some hazards, detailed historical records were available; others were reported less frequently. When available, this section includes examples of the largest or most consequential historical occurrence of the hazard in the Commonwealth.

Location

This section describes the location or geographic extent and probability of the hazard, as well as how climate change is projected to change these factors in the future.

Previous Occurences and Frequency

This section summarizes previous occurrences of the hazard in Massachusetts. Where possible, it also describes the probability of a future hazard event using the latest scientific information: probability of future occurrence and current and future frequency. For hazards that are affected by climate change, the discussion includes the latest scientific information on the impacts of climate change on vulnerability.

Severity/Intensity

This section describes the likely magnitude (or range of likely magnitudes) of the hazard. Whenever available, industry standard scales are used to describe the intensity of the

hazard. For example, the National Hurricane Center's categorizations of tropical storms and hurricanes was used to define the range of hurricanes that may affect areas of Massachusetts. When no standard scale is available, a qualitative description is provided.

Warning Time

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. The best way to reduce risk is to mitigate sources of risk ahead of time and eliminate, or reduce, reliance on warning times for critical issues that relate to life safety, environmental and public health, and lifelines.

Warning times can reduce damage, disruption, and loss of life if they are long enough to allow temporary measures—boarding up buildings, moving sensitive assets, evacuations, moving items inside or away from danger. For example, people may respond to a hurricane warning by boarding up their homes and businesses, moving sensitive items out of the flood zone, and evacuating. Some hazards (such as hurricanes, severe winter weather or nor'easters, high heat or extreme cold, and droughts) allow for hours, days, or weeks of warning time, while others (such as earthquakes, wildfires, tornadoes, and flash floods) allow for little to no warning time. The warning time for each hazard depends on the available scientific data and information for that hazard and the ability to use that information to accurately predict the timing and severity of an event.

Local Context for Hazard and Vulnerability: A Review of Local Plans

The analysis was informed by a systematic review of 37 local hazard mitigation plans to identify hazard exposure, vulnerability, damage, and other relevant local conditions. These plans were chosen to provide a range of local characteristics throughout the Commonwealth, illustrated in Figure 5.1-1 below.

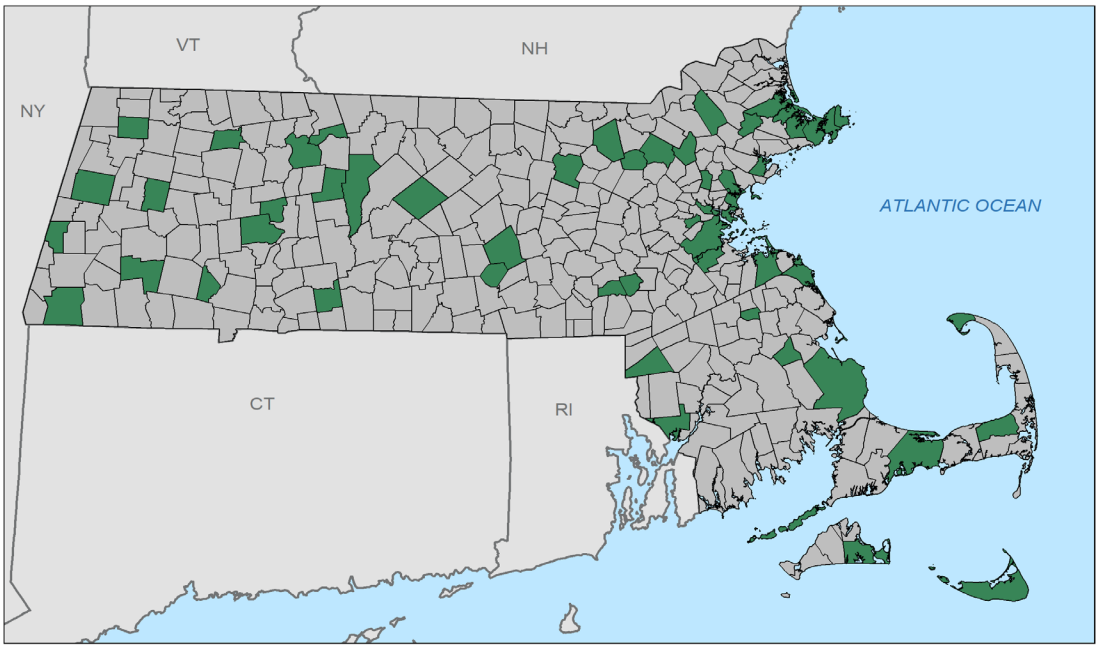


Figure 5.1-1. Map of local hazard mitigation plans included in the review.

The plans reviewed are representative of the geographic, economic, and demographic diversity of Massachusetts, as well as the diversity of current and future risks in different areas of the Commonwealth. Each plan was surveyed to collect information on the municipality's experience with each hazard, information on local conditions, vulnerability (e.g., assets and populations at risk), and actions or adaptation strategies. This information is integrated throughout each hazard section and specifically discussed in a subsection titled "Local Context for Hazard and Vulnerability." For some hazard sections, the Commonwealth reviewed additional local plans and integrated the information into the vulnerability analysis.

Secondary Hazards

A secondary hazard is a hazard whose risk increases after the primary hazard event occurs. For example, landslides and mudflows are a secondary hazard to earthquakes and extreme precipitation events. Secondary hazards are identified for each hazard based on scientific consensus and literature review. In many cases, the secondary hazards can result in as much or more damage, disruption, and loss as the primary hazard.

Sectors Assessed in Exposure and Vulnerability Analysis

The Risk Assessment analyzes the exposure and vulnerability of state assets, human populations, lifelines, critical facilities, economic activity, natural resources, and other infrastructure or resources from each hazard.

The Risk Assessment assesses vulnerability, risks, and consequences for each of the five sectors that were defined in the MA Climate Assessment (Commonwealth of Massachusetts, 2022, p. ES2). A summary of these sectors is described in Table 5.1-2.

Table 5.1-2. Exposure and Vulnerability Sectors

	**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, the Commonwealth used data from the U.U.S. Census, the MA environmental justice data mapping tool, and population projections, among other sources.*
	***Governance sector*** Impacts to state and 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.

5.1.5 Risk Assessment Methods

Each hazard Risk Assessment section discusses specific methods used to assess risk for that hazard. Below, this section describes the Risk Assessment's methodology—the

information and analysis used to assess past, current, and projected risks—more generally.

1. Integrating the 2022 Massachusetts Climate Change Assessment
2. Considering Vulnerability and Distribution of Impacts
3. Projected Changes in Population and Development
4. Updated Sources and Documents Reviewed
5. Expert Consultation and Review
6. Analysis of Assets at Risk and Estimated Losses
7. Conducted Regional Analysis

5.1.5.1 Integrating the 2022 Massachusetts Climate Change Assessment

The MA Climate Assessment includes an analysis of the most significant impacts that climate change poses to each of the five sectors (human health, governance, infrastructure, natural environment, and economy) in Massachusetts. This analysis identified priority impacts in each sector based on three factors: the magnitude of the hazard, the presence of disproportionate impacts on communities identified as having environmental justice concerns, and the scale of action or inaction in place to address the hazard.

Where available, the 2023 MA SHMCAP Risk Assessment integrates analysis from the MA Climate Assessment to understand how climate change may affect the frequency, intensity, duration, and scale or location of hazards. (The hazards that drew heavily from analysis in the MA Climate Assessment are marked in Table 5.1-1.) The MA Climate Assessment's priority impacts—including disproportionate effects and adaptation gaps—are considered in the Risk Assessment to focus actions and strategy for the 2023 SHMCAP. As relevant, these priority impacts are included in risk and vulnerability discussions in the hazard sections; impacts drawn from the MA Climate Assessment can be identified because they have an urgency ranking in parenthesis (e.g., "Most urgent," "Urgent").

Note that, in addition to information from the MA Climate Assessment, the Risk Assessment identifies additional risks and vulnerabilities for each hazard based on likelihood and magnitude of consequence.

5.1.5.2 Considering Vulnerability and Distribution of Impacts

Every hazard section includes a discussion and analysis of vulnerability factors and considers environmental justice and other priority populations and social vulnerability explicitly to indicate how populations may be disproportionately affected by a hazard and the underlying factors that drive vulnerability.

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. This is driven by underlying contributors such as racial discrimination, economic disparities, or accessibility barriers that create vulnerability. The term "priority populations" acknowledges that the needs of people with these experiences and expertise must take precedence when developing resilience solutions to reduce vulnerability to climate change.

> **Environmental justice** is based on the principle that all people have a right to be protected from environmental hazards and to live in and enjoy a clean and healthful environment regardless of race, color, national origin, income, or English language proficiency. Environmental justice is the equal protection and meaningful involvement of all people and communities with respect to the development, implementation, and enforcement of energy, climate change, and environmental laws, regulations, and policies and the equitable distribution of energy and environmental benefits and burdens.
>
> —Massachusetts *Environmental Justice Policy*, 2021

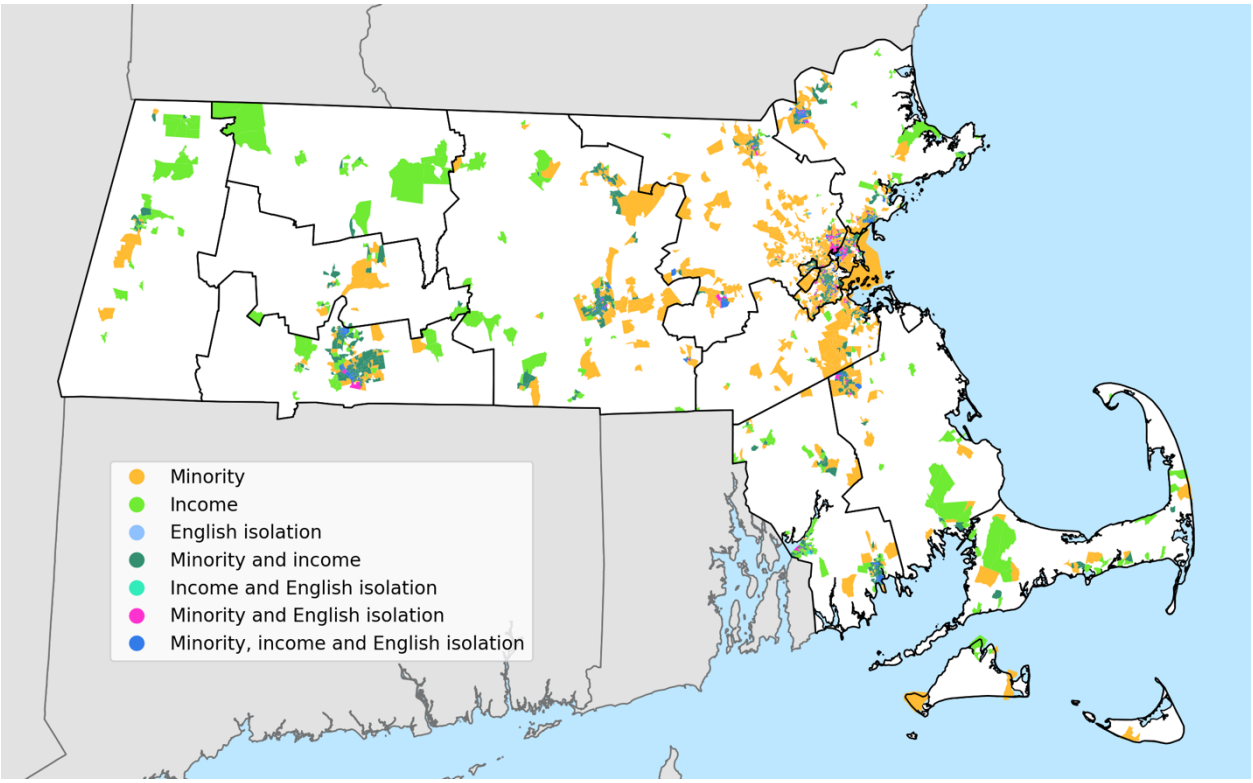
Priority populations are often exposed to pollution, impacts of climate change, and hazards while simultaneously experiencing long-term stressors. Communities experiencing these structures are referred to as environmental justice communities or communities with environmental justice concerns. Communities from minoritized identities, also referred to as "minority, including Black, Indigenous, People of Color" communities, are often exposed to conditions of disadvantage and face environmental injustice. Communities are considered disadvantaged based on several variables.

The Risk Assessment uses variables and data developed by the Executive Office of Energy and Environmental Affairs (EEA) to map communities with environmental injustice concerns by census block groups. A Census block group is identified as an environmental justice population area if it meets one or more of the following criteria:

- The annual median household income is not more than 65 percent of the statewide annual median household income.
- Individuals who identify themselves as Latino/Hispanic, Black/African American, Asian, Indigenous people, and people who otherwise identify as non-White constitute 40 percent or more of the population.
- 25 percent or more of households lack English language proficiency.
- Individuals who identify themselves as Latino/Hispanic, Black/African American, Asian, Indigenous people, and people who otherwise identify as non-White constitute 25 percent or more of the population and the annual median household income of the

municipality in which the neighborhood is located does not exceed 150 percent of the statewide annual median household income. portion of a neighborhood designated by the Secretary as an environmental justice population in accordance with the *Act Creating a Next-Generation Roadmap for Massachusetts Climate Policy*, Chapter 8 of the Acts of 2021.

The map in Figure 5.1-2 shows the location of environmental justice populations throughout the state, as defined by Massachusetts environmental justice population data updated in 2022**.**



Map developed by ERG with data from Massachusetts Bureau of Geographic Information (MassGIS, 2022).

Figure 5.1-2. Map of environmental justice communities in the Commonwealth.

In addition to using the data and indicators of environmental justice and other priority populations developed by EEA, the Risk Assessment considers other indicators that could be used to identify risk and vulnerability to communities. Each hazard section addresses additional indicators based on the unique vulnerabilities and risks posed by the hazard. The following community and population characteristics were considered for each analysis and implemented depending on the relevance for the hazard:

- Low income
- Age (above 65, under five)
- Underlying health conditions

- Disabilities
- Residence in single-parent households
- Renting
- Residence in housing cost–burdened households
- Membership in an underrepresented or under-resourced community
- Transit dependency
- Linguistic isolation
- Unhoused status

In some cases, employment information was relevant to disproportionate vulnerabilities or consequences. Outdoor workers, workers in the coastal zone, emergency responders, public safety employees, and others might bear a disproportionate risk due to the location or characteristics of their employment.

5.1.5.3 Projected Changes in Population and Development

Considering future conditions of population and development is important to understand how risks from hazards and climate change can affect Massachusetts in the future. Changes in population and development can increase or decrease the number of people, buildings, and/or infrastructure at risk from a hazard event. Many of the most effective strategies to reduce risks from hazards are land use strategies that decrease the number of people and assets within high-risk areas. Additionally, to understand the risks posed from current and future hazards, it is critical to assess how population and development density and design are changing over the same timeframe. The changes to hazards due to climate change make this assessment critical, since some areas that are projected to be at risk from a hazard in the future—such as high heat, coastal flooding, wildfires, and extreme precipitation—have not historically experienced these hazards.

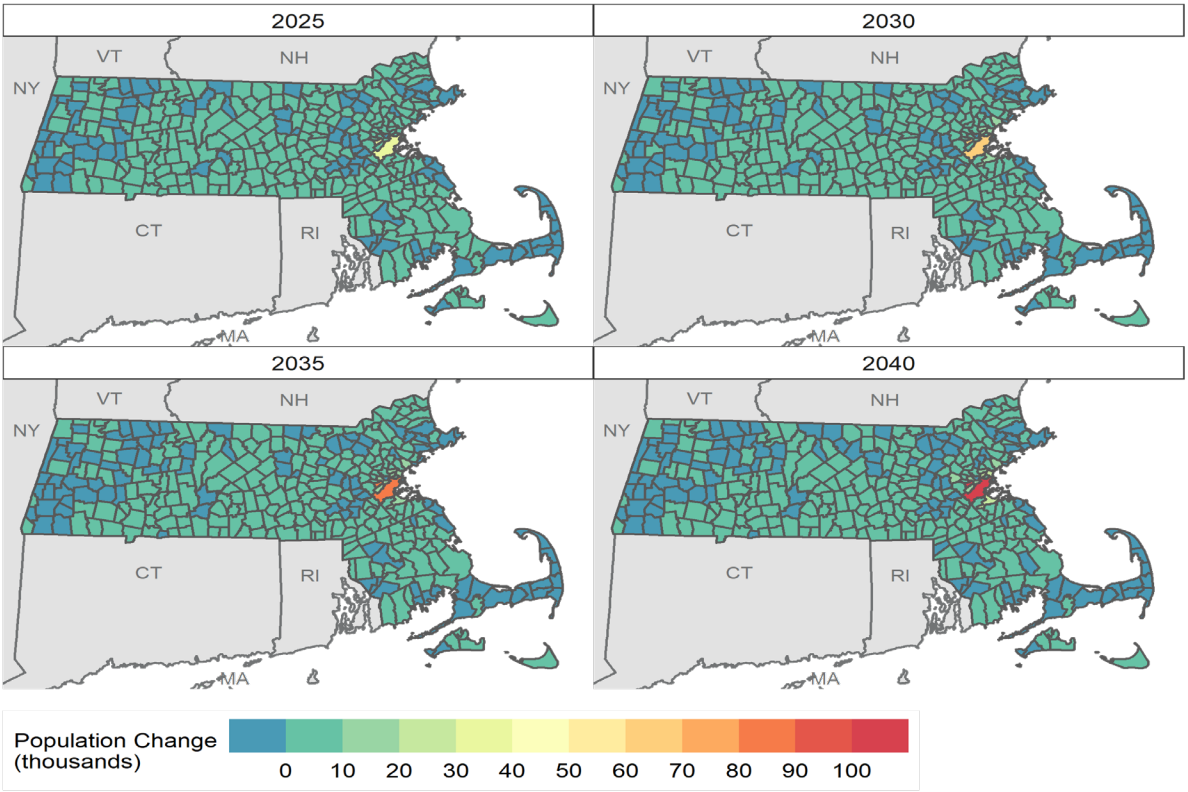
When considering changes in land use, population, and development, it is important to understand the jurisdictional authority over decisions that affect these changes. The Commonwealth of Massachusetts has granted home rule authority to municipal governance entities (i.e., cities and towns), which includes the authority to adopt ordinances and bylaws to regulate the use of land, buildings, and structures (Commonwealth of Massachusetts, 2023). Because it does not manage zoning and therefore construction permits, the Commonwealth does not have direct influence over land use decisions within Massachusetts; it can, however, support local municipalities' land use decisions by providing information on hazards and climate change risks; providing technical assistance to municipalities on actions to reduce risks; and encouraging safe and resilient development through funding support, resilient codes, and other best practices.

To assess the effect population and development characteristics on risk, the Risk Assessment team analyzed long-term changes in population, statewide construction patterns (as they bear on changes in development), and locally identified changes in development.

5.1.5.3.1 Changes in Population and Risk

Development often follows the same trends as population growth; accordingly, the Risk Assessment team used population changes as a proxy to evaluate whether recent development in hazard-prone areas could affect the Commonwealth's risk profile. Changes in population can influence demand for housing, infrastructure, and community services (e.g., schools, retail) and lead to land use change. The pace of population changes can also influence whether growth in population or decreases in population result in changes to the profile of risk for the areas experiencing changes.

Figure 5.1-3 below shows minor civil division (MCD)–level estimates of future population growth. Anticipated population changes through the Commonwealth were assessed using estimates of population growth from UMass Donahue Institute and MassDOT (UMass Donahue Institute, 2018). All hazards were assessed based on these population projections to determine if hazard exposure is growing or getting smaller.



Source: UMass Donahue Institute (2018).

MCDs shaded blue are expected to decrease in population.

Figure 5.1-3. Estimated change in population from 2020, per MCD.

To analyze how changes in population are influencing long-term risk in Massachusetts, the Risk Assessment team assessed these questions:

- Are geographic areas at current or future risk projected to grow?
- Is risk being considered when changing land uses and increasing density? Is risk being addressed through higher standards and building codes?
- Are there trends and patterns that need to be considered and described in the Risk Assessment?

Generally, the Boston Harbor region is expected to experience the most population growth in the Commonwealth, while population is expected to decline slightly in rural Massachusetts. For specific hazards, see the "Human" sector discussion in each hazard risk assessment's "Exposure and Vulnerability" section.

5.1.5.3.2 Statewide Construction Patterns

The Risk Assessment team identified one statewide resource on changes in development: the Metropolitan Area Planning Council's MassBuilds public database, which catalogues significant construction projects in Massachusetts (Metropolitan Area Planning Council, n.d.). MassBuilds collects data from participants at regional planning and other government agencies. The dataset includes locations of projects and either the year construction was completed or the projected year of completion. This information reveals which regions are experiencing more development now and in the near term.

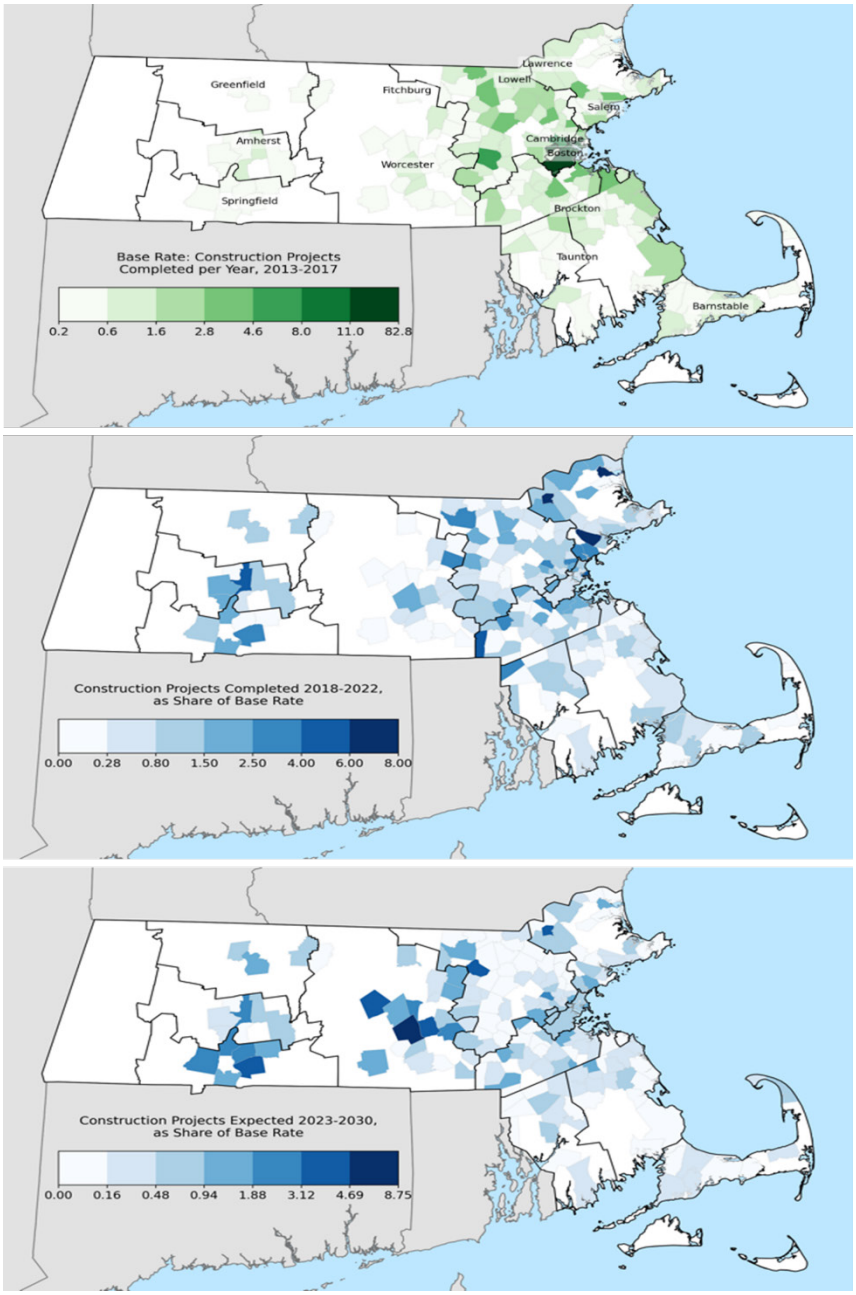
The Risk Assessment team used this dataset to assess which regions have experienced recent development and which locations are expected to experience further development. The Risk Assessment expresses both rates of recent development and projected development as shares of a "base rate," or the number of construction projects completed per year between 2013 and 2017, in Figure 5.1-4. To show the rate of recent development, it shows the number of projects completed per year between 2018 and 2022 as a share of the base rate. To show the rate of expected further development, it takes the number of projects in planning, projected, or in construction between 2023 and 2030 as a share of the base rate. Only municipalities with construction during the base period are included.

Note that MassBuilds has significant limitations. It focuses on the Greater Boston area, with far less coverage for other regions in the Commonwealth. It also focuses on large housing or commercial building projects, omitting other important types of construction such as single-family homes.

5.1.5.3.3 Locally Identified Changes in Development

Local government hazard mitigation planning can also provide insight into changes in development and population dynamics that affect risk locally. In addition to providing local context, local planning documents can provide detailed examples that illustrate patterns experienced by a region.

In collaboration with the Massachusetts Emergency Management Agency, the Risk Assessment team reviewed a representative sample of local hazard mitigation plans and extracted discussions of changes in development and land use. This review was used to gauge regional development changes. Conclusions from this exercise are included in each hazard section, in the infrastructure sector discussion under "Exposure and Vulnerability."



Maps generated using MassBuilds data.

From top to bottom, maps show base rate, recently completed, and expected construction projects.

Figure 5.1-4. Construction projects in Massachusetts.

5.1.5.3.4 Results from Analysis of Changes in Development

Recently completed projects and permitted projects with projected completion dates are key indicators for changes in development. Increases in construction are associated with growth and increased density of housing and commercial properties. While increased development in hazard-prone areas increases the number of people and buildings exposed to hazards, there are other factors in risk such as land-use decisions, construction standards and building codes, conditions and requirements that may reduce risks, and emergency management plans.

Coastal Areas

During the planning period that informed the 2018 SHMCAP, construction was concentrated in the counties around Boston Harbor, specifically Suffolk and parts of northern Norfolk, southern Essex, and eastern Middlesex counties. During this period, all coastal counties experienced construction rates higher than rates in other areas of the Commonwealth. The concentration of construction near Boston Harbor and along coastal areas exposed new buildings to coastal hazards like flooding, erosion, and storms.

Local hazard mitigation plans for governments in these regions confirm a concern with development in areas exposed to hazards, especially flooding. The Town of Hull worked with the Metropolitan Area Planning Council to evaluate areas that may be developed in the future and found that on the three parcels considered, 90 percent of the land was in a flood zone (Metropolitan Area Planning Council, 2018a). Most municipalities in and around the Boston Harbor area expressed concern over exposure to flooding but identified enough parcels outside flood zones that could be available for development (City of Boston, 2021; City of Somerville, 2022; Metropolitan Area Planning Council, 2016, 2018a, 2022). Notably, in the City of Boston, the local hazard mitigation plan estimates that nearly 19 percent of recent and future developments are in the Massachusetts Coast Flood Risk Model's (MC-FRM) projected 2070 flood zone (City of Boston, 2021). Some municipalities also expressed concern with heat associated with density and extreme heat that could be intensified by increased development (City of Somerville, 2022; Metropolitan Area Planning Council, 2016, 2022).

In 2018–2022, construction in coastal areas continued, but construction was less concentrated in the municipalities adjacent to Boston Harbor and more widely spread throughout coastal communities, with a slight concentration in Norfolk, Middlesex, and Essex. While growth was less concentrated in coastal areas, the data analyzed suggest that construction continues to take place in areas exposed to multiple hazards that affect coastal areas.

Central and Western Massachusetts

A notable change in construction is occurring in central Massachusetts along the Connecticut River Valley (Franklin, Hampshire, and Hampden counties). Construction between 2018 and 2022 intensified, suggesting changes in land use toward and increases

in development. The development is correlated with increased growth in the cities of Springfield and Northampton. Construction permits suggest that these development patterns are likely to continue through 2030. Permits for future construction suggest that growth is likely to increase in Worcester County, where the highest concentration of construction projects is projected between 2023 and 2030. Many municipalities' local hazard mitigation plans noted that they had less than half of their land developed and identified several new developments in the planning and permitting stages (Erving Multi-Hazard Mitigation Plan Update Committee, 2020; Metropolitan Area Planning Council, 2018b; Shutesbury Hazard Mitigation Planning Team & Franklin Regional Council of Governments, 2021). Hazards like landslides and flooding were of highest concern.

Data on construction permits suggest that the Berkshires and Hilltowns region are not projected to experience significant growth. Local hazard mitigation plans confirm that most municipalities in this regions have experienced stagnation or very low growth rates (Buckland Local Natural Hazards Mitigation Planning Committee & Franklin Regional Council of Governments, 2013; City of North Adams, 2021; Town of Otis, 2022).

5.1.5.4 Updated Sources and Documents Reviewed

The Risk Assessment used a range of documents, reports, and studies to characterize the exposure, vulnerability, and consequences for each hazard. The documents reviewed included the most recent scientific literature available in Massachusetts or the Northeast United States, statewide and regional reports, and local and multi-jurisdictional hazard mitigation and climate adaptation plans, as well as studies, analyses, and research conducted at the local level.

- **Scientific literature.** The assessment team updated literature referenced in the 2018 MA SHMCAP as applicable. The literature search was restricted to articles published in peer-reviewed journals after 2018. Older references were included if they were important or foundational work, or if they represented the most current findings on a particular topic.
- **Local hazard mitigation plans.** FEMA-approved local hazard mitigation plans were reviewed and incorporated throughout the analysis. The review and incorporation of local plans is discussed in further detail in Section 5.1.4.3.2.
- **Survey.** Representatives from state agencies were surveyed as part of the 2023 MA SHMCAP development; one of the questions asked them to identify populations at risk from hazards reviewed in the Risk Assessment. The responses to the survey were completed by agency staff and did not go through a formal review process.
- **Document review exercise.** As part of the 2023 MA SHMCAP effort, a review of state agency and local jurisdiction documents, studies, and reports was conducted. The Risk Assessment draws information from reports considered in the document review exercise.

5.1.5.5 Expert Consultation and Review

The Risk Assessment team consulted with a wide array of subject matter experts (SMEs) at important stages of the process, with several opportunities for input and rounds of review. SMEs provided feedback on drafts of the Risk Assessment before the first draft was finalized. State agencies and the RMAT had an opportunity to review and comment on hazard profiles and problem statements through working group sessions and review cycles.

State agencies also participated in a survey, which included opportunities for them to comment on the impacts of each hazard. In these surveys, SMEs provided their primary concerns for assets, services, populations served, and disproportionate impacts and recommended updates or improvements to address these concerns. Summaries of these survey responses are included in the hazard risk assessments. Additional engagement included opportunities to provide comments during three 2023 MA SHMCAP working group meetings and small group meetings with SMEs on subjects including earthquakes, soils, groundwater, wildfire, and inland flooding.

The Risk Assessment received input from over 50 SMEs representing:

- Over 30 agencies and local governments, academic institutions and non-profit organizations.

5.1.5.6 Analysis of Assets at Risk and Estimated Losses

The Risk Assessment includes a discussion of the vulnerabilities of state-owned assets as well as lifelines, critical assets, and other significant assets and service areas and the consequences they face from each hazard. To evaluate risk and exposure of state assets, the Risk Assessment used data on state-owned buildings from the Division of Capital Asset Management and Maintenance. This dataset includes an inventory of over 250 types of state-owned assets; the team identified building types of highest relevance in connection to community lifelines, critical assets, and high-consequence risks for each sector. For example, in the infrastructure sector, assets such as transportation, buildings, hospitals, dams or communications, and water utilities were included in the analysis. Critical assets were defined as assets that provide critical services to protect and maintain human and environmental health and safety and included assets with high occupancies; assets used by sensitive populations; and assets that serve a residential function, such as homes, hospitals, jails, group homes, and more.

Analysis of risk considered the exposure and likelihood of damage, disruption, or loss of assets, or increased costs or time needed to address risks to critical assets. The Risk Assessment used both quantitative and qualitative measures to identify vulnerabilities and consequences; where the data were available, it included dollar value estimates of damage and disruption, as well as cost to rebuild.

In addition to the geospatial, asset, and regional or county data and analysis, the Commonwealth updated the Risk Assessment using the 2022 updated Hazus 6.0 model to estimate risk from earthquakes and hurricanes. Level 1 probabilistic analysis was used to estimate damage from peak wind gusts using the Hazus Hurricane Model. Displacement and short-term shelter needs for each county were calculated for 10-, 50-, 100-, and 500-year hurricane events. To estimate damage from earthquakes, a Level 2 probabilistic analysis was conducted using the Hazus Earthquake Model. The Hazus analysis for earthquakes includes new data on soil classification created by researchers at Tufts University published in 2023. The soils data were based on the state's surficial geology map and considered average overburden velocity, depth to bedrock, and bedrock velocity described by Pontrelli et all. (2023). The analysis considered 100-, 500-, 1,000-, and 2,500-year mean return periods using probabilistic scenarios. Further details on the data and information used to conduct each Hazus model run are presented in the relevant hazard sections.

5.1.5.7 Regional Analysis

The Risk Assessment considered global, national, state, regional, and local geographic contexts and sought to include information at the highest resolution using the most downscaled data available for each hazard and the physical, non-physical assets, ecosystems, and populations assessed. Extensive geographic information system (GIS) data from federal, state, regional, and local sources were used.

Geospatial analysis was also used to overlay hazard data with data from all five sectors and subcategories within each sector. Based on the data available, each hazard used the most downscaled information available to support the assessment. The scale of geospatial analysis varied, depending on what level was appropriate: the Risk Assessment includes location-specific, town-level, Census Block Group–level, county-level, regional, and statewide analyses as appropriate for various sections.

The Risk Assessment includes a technical appendix that documents the data sources used and the geospatial analysis conducted for all hazards. The appendix gives technical audiences the background needed to understand the data used and how each analysis was conducted.

5.1.6 Hazard Snapshots

5.1.6.1 Snapshots: Geospatial Scale of Hazards, Magnitude of Consequences, and Likelihood of Hazard and Warning Time

As part of the risk assessment process, there is a need to consider all hazards in a summarized way that enables a discussion of risk across all hazards. To do this, the Risk Assessment includes three hazard snapshots, presented as tables below. These represent

a consistent summary and comparison of all hazards, including rankings and statements across a set of consistent parameters. The Problem Statements present statements and maps, when relevant. This exercise provides a high-level overview, comparing:

- The locations and scales at which hazards are most likely to occur (Table 5.1-3)
- The likelihood that those hazards will occur (Table 5.1-4)
- The magnitude and range of anticipated/observed intensities of the hazards (Table 5.1-5)

While some hazards are more likely in the Commonwealth, all hazards identified in the 2023 MA SHMCAP come with high potential consequences, sometimes at local scales, sometimes at statewide scales. All hazards identified have a high or very high impact in at least one of three categories (human, economic, and natural environment). Some hazards are unlikely or very unlikely to occur at a significant scale (tsunamis, earthquakes), and some have primarily local impacts and consequences (landslide).

The scales used to define these relative categories are given in Section 5.1.6.2.

Table 5.1-3. Geospatial Scale of Hazards

	Impact	Consequences
Average/Extreme Temperatures	Multi-state	Multi-state
Changes in Groundwater	Statewide	Localized
Coastal Erosion	Coast-wide	Coast-wide
Coastal Flooding	Coast-wide	Statewide
Drought	Multi-state	Statewide
Earthquakes	Multi-state	Multi-state
Flooding from Precipitation	Localized	Regional
- *Dam Overtopping*	Localized	Regional
Hurricanes/Tropical Cyclones	Multi-state	Coast-wide
Invasive Species	Multi-state	Multi-state
Landslides/Mudflows	Localized	Localized
Other Severe Weather	Localized	Localized
Severe Winter Storms	Multi-state	Multi-state
Tornadoes	Multi-state	Localized
Tsunamis	Coast-wide	Statewide
Wildfires	Regional	Statewide

Table 5.1-4. Magnitude of Consequences

	Human	*Economic*	*Natural Environment*
Average/Extreme Temperatures	Very high	Medium	Very high
Changes in Groundwater	High	Medium	High
Coastal Erosion	High	Medium	High
Coastal Flooding	High	High	High
Drought	High	High	High
Earthquakes	High	Medium	Low
Flooding from Precipitation	Very high	High	Medium
- *Dam Overtopping*	High	Medium	Low
Hurricanes/Tropical Cyclones	Very high	High	Medium
Invasive Species	Medium	High	Very high
Landslides/Mudflows	High	Low	Medium
Other Severe Weather	High	Low	Low
Severe Winter Storms	Very high	Low	Low
Tornadoes	High	Medium	Medium
Tsunamis	Very high	High	Very high
Wildfires	High	Medium	Medium

Table 5.1-5. Likelihood of Hazard and Warning Time

	Likelihood	Warning Time
Average/Extreme Temperatures	Very high	1–5 days
Changes in Groundwater	High	1–5 days
Coastal Flooding	Very high	1–5 days
Coastal Erosion	Very high	More than 1 week
Drought	Medium	More than 1 week
Earthquakes	Medium	No warning
Flooding from precipitation	Very high	1–5 days
– *Dam Overtopping*	Medium	One Week
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 (24 hours)
Severe Winter Storms	High	1–5 days
Tornadoes	High	Hours
Tsunamis	Very low	Hours
Wildfires	Very high	Hours

5.1.6.2 Methods Used for Hazard Snapshots

The hazard snapshots use scales associated with aspects that affect an agency's or community's ability to prepare for, withstand, recover from, and adapt to a hazard. A stable set of factors were developed to classify hazards across dimensions that reflect location of impact, geographic scale of consequence, magnitude of consequence, likelihood of occurrence, and ability to prepare and respond. These factors are described below.

5.1.6.2.1 Location of Impact

The initial geographic reach of the hazard—that is, the locations where the hazard occurs. This ranges from multi-state to localized, as defined in Table 5.1-6 below.

Table 5.1-6. Hazard Snapshots: Geographic Scales

Multi-state	State	Regional	Coastwide	Localized
Impacts spanning several states or large regions of states	Effects on the entire state without significant overflow to other states	An area or division of the state with definable characteristics, such as counties with shared hazard-relevant conditions	One county or set of counties that experiences pronounced hazard impacts	A focused and limited area of impact

5.1.6.2.2 Geographic Scale of Consequences

The geographic reach of consequences of the hazard. This scale ranges from multi-state to localized, as defined in Table 5.1-6 above; it differs from the scale of impact in that it considers indirect consequences of the hazard. For example, if a hurricane strikes Logan Airport, thus disrupting transportation for the Northeast (and across the U.S. and the world), it has a localized scale of impact but a multi-state scale of consequences.

5.1.6.2.3 Magnitude of Consequences

The magnitude of consequence for three categories: human impacts, economic impacts, and natural environmental impacts, with a scale from very high to very low. The threshold for each ranking is provided below in Table 5.1-7.

Table 5.1-7. Hazard Snapshots: Magnitude of Consequences

	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	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

	Very High	High	Medium	Low	Very Low
		last several years after a disaster			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

5.1.6.3 Likelihood of Occurrence

This ranking considers likelihood that a hazard will occur and that consequences will result from the hazard occurring. 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. The scale below allows all hazards to be compared. The scientific knowledge available to predict or estimate an exact probability or likelihood of a hazard occurring varies significantly across hazards. As a result, the Risk Assessment team used a scale with five grades and ranked the likelihood of consequences from very high to very low using the criteria defined in Table 5.1-8. The results are illustrated in the first column of Table 5.1-5 under "Likelihood of Hazard and Warning Time".

Table 5.1-8. Hazard Snapshots: Likelihood of an Occurrence Resulting in Consequences

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

5.1.6.4 Warning Time

The time available for preparation between reliable predictions of a hazard and the onset of that hazard. The scale ranges from "no warning" to "one week or more," as defined in

Table 5.1-9 below. (For more information on warning time in relationship to risk, see Section 5.1.4.3.2.)

Table 5.1-9. Hazard Snapshots: Warning Time

No Warning	*Hours*	*1 Day (24 Hours)*	*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

5.1.7 Technological and Human-Caused Hazards

The 2018 MA SHMCAP discussed technological and human-caused hazards as well as the separate hazard identification and risk assessment (HIRA) process. The inclusion of technological and human-caused hazards demonstrates that the Commonwealth's Emergency Management Program accounts for both natural and non-natural hazards to aid in maintaining the Commonwealth's Emergency Management Accreditation Program (EMAP) accreditation.

This section provides updates to the review of state emergency management plans that assess hazards in the technological and human-caused category. This HIRA undertakes an all-hazards identification, classification, and vulnerability indexing process to ensure risk analysis is comprehensive and all-encompassing.

For the purposes of the HIRA, a natural 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. In addition, a human-caused hazard includes any disastrous event caused directly and principally by one or more identifiably deliberate or negligent human actions, while a technological hazard is a hazard originating from technological or industrial conditions, including accidents, dangerous procedures, or failures.

To update the summary of mitigation plans and studies on technological and human-caused hazards, some human-caused hazards are discussed in this section, separately from the 15 main hazards in the 2023 MA SHMCAP Risk Assessment.

The following hazards are not analyzed in the Risk Assessment or action strategy because their subject matter diverges from the natural or climate change–influenced hazard categories. The 2018 SHMCAP identified the following non-natural threats. The threats in the following table are discussed in Section 6 of the 2023 Risk Assessment Introduction:

Deliberate Acts	Technological Hazards
• Cyber incident • Terrorism • Active shooter • Civil unrest • Chemical, biological, radiological, nuclear incident	• Infrastructure failure • Hazard material accident/spills • Nuclear power plant event • Major air crash • Dam failure

These threats are still relevant to the Commonwealth. Additionally, pandemics are a significant human-caused hazard that was not listed in the 2018 SHMCAP. The HIRA will act as the comprehensive all-hazards identification, assessment, and consequence analysis for the Commonwealth's Emergency Management Program.

5.1.7.1 Massachusetts THIRA/SPR

In 2018, FEMA issued updated guidelines that require the state administrative agency and urban area (as designated under the Urban Areas Security Initiative) receiving FEMA Preparedness Grant funding to complete and submit a Threat Hazard Identification and Risk Assessment (THIRA) every three years and submit annually a Stakeholder Preparedness Review (SPR) to the FEMA regional federal preparedness coordinator. The Comprehensive Preparedness Guide (CPG) 201 was issued by FEMA to provide guidance for conducting a THIRA/SPR (FEMA, 2018). The Commonwealth maintains a THIRA that is developed following CPG 201 and updated every three years; the THIRA serves as a risk assessment and consequence analysis process for technological and human-caused hazards as well as some natural hazards that are addressed in the HIRA included in this SHMCAP. The last version of the THIRA involves stakeholders representing local, regional, and state government offices, the Federal Government, as well as nongovernmental organizations (NGOs) and the private sector.

The Massachusetts THIRA/SPR follows a three-step tri-annual process and a three-step annual SPR process, as described in CPG 201:

5.1.7.1.1 THIRA Three Step Process

Step 1. **Identify the Threats and Hazards of Concern.** Based on a combination of experience, forecasting, expert judgment, and other available resources, identify a list of the threats and hazards of primary concern to a community.

Step 2. **Give the Threats and Hazards Context.** Describe the threats and hazards of concern, showing how they may affect a community.

Step 3. **Establish Capability Targets.** Assess each threat and hazard in context to develop a specific capability target for each core capability. The capability target defines success for the capability. This step consists of two sub steps: the first is to develop impact and outcome statements, and the second is to establish targets. The capability targets outlined in the most recent THIRA were integrated into the goals of this SHMCAP.

5.1.7.1.2 SPR Three Step Process

Step 1. **Assess Capabilities.** Based on the language from the capability targets set in THIRA Step 3, identify the community's current capability and how that capability changed over the last year, including capabilities lost, sustained, and built. Then, provide additional context to explain the reported data and its sources.

Step 2. **Identify Capability Gaps and Intended Approaches to Address Them.** Determine the causes of the capability gap between the capability target and the current capability identified in SPR Step 1. Then, describe the actions and investments needed to close the capability gap or sustain the capability.

Step 3. **Describe the Impacts of Funding Sources.** Identify how relevant funding sources, including but not limited to grant programs and the community's own resources, helped to build, or sustain the capabilities assessed by the capability targets and describe how those capabilities were used in a real-world incident(s) over the past year.

5.1.7.1.3 Comprehensive Emergency Management Plan

The Commonwealth of Massachusetts' Comprehensive Emergency Management Plan (CEMP) provides a framework for state-level emergency management activities and defines how state government interfaces with other emergency management stakeholders, including local and tribal governments, non-governmental organizations (NGOs), other states, the federal government, and the private sector during all phases of an emergency or disaster.

The CEMP describes the system that will be used by the Commonwealth of Massachusetts to prepare for, respond to, recover from, and mitigate an emergency or disaster. It also identifies and assigns specific areas of responsibility for coordinating resources to support the Commonwealth's response to an emergency or disaster. The CEMP is an all-hazards plan, developed to address the Commonwealth's unique natural, technological, and human-caused hazards.

The Commonwealth has structured its CEMP into three distinct, but interconnected volumes:

- Volume 1: Massachusetts State Hazard Mitigation and Climate Adaptation Plan
- Volume 2: Response and Short-Term Recovery Plan

- Volume 3: Long-Term Recovery Plan

Volume 1 of the State CEMP is the State Hazard Mitigation and Climate Adaption Plan (SHMCAP). The SHMCAP was approved by FEMA in September 2023. Pursuant to the requirements of 44 CFR 201.4, the SHMCAP is required to focus on natural hazards that are likely to cause a substantial impact on the state. Additionally, it accounts for projected changes in precipitation, temperature, sea level rise, and extreme weather events to position the Commonwealth to effectively reduce the risks associated with natural hazards and the effects of climate change. The SHMCAP complies with federal requirements for state hazard mitigation plans and maintains the Commonwealth's eligibility for federal disaster recovery and hazard mitigation funding under the Stafford Act.

In terms of hazard mitigation activities, the Commonwealth of Massachusetts participates in federal, state, and local mitigation programs and identifies ongoing mitigation opportunities. The State takes advantage of available federal funding to implement mitigation measures at the state and local levels. Throughout the past several years, a substantial amount of funding has been directed at understanding and addressing some of the Commonwealth's most pressing hazards and their climate impacts.

Volume 2 of the CEMP, Response and Short-Term Recovery Plan is comprised of:

- The base plan
- 16 Emergency Support Function (ESF) Annexes
- Hazard-or Threat Specific Annexes
- Functional Annexes.

This Plan forms the overall framework for emergency response and short-term recovery operations in the Commonwealth. The ESF annexes describe the policies, planning assumptions, concepts of operations and responsibilities for their activities while the hazard- or threat specific and functional annexes contain specialized information and procedures required to address specific types of incidents or events. Both hazard- or threat-specific and functional annexes are maintained separately from this Plan but are incorporated by reference.

Volume 3 of the State CEMP is the Long-Term Recovery Plan. Volume 3 includes the mechanisms for utilizing long-term recovery components, including mitigation, which is provided for under the Robert T. Stafford Disaster Relief and Emergency Assistance Act. Volume 3 sets the foundation for the State's Recovery Support Functions (RSFs) designed to effectively interoperate with federal disaster recovery components as identified in the National Disaster Recovery Framework (NDRF). Volume 3 also recognizes the primacy of local governments in the implementation of long-term recovery plans and, depending on the nature and impact of the disaster, new programs that might be available to achieve full recovery.

Please see the CEMP for a list of annexes, which illustrate the extent of natural, technological, and human-caused hazards that are addressed through the CEMP.

5.1.7.1.4 Infectious Disease Emergency Response

The Massachusetts Department of Public Health (MDPH) Infectious Disease Emergency Response (IDER) Plan defines the MDPH's concept of operations for an infectious disease emergency response. At its core, the goal of the IDER is to mitigate the impact of a disease outbreak caused by an infectious agent or biological toxin, or to respond to other infectious disease emergencies. The Bureau of Infectious Disease and Laboratory Sciences (BIDLS) closely monitors infectious disease activity as part of their normal operating procedures. As a result of constant engagement with infectious disease experts and resources, BIDLS may receive information that suggests or indicates a potential or real public health threat. Once that information is assessed the IDER may be activated if needed.

This emergency response plan may be activated for an outbreak of an existing reportable condition, emerging infectious disease, pandemic, or suspected bioterrorism event that threatens the public's health. An infectious disease emergency will require timely and effective use of public health and medical resources, including facilities, personnel, equipment, mental and behavioral health services, and pharmaceutical and other supplies. The need for resources during an infectious disease emergency may exceed routine operations and overwhelm resources available at the local, tribal, regional, and state levels.

5.1.7.2 Nuclear Plans

The Pilgrim Nuclear Power Station ("Pilgrim") is in Plymouth, Massachusetts. Pilgrim permanently ceased power generation operations on May 31, 2019, and is currently being decommissioned. The Massachusetts Emergency Management Agency (MEMA) communicates radiological emergency response plans and standard operating procedures for communities and facilities falling within the Massachusetts portion of the Seabrook Nuclear Power Emergency Planning Zone. The information is communicated through the Emergency Public Information for Seabrook Nuclear Power Station.[1]

5.1.8 Hazard Profiles

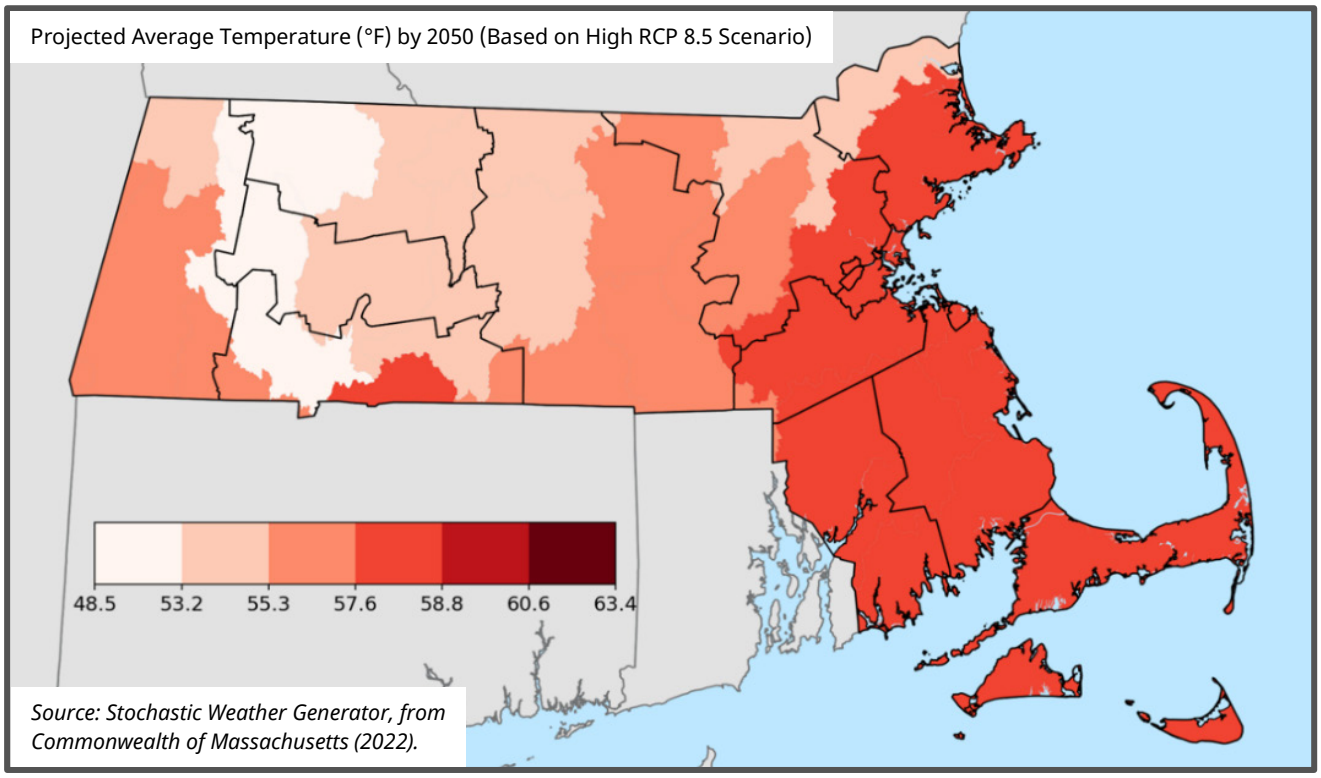
The 15 hazard profiles on the following pages provide high-level summaries of the hazard risk assessments, able to serve as a stand-alone document. For more information on their content and purpose, see Section 5.1.4.1.

Appendix 5.C includes detailed information on the risk assessment and hazard analysis of the 15 hazards presented in the 2023 MA SHMCAP.

[1] Emergency Public Information for Seabrook Nuclear Power Station information is available at the following link: https://www.mass.gov/info-details/seabrook-nuclear-power-station#seabrook-emergency-planning-zone-(epz)-

Average/Extreme Temperatures Hazard Profile

Temperatures vary across Massachusetts, with higher temperatures typical in the southeast and colder ones in the northwest. The *2022 Massachusetts Climate Change Assessment* predicts that temperatures are almost certain to rise across the Commonwealth. Humidity will rise as well, causing hot days to feel even hotter. These changes could have significant consequences for human and ecosystem health, as human populations and ecosystems in Massachusuetts are not adapted or accustomed to these temperatures. Projections show that inland areas are very likely to warm more and experience more extreme heat than coastal areas.



Source: Stochastic Weather Generator, from Commonwealth of Massachusetts (2022).

Most At-Risk Areas

Inland areas are very likely to experience extreme temperatures more often than coastal areas, as they are not moderated by the Atlantic Ocean. Urban areas experience greater temperatures due to the urban heat island effect.

Cause

Temperature variations occur due to several atmospheric phenomena. Increased greenhouse gas emissions from human activities are contributing to an increase in the earth's surface temperature, causing more extreme temperatures.

Historical Frequency and Recent Trends

2022 was one of the hottest and driest summers on record in Massachusetts. Over the last century, annual air temperatures increased at an average rate of 0.5°F per decade. Massachusetts' hottest recorded temperature was 107°F in August 1975. Its coldest was -35°F in February 1943.

Projected Effects of Climate Change

Climate change is already contributing to increasing average temperatures and more extreme temperatures and is virtually certain to continue doing so. Climate change in the near term is also likely to contribute more severe winter storms, bringing colder temperatures, even if the winter season overall is shorter.

Secondary Hazards from Temperature:

- Severe weather events such as hurricanes, increases in precipitation intensity (e.g., inches/hour) and amount (e.g., inches), and more severe winter storms.
- Longer, more severe droughts and a longer, more severe wildfire season.
- Invasive species, habitat shifts, and surface water warming.

Average/Extreme Temperatures Hazard Profile

Impacts to Sectors:

Human

Impacts to people's health, welfare, and safety.

- Extreme temperature is the leading cause of weather-related mortality in the U.S.
- Reductions in air quality can lead to lung and respiratory diseases and require medical visits and costly prescriptions, in addition to resulting in death. Currently, one in eight children in Massachusetts suffers from asthma.
- Age and chronic health conditions can also increase susceptibility to heat-related illnesses.
- Environmental justice populations are particularly at risk from extreme temperature–related health effects because they reside in temperature hotspots. Linguistically isolated populations are most disproportionately exposed to this hazard.
- Black and African American people are 40% more likely to live in areas with high childhood asthma rates.
- The majority of extreme heat impacts fall in the Eastern Inland and Boston Harbor regions.

Infrastructure

Impacts to buildings, transportation systems, and electricity and water systems.

- Damage to roads and loss of road service.
- Damage to rail and loss of rail/transit service.
- Damage to electric transmission and utility distribution infrastructure.
- Pipes freezing and bursting due to extreme cold, leading to flooding and water damage/mold inside homes and buildings.
- Loss of urban tree cover.
- Potential impacts to critical facilities, such as water infrastructure and emergency response infrastructure.

Economy

Impacts to people's ability to work and make a living due to damage to infrastructure, our natural environment, or people's health.

- Reduced ability to work.
- Decrease in marine fisheries and aquaculture productivity.
- Decrease in agricultural productivity.
- Increased possible cost for water and electricity, caused by higher demand.

Governance

Impacts to state and local government–owned buildings, government finances, and the ability of the government to run effectively.

- Increased demand for state and municipal government services. All state-owned buildings are exposed to extreme temperatures, increasing government expenditures for energy and maintenance.
- Increase in government expenditures to coordinate between state agencies and municipalities for adaptation efforts.
- Health risks and reduced productivity for state employees who work outdoors.

Natural Environment

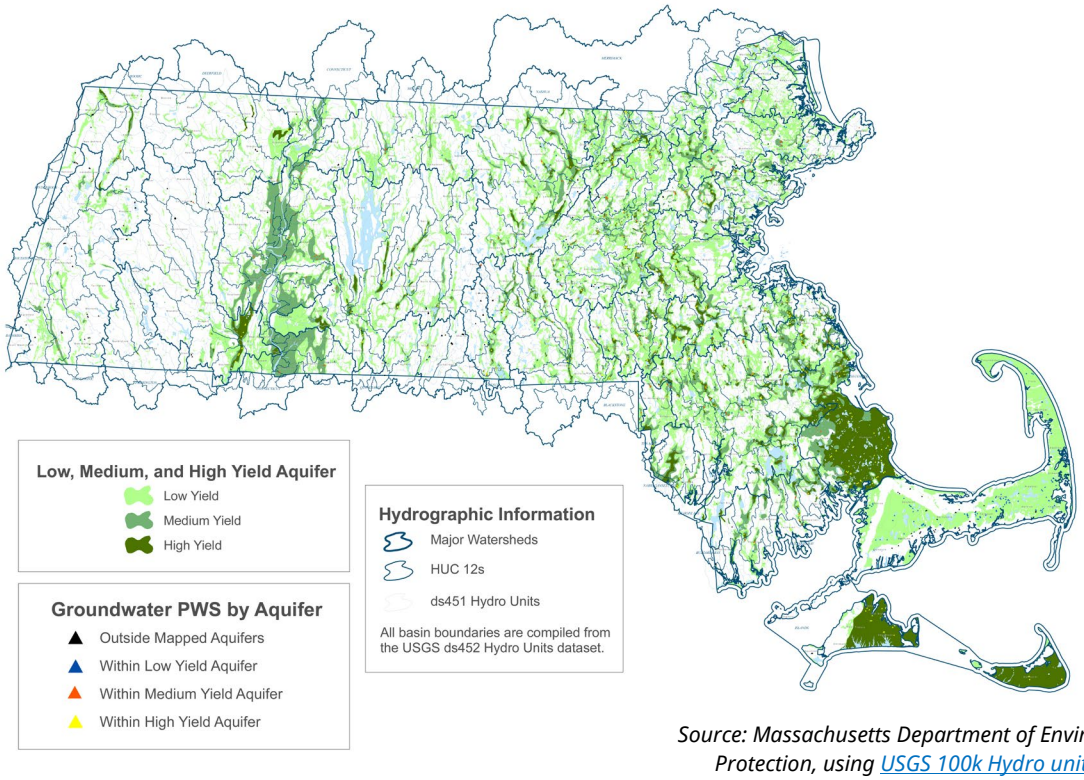
Impacts to ecosystems and natural resources, and how plants and animals can thrive there.

- Shifting distribution of native and invasive species.
- Negative impacts on the Commonwealth's natural resources—such as wetland, cold-water, marine, and forested ecosystems; agricultural resources; and open space—due to temperature increases.
- Reduced ecosystem services, such as carbon sequestration and storage in forests or water filtering in coastal wetlands, due to ecosystem stress.
- Stress to ecosystems from secondary hazards associated with increased temperatures such as drought, invasive species, wildfire, and more varied intensity and frequency of rainfall.

Changes in Groundwater Hazard Profile

There are three primary risks associated with groundwater in Massachusetts: increase in groundwater levels, groundwater resource depletion, and contamination of groundwater by pollution and salinity changes from sea level rise and flooding. Shallow, unconstrained, unconfined aquifers are likely to interact with the surface and can affect local temperatures. Groundwater recharge depends on precipitation, water evaporation from the land surface and vegetation, snowpack and timing of snowmelt, hydrologic connectivity zones, and geological features that influence permeability and water flow. Issues associated with groundwater vary by region, season, and topography and are influenced by hazards such as sea level rise, flooding, heat, drought, and extreme precipitation as well as development patterns and flood management measures that reduce permeability of soils.

Map of Aquifers (Low, Medium, and High Yield)



Source: Massachusetts Department of Environmental Protection, using USGS 100k Hydro units dataset.

Most At-Risk Areas

Changes in groundwater affect the entire state. They can lead to flooding, instability in structures, and effects on drinking water availability.

Cause

Above-average increases or decreases in groundwater create risk. They are a result of changes in the water cycle. Sea level rise affects groundwater in coastal areas.

Historical Frequency and Recent Trends

There are no published data on historical frequency or recent trend data associated with groundwater hazards. There are historical trends and projections for seasonal groundwater recharge in Massachusetts.

Projected Effects of Climate Change

Sea level rise, extreme heat, drought, extreme precipitation, and a reduction in snow are all climate change impacts that will affect groundwater. Risks will vary by season and location and type of change.

Secondary Hazards from Changes in Groundwater:

- Depleted groundwater reserves can increase drought, affecting the environment and communities.
- Groundwater rise can lead to coastal and inland flooding. Contamination can mobilize during flooding events, with impacts to waters, soils, ecosystems, and communities.
- Shallow aquifers are likely to interact with the surface and experience increases in temperature, amplifying heat island effects.

Changes in Groundwater Hazard Profile

Impacts to Sectors:

Human

Impacts to people's health, welfare, and safety.

- Reduced access to and increased cost of freshwater for drinking and other uses (e.g., agriculture) from saltwater intrusion, contaminants, or depleted aquifers.
- Flooding and damage to basements and below-grade living spaces, creating risk of contamination, mold, and injury.
- Damage and disruption to water, sewer, stormwater, or power service from flooding that affects below-grade utilities and infrastructure.
- Salinity intrusion, caused by sea level rise, that affects salt-sensitive components of people's homes and other assets.
- Septic system failure leading to water quality degradation in nearby waterways and increased bacterial exposure.

Infrastructure

Impacts to buildings, transportation systems, and electricity and water systems.

- Damage, disruption, or loss to below-grade buildings and foundations of buildings due to flooding or unstable soils.
- Damage, disruption, or loss to below-grade or at-grade utilities, infrastructure, roads, and transit (including power, heat, water, sewer, and stormwater services) due to flooding or unstable soils.
- Damage to building foundations, as well as salt-sensitive infrastructure and utilities, from salinity intrusion.
- Mobilization of contaminants.
- Cost to repair or relocate due to flood damage.

Economy

Impacts to people's ability to work and make a living due to damage to infrastructure, our natural environment, or people's health.

- Costs to businesses and industries, particularly small businesses and water-related and -dependent businesses, due to increased flooding or reduced water supply.
- Increased costs for alternative sources of water such as desalination.
- Disruption of utility and infrastructure creating travel delays or lack of water, power, or sewer service.
- Flooding impacts on at-grade roads and infrastructure. (Government facilities with basements and below-ground areas are most heavily affected.)
- Cost of damage from flooding, especially in areas of repetitive loss.

Governance

Impacts to state and local government–owned buildings, government finances, and the ability of the government to run effectively.

- Increased demand for state and municipal government services and resources to conduct studies, run programs, develop policies, and engage locally to better understand the risks and mitigate the impacts.
- Flooding or salinity intrusion to state-owned assets including structures, parks, trails, natural areas, and others.
- Cost to repair or relocate state-owned assets at risk from or damaged by groundwater rise.
- Cost to identify alternative water sources for state-owned assets if supplies are depleted or (due to saltwater intrusion or groundwater rise) contaminated.

Natural Environment

Impacts to ecosystems and natural resources, and how plants and animals can thrive there.

- Damage to habitats, natural areas, and wetlands due to reduced freshwater supplies from groundwater recharge.
- Saltwater intrusion and inundation of aquifers, wetlands, and ecosystems that cannot adapt to new conditions due to sea level rise.
- Mobilization of contaminants into habitats, vegetation, and wetlands.
- Higher risk of wildfires, invasive species, and reduced health of native species, caused by drought and heat resulting from less groundwater in the ecosystem.
- Changes to groundwater temperature in urban environments, which can amplify heat island effects and stress vegetation and urban trees.

Coastal Erosion Hazard Profile

Coastal erosion affects populations, structures, and the environment along the coastline of the Commonwealth. High-risk areas include communities and ecosystems near developed barrier beaches, dunes, and coastal banks. Climate change impacts such as sea level rise and the increased intensity and frequency of coastal storms also contribute to increased coastal erosion. The combination of human activity along the shoreline and climate impacts can result in a net loss of coastal land. Massachusetts has 1,500 miles of coastline that includes a range of coastal landforms, habitats, developed lands, and infrastructure and utilities that are susceptible to coastal erosion.

Most At-Risk Areas

Most of the coastline is eroding. Urban shorelines with failing seawalls and no dry beach are the most susceptible to damage.

Cause

Coastal erosion is caused by many processes including waves, tides, storms, sea level rise, development, and shoreline armoring.

Historical Frequency and Recent Trends

Coastal erosion can be constant and episodic. Accelerated sea level rise will increase rates of erosion where change is already occurring. Storm intensity associated with climate change may contribute to episodic erosion.

Projected Effects of Climate Change

Sea level rise will increase the coastal areas exposed to wave and tidal action and reduce natural shoreline buffers. The changing intensity, frequency, and duration of coastal storms, including Nor'easters and hurricanes, will increase the rate of coastal erosion in areas already experiencing it. Research is needed to understand climate change impacts on the location, speed, and profile of erosion.

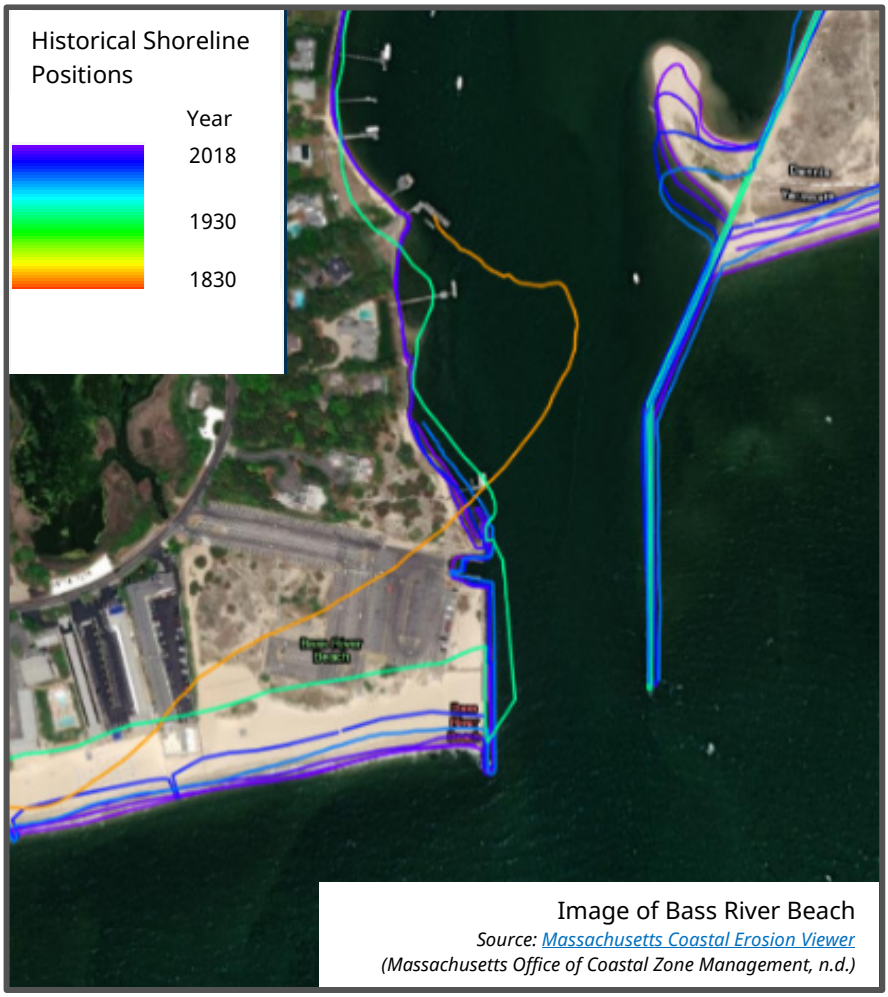


Image of Bass River Beach
Source: Massachusetts Coastal Erosion Viewer (Massachusetts Office of Coastal Zone Management, n.d.)

Secondary Hazards from Coastal Erosion:

- Landslides and loss of sediment and vegetation, with impacts to native species.
- Profile steepening or flattening, resulting in changes to flood risk.
- Changes in areal extent exposed to flooding, with resulting changes in land use.
- Mobilization of contaminants into water sources and the environment.

Coastal Erosion Hazard Profile

Impacts to Sectors:

Human

Impacts to people's health, welfare, and safety.

- Loss of life or injury may result from episodic and dramatic events of coastal erosion resulting from landslides and flooding.
- Property, homes, community assets, and neighborhoods may be lost to erosion and associated increased flood risk.
- Community assets and services such as parks, schools, businesses, roadways, and utilities are at risk of being damaged, disrupted, or lost.
- Cultural and archaeological resources are at risk of damage, disruption, and loss.
- Damage to sewer infrastructure and septic systems may lead to degradation of water quality: sewer leaks may release bacteria, red tides may result in gastrointestinal infections, and contaminated water may cause water-borne illness.

Infrastructure

Impacts to buildings, transportation systems, and electricity and water systems.

- Damage, disruption, or loss of coastal homes.
- Damage, disruption, or loss of utilities and infrastructure, particularly underground, linear infrastructure including water supply, sewers, power, roadways, rail, and recreational areas including trails.
- Damage or loss of shoreline flood management infrastructure.
- Damage, disruption, or loss of infrastructure to support water-dependent and water-related uses such as maritime, fisheries, and other industries.

Economy

Impacts to people's ability to work and make a living due to damage to infrastructure, our natural environment, or people's health.

- Damage, disruption, or loss of businesses in coastal areas, particularly small businesses and water-related and -dependent businesses.
- Loss or disruption of visitors and tourism spending.
- Loss or disruption to jobs and workforce.
- Disruption of utility and infrastructure that creates travel delays or lack of water, power, or sewer services.
- Erosion damage to 130 state-owned assets within 50 feet of the coast in at-risk areas in Barnstable, Bristol, Essex, Middlesex, Plymouth, and Suffolk counties.

Governance

Impacts to state and local government–owned buildings, government finances, and the ability of the government to run effectively.

- Increased demand for state and municipal government services and resources to conduct studies, run programs, develop policies, and engage locally.
- Demand for public safety and first responder services in preparation for incidents that may result in rapid episodes of coastal erosion.
- Loss of, disruption of, or damage to state-owned assets including structures, parks, trails, and natural areas. Increased cost to repair or relocate state-owned assets at risk from or damaged by coastal erosion.

Natural Environment

Impacts to ecosystems and natural resources, and how plants and animals can thrive there.

- Potential loss of uplands that support native species and provide wetland–upland transition zones.
- Loss of wetland and salt marsh shoreline functions, including habitat for native species, filtering pollutants, trapping and retaining sediment, and buffering the shoreline from wave energy and storms.
- Coastal erosion can accelerate impacts from sea level rise like saltwater intrusion and inundation, putting pressure on habitats and ecosystems that cannot quickly adapt to new conditions.
- Loss of biodiversity, natural resources, and state-owned natural areas, as well as disruption to ecosystem function along the coast.

Coastal Flooding Hazard Profile

Coastal regions of Massachusetts are increasingly susceptible to the risks of coastal flooding which are exhasterbated by to climate change impacts such as sea level rise and increased intensity of coastal storms. Coastal flooding results from a several factors, including waves, high astronomical tides, storm surges, and rising sea levels. Storm surges occur during hurricanes and nor'easters, when low barometic pressures and wind-driven water combine to push coastal water landward. Sea level rise is expected to accelerate and storm surge and coastal windstorm intensity are also expected to intensify as global temperatures rise. These conditions further increasing risks of damaging flood episodes.

Most At-Risk Areas

All coastal regions are at risk. However, the Boston Harbor region currently experiences about half of the average annual statewide impact from coastal flooding.

Cause

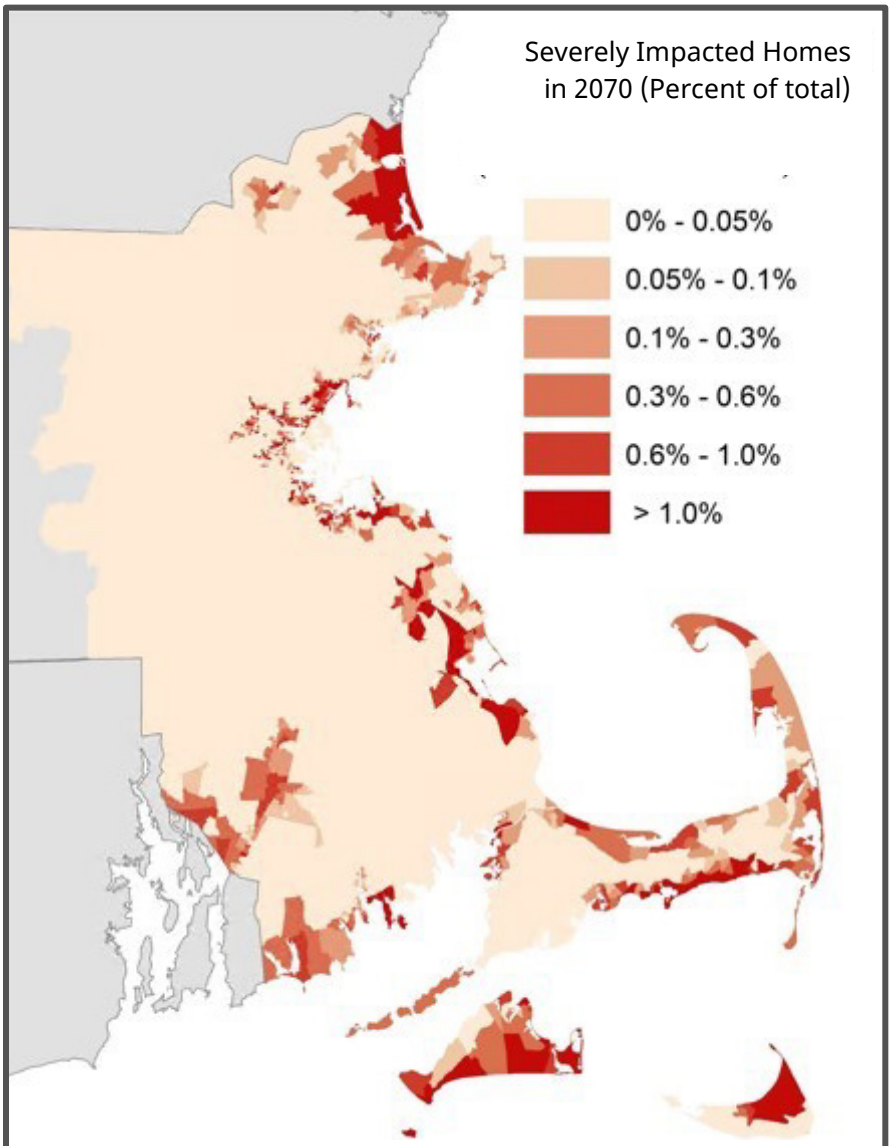
Coastal flooding is caused primarily by wind-driven waves combined with low barometric pressure during coastal storms, but is worsened by sea level rise, as is king tide flooding.

Historical Frequency and Recent Trends

The rate of sea level rise (SLR) could accelerate to 6.0 mm/year by mid- to late century. Boston Harbor tide gauge data show SLR at a current rate of 2.9 (+/- 0.15) mm/year. Coastal flooding could generate annual damages between $150 and $200 million (current storm activity, 2008 sea-levels).

Projected Effects of Climate Change

Rising temperatures accelerate thermal expansion and ice sheet melting, accelerating sea level rise—which in turn elevates daily and seasonal high tides, causing high-tide flooding. Rising temperatures also increase the frequency and severity of hurricanes and nor'easters, which could result in increased coastal flooding.



Source: MA Climate Assessment analysis of MC-FRM results using methods from Neumann et al. (2021).

Secondary Hazards from Coastal Flooding:

- Disruption, damage to or destruction of power, gas, water, broadband, and oil transmission infrastructure. Shutdown of mass transit, airports, roads, bridges, and other transportation systems.
- Indirect effects from damage to ports and marinas, including supply chain interruptions.
- Saltwater intrusion in to drinking water resources.
- Loss of jobs, wages, business revenue and childcare facilities.

Coastal Flooding Hazard Profile

Impacts to Sectors:

Human

Impacts to people's health, welfare, and safety.

- Coastal flooding affects populations who cannot evacuate quickly (e.g., people aged over 65 or under five, people with mobility limitations), as well as residents in rural areas with limited access to services.
- Extreme coastal storms can cause direct health impacts in the form of injuries or fatalities.
- Coastal flooding increases building moisture and exposure to mold, leading to respiratory health effects.
- Coastal storms can increase rates of food spoilage and bacterial infection during power outages.
- Contact with flood waters may lead to bacterial and/or toxic chemical exposure.
- Coastal flooding can cause loss of housing (permanently or temporarily) and subsequent physical displacement and financial burden to flood victims.

Infrastructure

Impacts to buildings, transportation systems, and electricity and water systems.

- Coastal flooding and higher seas inundate land and structures, erode beaches, and lead to more damaging storm surges, which can cause devastating episodic flooding.
- Coastal storms can damage roads, bridges, and culverts. This can cause loss or blockage of evacuation routes.
- The total value of structures within the floodplain for the current 100-year return period coastal storm is about $55 billion, of which about $40 billion is residential, $12 billion is industrial, and $2.5 billion is commercial. The number of vulnerable infrastructure assets and anticipated loss will grow over time as rising seas expand the coastal floodplain.

Economy

Impacts to people's ability to work and make a living due to damage to infrastructure, our natural environment, or people's health.

- High-tide flooding, exacerbated by rising seas, leads to traffic delays that affect people's ability to work.
- Coastal flooding can cause losses in revenue due to flood-induced business interruptions, damage to port infrastructure relied on for commercial fishing, and a decrease in beach tourism.
- Massachusetts is second in the nation in the percentage of federally subsidized affordable housing units vulnerable to coastal flood risk. Risks by 2050 are largest in Boston (3,189 units exposed per year), Quincy (668 units), Cambridge (510 units), and Revere (266 units).
- Massachusetts state-subsidized public housing accounts for 47 developments of housing at high risk for coastal flooding.

Governance

Impacts to state and local government–owned buildings, government finances, and the ability of the government to run effectively.

- Loss of coastal property threatens the property tax base and possible loss of tax revenue in coastal cities and towns.
- Annual expected loss of or damage to state-owned buildings and infrastructure is estimated at $8 million currently and may grow to $36 million by 2050.
- The largest risks to state-owned buildings and infrastructure are in the Cape/Islands/South Coast and the Boston Harbor regions.

Natural Environment

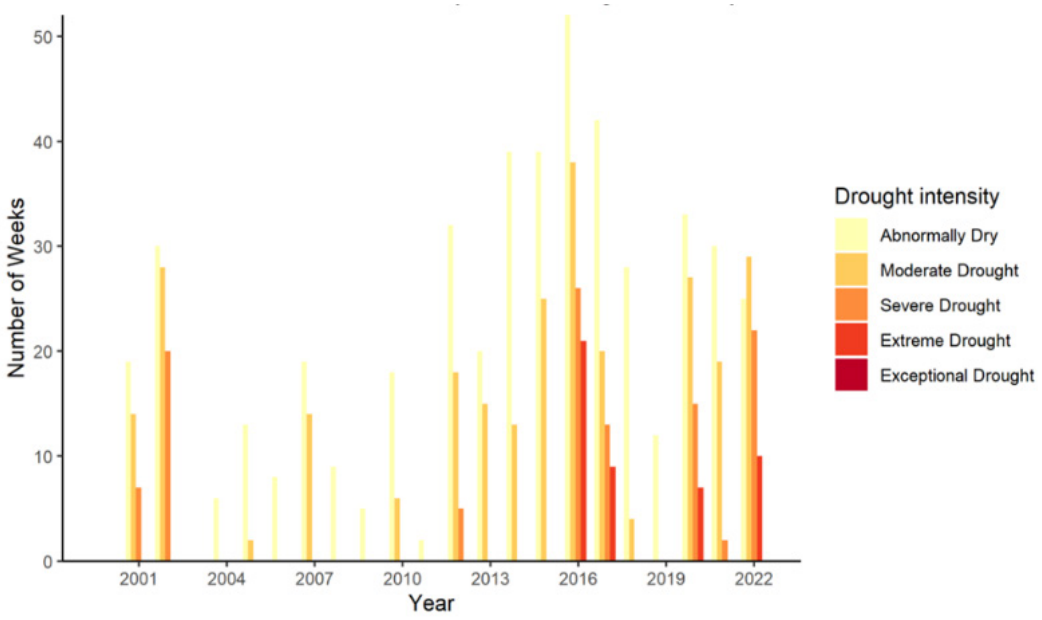
Impacts to ecosystems and natural resources, and how plants and animals can thrive there.

- Intensified coastal flooding threatens the viability of coastal wetlands, where natural processes of accretion cannot keep up with accelerating rates of change in sea levels.
- Modeling of the effect of higher sea levels on marshes concludes that roughly half of today's total salt marsh area in the Commonwealth could be lost by 2100.
- Loss of salt marshes and other shoreline habitats due to sea level rise and sea level rise–induced accelerated coastal erosion results in negative impacts to species dependent on these habitats (e.g., waterfowl, wading and coastal shorebirds, juvenile marine fish).

Drought Hazard Profile

More than 6 million Massachusetts residents receive their water from public water suppliers, while over 500,000 residents rely on their own private groundwater wells. In addition to impacting residential, commercial, and industrial water supply, droughts across Massachusetts can have implications on public health, agricultural crops, recreation, and natural resources. Approximately 10 percent (500,000 of 4.9 million acres) of Massachusetts is agricultural land, located primarily in Franklin County, Plymouth County, and Hampshire County. There are about 3 million acres of core habitat and critical natural landscape in the Commonwealth that support native and rare species, maintain ecological connectivity, and provide recreational value.

Number of Weeks in Drought Conditions (2001–2022)



Source: Massachusetts Executive Office of Energy and Environmental Affairs & Massachusetts Emergency Management Agency

Most At-Risk Areas

The entire Commonwealth is exposed to drought. The most at-risk assets include agriculture, natural lands and waters, and groundwater and aquifers. From 2001 to 2017, the Connecticut River Valley region and Central region experienced extreme drought.

Cause

Droughts are caused by low precipitation and high evapotranspiration. Land use change, the existence of dams, and water supply withdrawals or diversions also contribute to drought conditions.

Historical Frequency and Recent Trends

Disaster-level drought is infrequent in Massachusetts. As of 2022, the Commonwealth has not received a drought-related Presidentially Declared Disaster. The 2016–2017 drought was the most significant drought in recent years.

Projected Effects of Climate Change

Rising temperatures and changes in precipitation patterns are expected to increase the length, frequency, and intensity of droughts. Reduced snowpack will affect the ability of groundwater supplies to recharge and the availability of water for the growing period.

Secondary Hazards from Drought:

- Reduced quantity and quality of streamflow, groundwater, and surface water stored in lakes and ponds.
- Potential impairment to wetlands bordering rivers and streams, or loss of riverfront areas in headwaters.
- Increased susceptibility of urban tree cover and forest health to wildfire and invasive pests.
- Reduced bank stability from dry soil in root zones, potentially leading to increased erosion.
- Increased contamination of freshwater ecosystems (i.e., harmful algal blooms) during drought conditions.

Impacts to Sectors:

Human

Impacts to people's health, welfare, and safety.

- Decrease in yields or dry wells for residents with private water supplies.
- Increase in prices and water rationing for people who receive water through a public provider.
- Reduction in food safety and security.
- Increase in mental health stressors.
- Increase in health effects from aeroallergens and mold.
- Increase in vector-borne diseases and bacterial infections.

Infrastructure

Impacts to buildings, transportation systems, and electricity and water systems.

- Reduction in clean water supply.
- Increased strain on public water utilities.
- Need for alternate supplies, such as emergency backup water supplies.
- Impacts on energy generation that requires water for cooling.
- Loss of urban tree cover.

Economy

Impacts to people's ability to work and make a living due to damage to infrastructure, our natural environment, or people's health.

- Decrease in agricultural productivity.
- Increase in food prices due to recued yield or loss of crops and the need to purchase water.
- Loss of income for farms and farm workers.
- Disproportionate impacts on water-dependent industries such as nurseries and hydroelectric power generation.

Governance

Impacts to state and local government-owned buildings, government finances, and the ability of the government to run effectively.

- Increased demand for state and municipal government services.
- Impacts to wildfire firefighting due to water shortages.
- Disruption in landscaping at parks and natural areas.

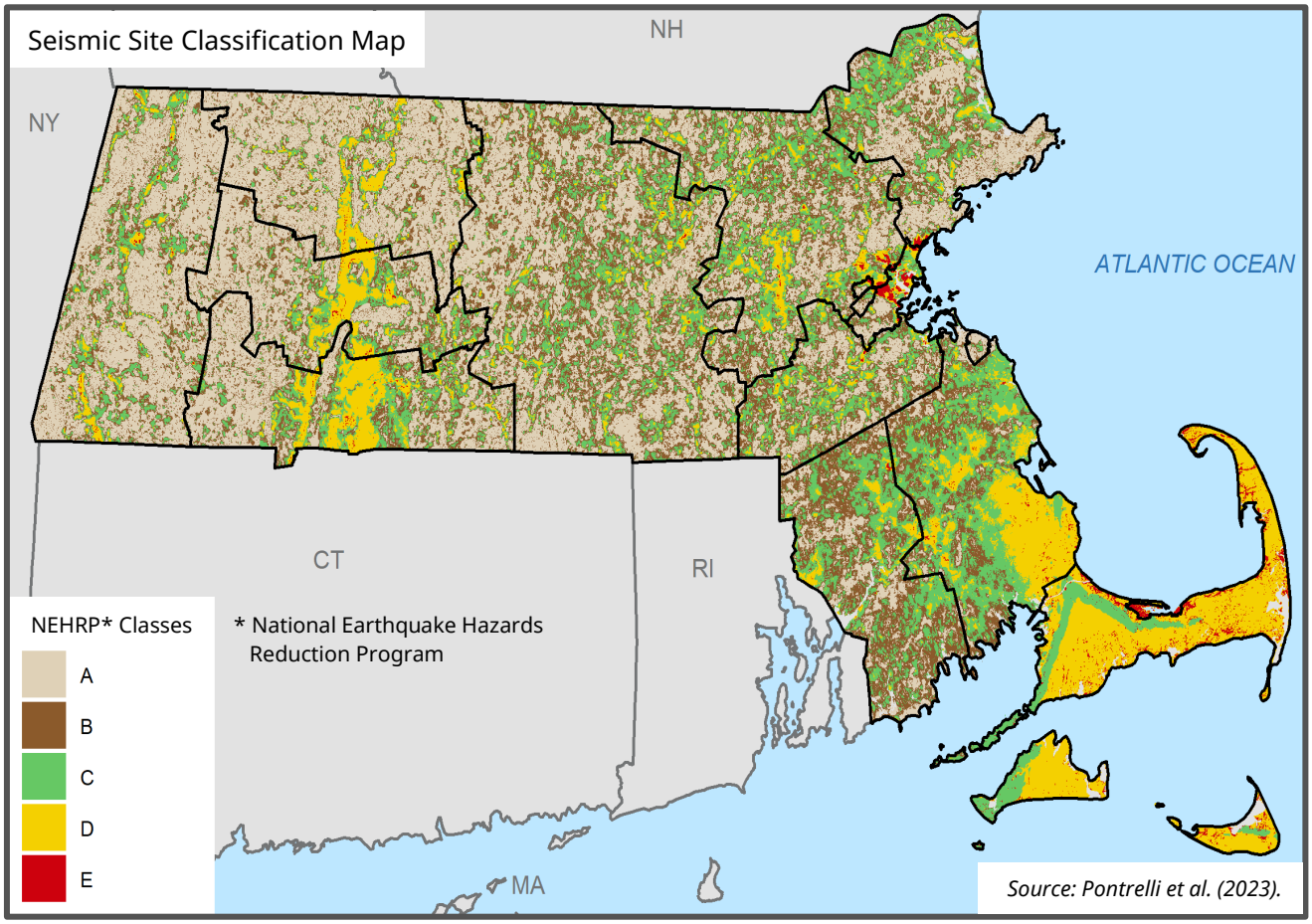
Natural Environment

Impacts to ecosystems and natural resources, and how plants and animals can thrive there.

- Decline in groundwater recharge to aquifers and reduced streamflow.
- Freshwater ecosystem degradation.
- Forest health degradation.
- Coastal wetland degradation.
- Shifting distribution of native and invasive species.
- Increased incidence of wildfires.

Earthquakes Hazard Profile

Massachusetts is not near tectonic plate boundaries, but it is still susceptible to earthquakes that can occur within the interior North American Plate. Earthquakes centered in other parts of New England or Canada could also affect the Commonwealth. Building and land use characteristics increase the risk of local damage. Unreinforced masonry buildings that are common in Boston are especially vulnerable to being damaged by ground shaking. Softer soil types amplify and magnify ground shaking relative to nearby bedrock, which may increase building damage and losses. Liquefaction poses an additional risk in areas with water-saturated sands, silts, or gravelly soils that lose their strength in an earthquake.



Most At-Risk Areas

Greater Boston, Cape Cod, and the Connecticut River Valley have softer soils that can amplify shaking. Boston's many unreinforced masonry buildings and areas of filled land place the city at higher risk of earthquake damage.

Cause

An earthquake is the vibration of the Earth's surface that follows a release of energy in the Earth's crust. Risk is related to how the ground shaking interacts with people, buildings, and natural features.

Historical Frequency and Recent Trends

The 1755 Cape Ann earthquake (magnitude 6.2) is the most significant event recorded. The probability of a magnitude 5.0 or greater earthquake centered in New England in a 10-year period is about 10–15%.

Projected Effects of Climate Change

Research does not identify effects of climate change on the earthquake hazard in Massachusetts.

Secondary Hazards from Earthquakes:

- Fires in buildings, communities, or ecosystems, which can cause injury or loss of life.
- Soil liquefaction in certain soil types. Slope failure and landslides; tsunamis.
- Potential release of hazardous materials.

Earthquakes Hazard Profile

Impacts to Sectors:

Human

Impacts to people's health, welfare, and safety.

- Elderly and low-income populations, and people living in substandard housing, are more vulnerable to the impacts of earthquakes.
- Emergency service response delays and evacuation disruptions.
- Direct health risks include trauma-related injuries and deaths. Access to hospitals and medical intervention may be limited following severe earthquakes.
- Hazus estimates fewer than five people may be injured in a 100-year mean return period (MRP) earthquake. Between 1,200 and 3,200 casualties could result from a 2,500-year MRP earthquake, depending on what time it occurs.
- About six households may be temporarily displaced in a 100-year MRP earthquake, and 9,100 households may be displaced in a 2,500 MRP earthquake.
- Earthquakes can damage cultural resources.

Infrastructure

Impacts to buildings, transportation systems, and electricity and water systems.

- Damage to roads and loss of road service.
- Damage to rails and loss of rail/transit service.
- Damage to or limited emergency communications.
- Damage and disruption to electric transmission and utility distribution infrastructure.
- Reduction in clean water supply.
- Potential release of hazardous materials into the environment from damage to production or storage facilities.
- Damage to unreinforced masonry buildings and structures built on soils that are susceptible to liquefaction. (These are especially vulnerable to shaking.)
- Estimated transportation and utility losses of nearly $10.1 million from a 100-year MRP earthquake and over $1.3 billion from a 2,500-year MRP earthquake.

Economy

Impacts to people's ability to work and make a living due to damage to infrastructure, our natural environment, or people's health.

- Economic losses from commercial structural damage and business interruptions.
- Building-related economic losses estimated at around $10.7 million for a 100-year MRP earthquake and over $18.4 billion for a 2,500-year MRP earthquake.
- Costs of debris management and removal.

Governance

Impacts to state and local government–owned buildings, government finances, and the ability of the government to run effectively.

- All government buildings in Massachusetts are exposed to potential earthquakes.
- Earthquakes may damage public safety infrastructure.
- Increased service demands of first responders during earthquake response and recovery.

Natural Environment

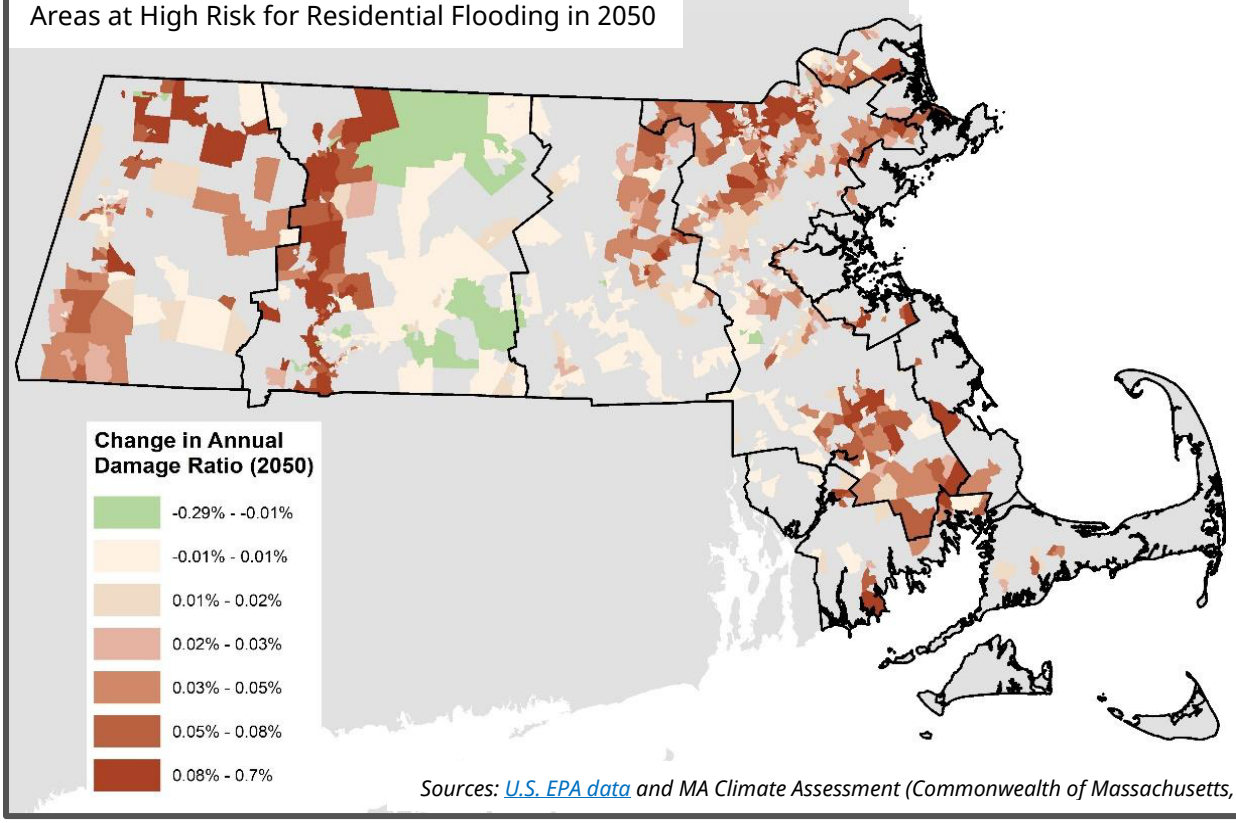
Impacts to ecosystems and natural resources, and how plants and animals can thrive there.

- Physical changes to an ecosystem from an earthquake can disrupt species balance and leave an area more vulnerable to the spread of invasive species.
- Secondary impacts (flooding, liquefaction, landslide, fire) may cause localized species loss.
- Damaged infrastructure may leak hazardous materials into the local environment or watershed.

Flooding from Precipitation Hazard Profile

Changes in development and population density, connected to changes in the frequency and intensity of precipitation patterns in Massachusetts, increase the risk from flooding from precipitation. The increase in impervious surfaces due to changes in development limits infiltration during heavy rainfall, resulting in greater runoff and demands on drainage systems. Existing infrastructure is not designed to respond to current precipitation and is increasingly strained as climate change increases the intensity and duration, as well as possibly the frequency, of precipitation. As systems experience demand to move water beyond their designed capacity, precipitation-related flooding is likely to occur more often.

Areas at High Risk for Residential Flooding in 2050



Sources: U.S. EPA data and MA Climate Assessment (Commonwealth of Massachusetts, 2022).

Most At-Risk Areas

Areas with strained drainage system capacity face the most risk. Riverine flood risk is high near current and historical wetlands and river systems, especially along the Connecticut River Valley and coastal watersheds.

Cause

Inland riverine flooding results when a high rainfall event exceeds the capacity of natural drainage systems. Risk can be amplified when land cover has a high percentage of impermeable surface.

Historical Frequency and Recent Trends

Climate change is projected to increase the variability of precipitation events within a year, including the potential for extreme precipitation events. Instances of inland flooding, river overflows, and pressure on dams may result.

Projected Effects of Climate Change

Projected changes in precipitation patterns in all seasons, as well as higher frequency of extreme weather (including hurricanes and nor'easters), will change patterns of river flow and increase the frequency and severity of inland riverine flooding.

Secondary Hazards from Flooding from Precipitation

- Reservoir or waterway contamination due to high river flow, re-suspension of contaminated sediment, and transport of that sediment downstream.
- Stress on ecosystems that could increase the risk of invasive species.
- Damage or increased degradation of critical infrastructure and habitats, including residences, that increases vulnerability and risk to other hazards.

Flooding from Precipitation Hazard Profile

Impacts to Sectors:

Human

Impacts to people's health, welfare, and safety.

- Physical injury and premature death—the most serious and acute health impacts during a flood.
- Increase in mental health stressors.
- Health effects from aeroallergens and mold, especially for people with existing respiratory conditions.
- Increase in vector-borne disease incidence and bacterial infections; elevated rates of emergency room visits for gastrointestinal illness.
- Emergency service response delays and evacuation disruptions.
- Loss of or damage to cultural resources.

Infrastructure

Impacts to buildings, transportation systems, and electricity and water systems.

- Damage to electric transmission and utility distribution infrastructure.
- Reduction in clean water supply.
- Damage to roads and loss of road services.
- Bridge support scour caused by high river flow events. (Up to 25 percent of bridges in New England may be vulnerable to this effect.)
- Increased risk of dam overtopping or failure.
- Disruption of water resources, including waste management (sewage) and water supply, caused by dam failure.

Economy

Impacts to people's ability to work and make a living due to damage to infrastructure, our natural environment, or people's health.

- Economic losses from commercial structure damage and business interruptions, with potential for cascading supply chain disruptions.
- Reduced availability of affordably priced housing, which disproportionately affects low-income populations.
- Reduced ability to work and loss of wages.
- Dam overtopping or failure can lead to economic impact due to initial loss of structures, loss of businesses and homes, damage to land, and cost of debris cleanup.

Governance

Impacts to state and local government–owned buildings, government finances, and the ability of the government to run effectively.

- Demand for state and municipal government services could increase.
- Fewer than 10 state-owned major facilities are in areas expected to experience significant riverine flooding by the end of the century. As a result, it appears that current facility siting decisions are adequately addressing the risk of riverine flooding—but many of these buildings (the exact number is currently unknown) may be subject to stormwater drainage flooding.
- State-owned parks, roads, and minor facilities could experience disruptions or damage due to heavy rainfall and flooding.
- 159 state and 469 municipality–owned and operated dams are at a high or significant hazard level and therefore at risk of damage or destruction.

Natural Environment

Impacts to ecosystems and natural resources, and how plants and animals can thrive there.

- Freshwater ecosystem degradation and water quality issues due to increased sediment, nutrient, and contaminant delivery from stormwater runoff and combined sewer overflows.
- Alteration and contamination of coastal ecosystems due to increased freshwater flow to estuaries.
- Soil erosion affecting local ecological functions.
- Forest health degradation.

Hurricanes/Tropical Cyclones Hazard Profile

Massachusetts has over 1,500 miles of coastline, which is home to more than 1,900 beaches, boat ramps, trails, and other public access sites. Many houses, businesses, ports, critical infrastructure sites, and utilities also share the Massachusetts coast, and 74 percent of the Commonwealth's population resides in coastal counties. Hurricanes and tropical storms reach Massachusetts after traveling up the Atlantic Ocean, leaving areas near the coast most vulnerable to damage from these storms. Tropical storms lose strength once they move inland; however, all regions of the Commonwealth may experience strong winds and heavy rainfall from a storm moving inland and significant hurricane impacts have occurred in western Massachusetts in recent years. Stronger storms may lead to increased wind damage and flooding, which in turn may produce power outages, structural damage to homes and critical assets, business damage and disruption, human health and public safety impacts, and ecosystem damage and loss. As sea levels rise, storm surge and coastal flooding from tropical storms and hurricanes will have impacts further inland.

Most At-Risk Areas

Coastal populations, infrastructure, and ecosystems are most vulnerable. Historically, south-facing shores have been the hardest hit.

Cause

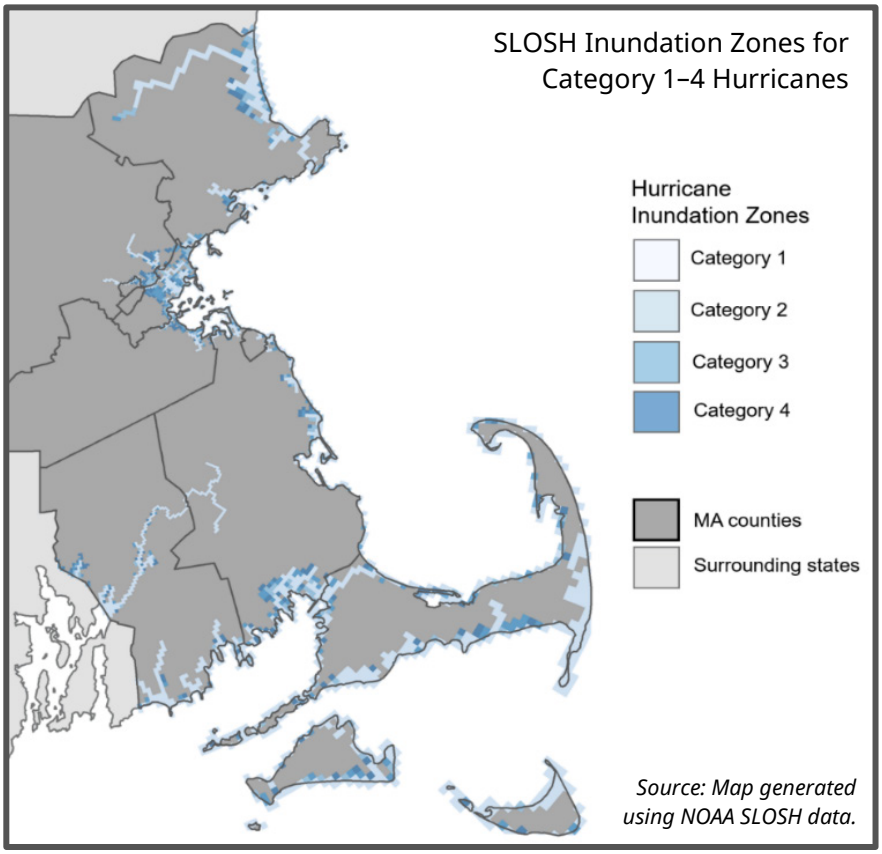
Tropical cyclones form over warm ocean waters, as moisture evaporates and rises into enormous amounts of heated, moist air twisted high in the atmosphere.

Historical Frequency and Recent Trends

97 hurricanes or tropical storms occurred near Massachusetts from 1842 to 2022, averaging one storm every two years. Four have occurred between 2020 and 2022.

Projected Effects of Climate Change

Warming ocean and air temperatures are expected to contribute to the increased intensity of hurricanes and tropical storms. There may be a related increase in the frequency of Atlantic tropical cyclones as well.



Secondary Hazards from Hurricanes/Tropical Cyclones:

- Possibility of tornado generation.
- Coastal and riverine erosion.
- Increased risk of landslides.
- Contamination of water supplies and flooding of sewage treatment facilities.

Impacts to Sectors:

Human

Impacts to people's health, welfare, and safety.

- Health effects of extreme storms and power outages, including injury, carbon monoxide poisoning, and medical device failure.
- Health effects from mold due to flooding and water damage, which may disproportionately affect people who live in substandard housing, live in flood-prone areas, or have existing respiratory illness.
- Flood-related injury or fatality. First responders and utility workers are especially vulnerable to high water, swift currents, and submerged debris.
- Impaired public safety response due to infrastructure and transportation damage.
- Higher difficulty in preparing for, evacuating from, and recovering from extreme events for minority, language-isolated, low-income, elderly, and disabled populations.

Infrastructure

Impacts to buildings, transportation systems, and electricity and water systems.

- Damage to electric transmission and utility distribution infrastructure.
- Damage to coastal buildings and ports.
- Damage to critical facilities. (Storm surge in a Category 1 hurricane could inundate 190 critical facilities, including 15 energy facilities. Suffolk County has the highest concentration of affected critical facilities.)
- Inundation of roads. (Over 1,800 miles of road are in coastal hazard areas for a Category 1 storm; nearly 3,000 miles of road could be inundated in a Category 3 storm. Barnstable County has the highest road exposure to hurricane storm surge inundation.)

Economy

Impacts to people's ability to work and make a living due to damage to infrastructure, our natural environment, or people's health.

- Economic losses from commercial structure damage and business interruptions, especially in flood-prone areas.
- Decrease in agricultural productivity where field crops or tree products are damaged by flooding or wind.
- Damage to tourist attractions and recreation amenities (e.g., beaches, coastal hotels, rental homes) and disruptions to travel.

Governance

Impacts to state and local government–owned buildings, government finances, and the ability of the government to run effectively.

- Increase in costs of responding to climate migration, and of coordination between sending (coastal) and receiving (inland) communities.
- Increase in costs associated with public safety agency responses, caused by a higher magnitude and frequency of events.
- Loss of or damage to state-owned buildings and infrastructure. (732 state-owned buildings are in Storm surge inundation zones for a Category 1 hurricane. The highest concentration of these buildings is in Suffolk County.)

Natural Environment

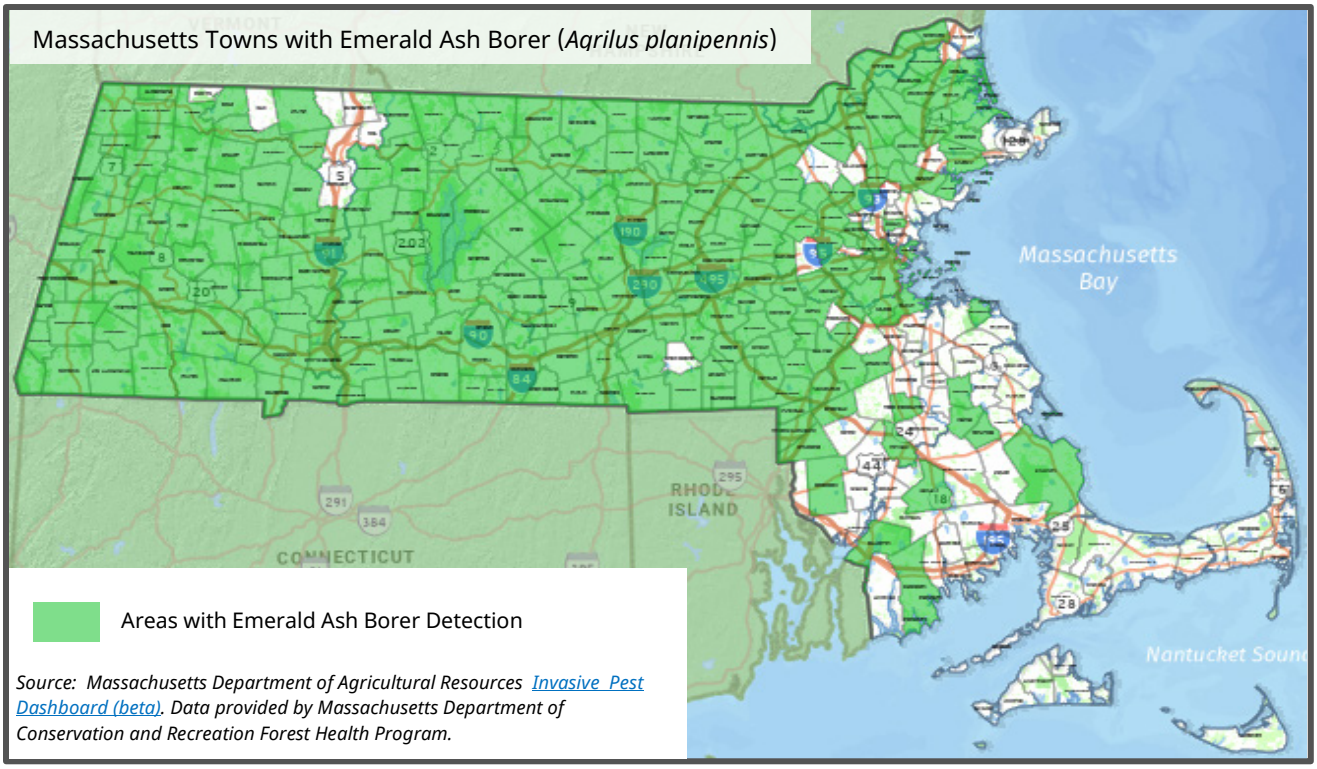
Impacts to ecosystems and natural resources, and how plants and animals can thrive there.

- A storm can cause short-term disruptions to normal ecosystem function.
- Estuarine habitats and species are vulnerable to coastal storm surge and changing salinity of their water.
- Storms can have longer-term impacts related to physical structure of ecosystems, such as riverbed erosion and tree loss.
- Exposure to pollutants spread by storm-damaged infrastructure may cause widespread and long-term population impacts on species in the area.
- Out of the 528 Massachusetts Department of Conservation and Recreation sites assessed, 96 have moderate vulnerability to coastal flooding (which hurricanes and tropical storms can cause) and 47 have increased or high vulnerability to coastal flooding.

Invasive Species Hazard Profile

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.

Massachusetts Towns with Emerald Ash Borer (*Agrilus planipennis*)



Areas with Emerald Ash Borer Detection

Source: Massachusetts Department of Agricultural Resources Invasive Pest Dashboard (beta). Data provided by Massachusetts Department of Conservation and Recreation Forest Health Program.

Most At-Risk Areas

Invasive species are a threat to ecosystems across the Commonwealth. The emerald ash borer can kill an ash tree in just three years. Some marine species can structurally change native ecosystems, while others (like the green crab) prey on native species.

Cause

Human activity intentionally or unintentionally introduces invasive species into native ecosystems.

Historical Frequency and Recent Trends

Increased global trade created new pathways for the spread of invasive species. Global climate change has contributed to introduction of invasive species. In 2008, an outbreak of Asian long-horned beetles in Worcester destroyed nearly 30,000 trees.

Projected Effects of Climate Change

Climate change is predicted to increase the abundance of invasive species and expand their habitat ranges. Species hierarchies in ecosystems are also expected to change, and ecosystems that are stressed (due to climate-change associated drought, increased temperatures, wildfires, etc.) will be more susceptible to invasive species.

Secondary Hazards from Invasive Species:

- Increased heat island effect from tree mortality, damage to agriculture crops.
- Tree damage and die-offs that can result in increased wildfire risk and erosion.
- Stress from changes (increase, decrease) on ecosystems can make them more susceptible to invasive species.

Invasive Species Hazard Profile

Impacts to Sectors:

Human

Impacts to people's health, welfare, and safety.

- Invasive species can bring new diseases or aggravate existing health problems (e.g., it may increase arbovirus risk for humans).
- People with compromised immune systems or pre-existing health conditions, children under five, and people over 65 might be particularly vulnerable to new diseases or aggravated health problems.
- The dinoflagellate *Alexandrium minutum* contributes to red tide outbreaks, which produce toxins that accumulate in shellfish and can be toxic to humans who ingest them.

Infrastructure

Impacts to buildings, transportation systems, and electricity and water systems.

- Facilities that rely on biodiversity or the health of surrounding ecosystems, such as outdoor recreation areas or agricultural/forestry operations, could be vulnerable to impacts from invasive species.
- Japanese knotweed is known to decrease streambank stability and contribute to topsoil erosion, which can contribute to flood damage. Japanese knotweed also grows on roadways, sometimes growing large enough to impair sightlines and growing over guardrails; this can contribute to maintenance and safety issues.

Economy

Impacts to people's ability to work and make a living due to damage to infrastructure, our natural environment, or people's health.

- Invasive species are one of the costliest natural hazards in the U.S. given the widespread nature of the hazard; the cost of ongoing control efforts; and economic impacts from loss of crops, aquaculture, and public goods such as water quality. Invasive species such as the European green crab have significant impacts to the shellfish industry: a 1999 study estimated that this species caused a loss of $44 million per year in New England and Canadian shellfish industries.
- The Commonwealth spends over $95,000 per year on invasive species on control at state properties and over $290,000 annually for control efforts in over 290 infested lakes.

Governance

Impacts to state and local government–owned buildings, government finances, and the ability of the government to run effectively.

- State-managed water bodies are vulnerable to invasive species such as zebra mussels.
- State-managed wildlife areas and state forests face impacts now and are vulnerable to future impacts.
- Invasive species throughout the Commonwealth pose a cost and management burden to government agencies tasked with preventing or controlling the spread of these plants, animals, and fungi. The cost of restoration due to damage from invasive species can be significant.

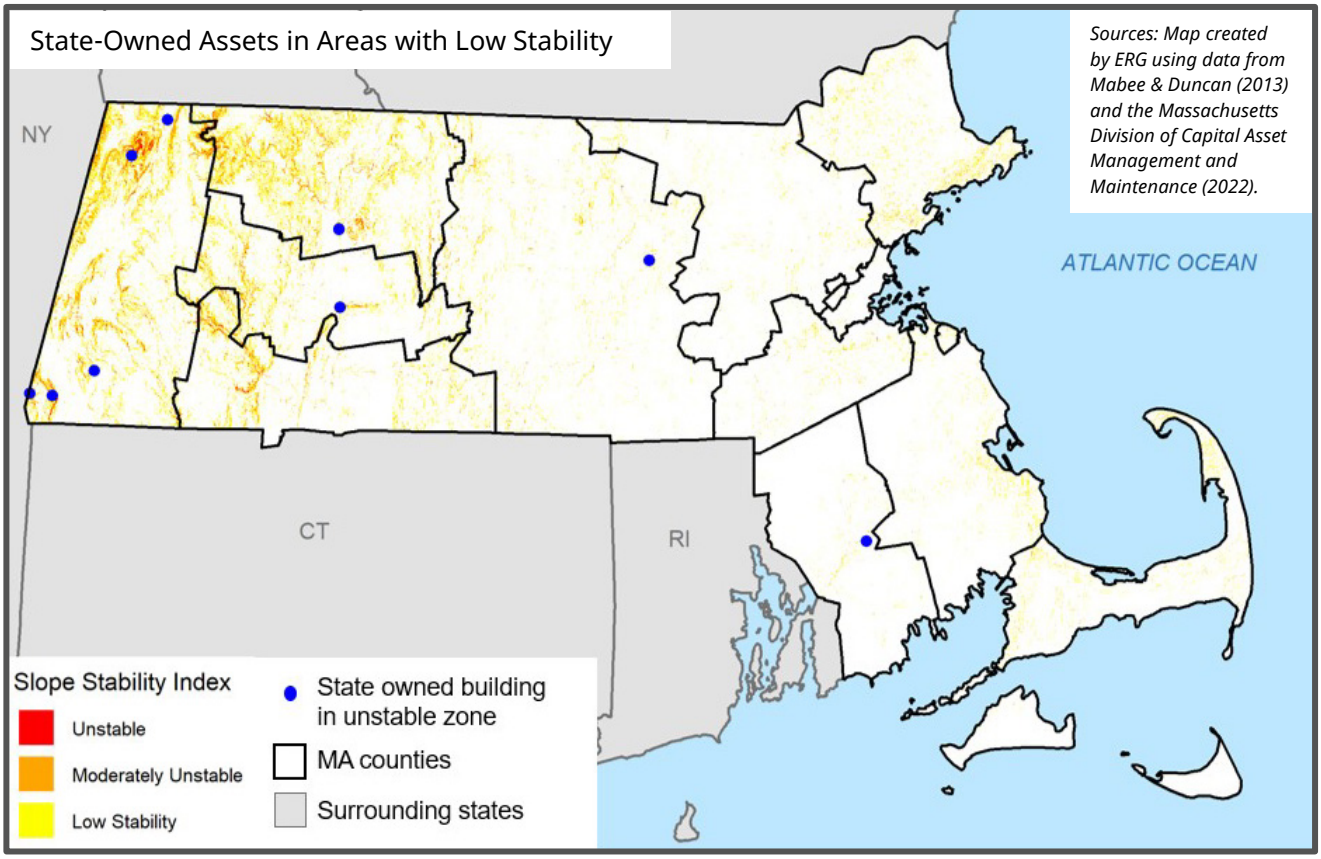
Natural Environment

Impacts to ecosystems and natural resources, and how plants and animals can thrive there.

- Invasive species spread quickly, rapidly taking over an area. Native species are likely unable to resist the invasive species, which often outcompete them.
- Native species are pressured by the spread of invasive insects and disease. For example, native species such as the American elm have essentially been eradicated due to Dutch elm disease and native shellfish are preyed upon by European green crabs.
- Some invasive plant species are capable of changing ecosystem conditions such as soil chemistry and intensity of wildfires. Invasive species that are not fire-adapted may take over fire-prone grassland or forest areas, thereby increasing wildfire risk.
- Japanese knotweed can contribute to streambank destabilization and erosion. *Phragmites australis* invade wetlands and can form thick, dense stands that displace native species and reduce habitat for native wildlife.
- In the U.S., an estimated 4,600 acres of land are invaded by invasive plants daily. This can result in loss of vulnerable species, species of concern, or endangered species.

Landslides/Mudflows Hazard Profile

Landslide and mudflow risk is higher in the western portion of the Commonwealth. Landslides and mudflows tend to be isolated in size and location and have localized impacts that pose threats to highways, rail, and other linear networks and systems. Additionally, communities and development on unstable slopes or in areas of high fire and flood risk are at risk from localized damage and loss of infrastructure from landslides and mudflows. Data are limited on the full extent of landslide and mudflow events across the Commonwealth, as they may occur in remote areas. As development expands across Massachusetts, land use changes may contribute to an increase in landslides and mudflows or introduce development into areas already at risk from these hazards.



Most At-Risk Areas

Mount Greylock and the nearby portion of the Deerfield Park, the U.S. Highway 20 corridor near Chester, and the main branches of the Westfield River are most at risk.

Cause

Most landslides and mudflows in Massachusetts are caused by a combination of unfavorable geological conditions, steep slopes, and/or excessive soil moisture.

Historical Frequency and Recent Trends

Reported landslides and mudflows occur every other year. Many landslides occur unobserved in remote areas, meaning that the actual rate of occurrence is higher than the rate of observed and reported events.

Projected Effects of Climate Change

More frequent and intense storms will result in soil saturation, leading to more frequent landslides and mudflows. The projected increased risk of frequency and intensity of drought and wildfires will reduce the vegetation cover in the Commonwealth, which leads to loss of soil stability and an increase the probability of landslides.

Secondary Hazards from Landslides/Mudflows:

- Damage to vegetation on steep slopes weakens soils contributing to increased runoff and sediment in runoff that affects water quality of downstream water bodies.
- Contamination of reservoirs or waterways from to soil/sediment flow and susceptibility to invasive species.

Landslides/Mudflows Hazard Profile

Impacts to Sectors:

Human

Impacts to people's health, welfare, and safety.

- People living or traveling in areas with steep slopes and unstable soils.
- Populations who cannot evacuate quickly (people aged over 65 or under 5), populations with mobility limitations, residents in rural areas with limited access to services.
- Potential loss of life for people living in landslide and mudflow hazard areas.

Infrastructure

Impacts to buildings, transportation systems, and electricity and water systems.

- Damage and disruption to roads and buildings in the western regions of Massachusetts. Potential loss or blockage of evacuation routes and for areas with limited or single point of access.
- Damage and disruption to electric transmission and utility distribution infrastructure.
- Loss of energy production and resources.
- Reduced potability of water due to organic materials entering streams.

Economy

Impacts to people's ability to work and make a living due to damage to infrastructure, our natural environment, or people's health.

- Loss of or damage to buildings, properties, and infrastructure, including communications in areas with steep slopes in the western portion of the Commonwealth where there are limited and non-redundant services.
- Interruption to businesses and loss of productivity due to road closures and utility damage, particularly for small businesses and movement of time-sensitive or perishable goods.
- Loss of tax revenues and reduced property values.
- Cost of cleanup, debris removal, and restoration of affected areas.

Governance

Impacts to state and local government–owned buildings, government finances, and the ability of the government to run effectively.

- Increased demand for state and municipal government services.
- Increased need to prepare for and respond to damage and disruption from landslides and mudflows.
- Loss of or damage to state-owned buildings and infrastructure, including communications in areas with steep slopes.
- Impacts on 14 state-owned facilities in landslide and mudflow hazard areas, including Bash Bish Falls State Park (2), East Mountain State Forest, Freetown-Fall River State Forest, Mount Everett State Reservation (2), Mount Greylock Reservation, Mount Sugarloaf Reservation (3), Natural Bridge State Park, Joseph Allen Skinner State Park (2), and the Wachusett Reservoir.

Natural Environment

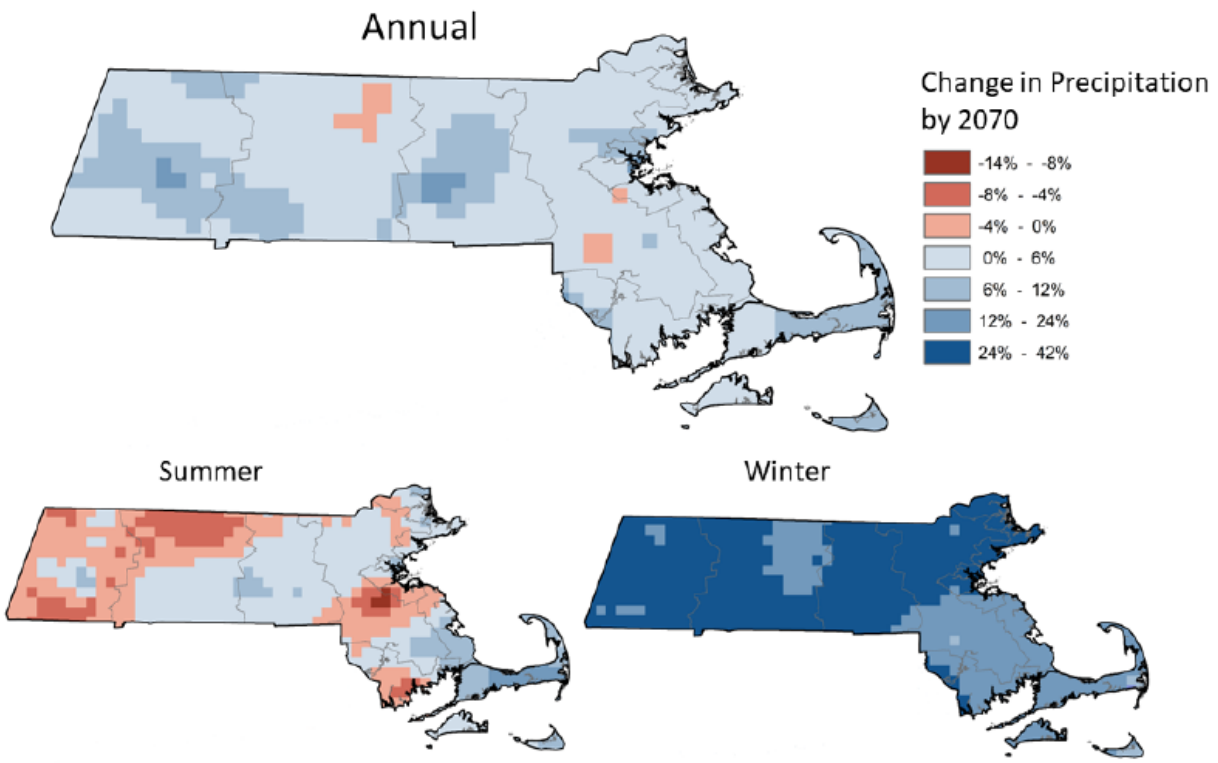
Impacts to ecosystems and natural resources, and how plants and animals can thrive there.

- When landslides or mudflows make physical changes to the landscape, the lack of topsoil limits the ability of flora to re-establish.
- Mass movement of soil can uproot trees and understory, degrading forest health.
- Streams and waterbodies near landslide or mudflow hazard areas have the highest risk of pollution, and excess sediment in them can create dams. This can affect both water quality and fish habitat.

Other Severe Weather Hazard Profile

Several frequent natural hazards in Massachusetts—such as strong winds and extreme precipitation events—occur outside of notable storm events (e.g., hurricanes, nor'easters, snowstorms). The entire Commonwealth is susceptible to these severe weather events. While high winds can affect the entire Commonwealth, the coast is most at risk of exposure to high-wind events and damage. The Commonwealth is also located within a region that is susceptible to hurricanes, and the western portion is located within the special wind region, in which wind-speed anomalies are present and additional consideration of wind hazards is warranted.

Predicted Change in Annual, Summer, and Winter Season Precipitation in 2070 Compared to Current Climate



Source: Commonwealth of Massachusetts (2022); data from Localized Constructed Analogs repository.

Most At-Risk Areas

The coastal zone is most at risk from high-wind events. This includes Dukes, Nantucket, Suffolk, and Barnstable Counties, as well as areas of Bristol, Plymouth, Suffolk, and Essex Counties.

Cause

Thunderstorms form when there is rising unstable air, moisture, and a lifting mechanism. Wind is caused by differences in atmospheric pressure and the Coriolis Effect.

Historical Frequency and Recent Trends

Precipitation volume from the heaviest storms in the Northeast has increased by 55 percent since 1958. Massachusetts experiences an average of 10 to 15 days per year with severe thunderstorms.

Projected Effects of Climate Change

Higher temperatures due to climate change will increase the atmosphere's capacity to hold moisture, increasing the intensity of extreme precipitation events. The number of days of precipitation are expected to be more variable.

Secondary Hazards from Other Severe Weather:

- Heavy rain can overwhelm artificial and natural drainage systems, causing overflows and property damage.
- Soil on slopes can oversaturate from extreme precipitation, causing landslides and floods.
- More frequent lightning can spark fires, even when accompanied by heavy rains.
- Lightning can cause severe damage, injury, and death.

Other Severe Weather Hazard Profile

Impacts to Sectors:

Human

Impacts to people's health, welfare, and safety.

- Increased vulnerability to extreme weather impacts, particularly lightning strikes, for populations living outdoors. An estimated 18,400 people in Massachusetts experience homelessness, and an estimated 830 are unsheltered.
- Challenges to large-scale emergency response to transport or assist impacted populations.
- Health effects, such as gastrointestinal illness, from extreme rainfall events, which degrade water quality by introducing bacteriological contaminants.
- Delayed access to emergency care and impacts to electricity-dependent medical equipment due to power outages.
- Health and financial impacts from increased inland flooding, which may flood basements and increase exposure to mold.

Infrastructure

Impacts to buildings, transportation systems, and electricity and water systems.

- Damage to electric transmission and utility distribution infrastructure, resulting in power outages.
- Damage to roads, culverts, and transportation infrastructure.
- Potential loss or blockage of evacuation routes and long-term transportation needs, which disproportionately impacts people who rely on public transportation.
- Damage to roads for emergency response teams.
- Impacts to seven critical facilities, including five residential facilities, located in the highest wind load zone. The highest concentration of critical facilities in this hazard area is in Nantucket County.

Economy

Impacts to people's ability to work and make a living due to damage to infrastructure, our natural environment, or people's health.

- Disrupted business operations and loss of revenue due to utility damage; this disproportionately impacts small businesses.
- Damage to and loss of homes, which impacts people's ability to work and consumers' spending power.
- Damage to agricultural crops, equipment, and infrastructure from high winds.
- Damage to crops from intense rains; changes in precipitation patterns can delay planting for corn and vegetables or reduce yields.

Governance

Impacts to state and local government–owned buildings, government finances, and the ability of the government to run effectively.

- Increased demand for state and municipal government services to address damage from extreme weather events and implement pre-disaster preparations, including warning systems and evacuation procedures.
- Loss of or damage to state-owned buildings and infrastructure, including communications located in high-wind zones.
- Impacts to 11 state-owned buildings located in the highest wind load zone, all of which are in Nantucket County.

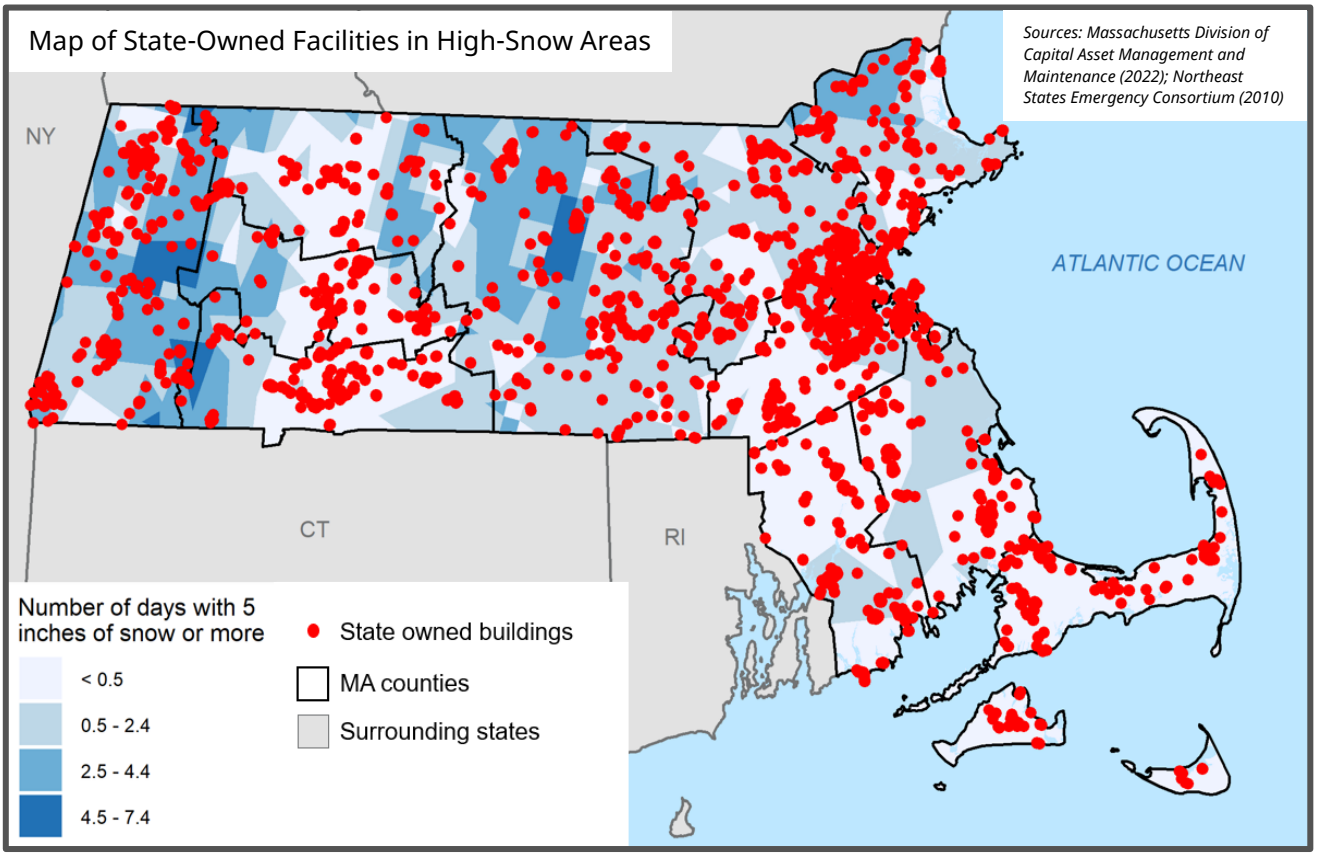
Natural Environment

Impacts to ecosystems and natural resources, and how plants and animals can thrive there.

- Defoliation of forest canopies can degrade forest health, which could lead to loss of biodiversity and structural ecosystem changes.
- Extreme precipitation events can disrupt some species' mating behaviors, causing population decline.
- Direct damage to plants from uprooting or destruction of trees can increase wildfire risk.
- Extreme precipitation events can cause harmful algal blooms and associated aquatic neurotoxins.
- Widespread winds can uproot watershed forests and create serious water quality disturbances, damaging public drinking water reservoirs.

Severe Winter Storms Hazard Profile

Severe winter storms, which include ice storms, nor'easters, heavy snow, blowing snow, and other extreme forms of winter precipitation, occur regularly in Massachusetts. Coastal communities are particularly vulnerable to impacts from nor'easters due to the combination of high winds, waves, and tidal surge. Rural populations are more at risk from service and access issues because heavy snow conditions can block roads and often result in downed power and communication lines. As coastal development increases and sea levels continue to rise, nor'easters will lead to more substantial damage due to high water levels, higher coastal populations, and increased land use in current and future risk zones.



Most At-Risk Areas

North- and east-facing coastal areas are the most exposed to nor'easter winds and storm surge. Rural populations in central and western Massachusetts are most exposed to severe snow fall.

Cause

Severe winter storms are types of extratropical cyclones, which are formed when a cold mass of air meets with a warm mass of air and create a front. They can have weak or strong winds.

Historical Frequency and Recent Trends

On average, Massachusetts experiences one to two nor'easters per year. In the past 10 years (2013–2022), there have been 63 heavy snow days, 12 blizzard days, and two ice storm days in Massachusetts.

Projected Effects of Climate Change

Sea level rise, warming ocean temperatures, and changing atmospheric circulation patterns are likely to increase the frequency and severity of winter storms. Warmer temperatures indicate that more precipitation will fall as rain rather than snow throughout the 21st century.

Secondary Hazards from Severe Winter Storms:

- Large amounts of precipitation cause flooding or levee and dam failure. Flooding can increase incidents of mold and mildew, and release of hazardous materials.
- Snow and ice melt runoff can destabilize slopes leading to landslides.
- Storm surge can increase coastal erosion and flooding.

Severe Winter Storms Hazard Profile

Impacts to Sectors:

Human

Impacts to people's health, welfare, and safety.

- Increased risks to the 14,000 people living in high-snow areas.
- Exposure to higher winds and storm surge for the 5.2 million people living in the coastal zone.
- Disrupted and delayed public transit.
- Increased risk of hypothermia and frostbite to populations without access to housing or sufficient heat, including the estimated 18,400 people in Massachusetts experiencing homelessness.
- Isolation of rural populations due to storm debris, blocked roadways, and power outages.
- Increased risk of carbon monoxide poisoning from inappropriate use of combustion heaters, cooking appliances, and generators during power outages.
- Injury and loss of life from automobile accidents, overexertion, and exposure.
- Increased risk to public safety personnel and increased response times.

Infrastructure

Impacts to buildings, transportation systems, and electricity and water systems.

- Damage to roofs and structures due to the weight of snow and ice.
- Damage to coastal infrastructure and ports.
- Damage or destruction of power, gas, water, broadband, and oil transmission lines.
- Damage to roads and culverts. Potential blockage of emergency response vehicles and evacuation routes.
- Increased risk to the 33 critical facilities—including 17 residential and four water resource facilities—located in high-snow zones. The highest concentration of critical facilities in this hazard area are in Worcester and Berkshire Counties.

Economy

Impacts to people's ability to work and make a living due to damage to infrastructure, our natural environment, or people's health.

- Significant economic impacts and revenue losses due to building damage and disruption in telecommunications, electricity, and transportation systems.
- Revenue losses from reduced snow cover in the winter recreation and tourism industries.
- Impacts to aquaculture and marine fisheries from damage to ports and processing facilities, which may prevent fisher's ability to process, land, and sell catches.

Governance

Impacts to state and local government–owned buildings, government finances, and the ability of the government to run effectively.

- Loss of or damage to state-owned buildings and infrastructure, including communications facilities located in coastal flood zones.
- Increased demand and cost for state and municipal government services for storm preparation, response, and recovery.
- Increased risks to 90 state-owned buildings in high-snow zones. These buildings are most concentrated in Berkshire and Worcester Counties.

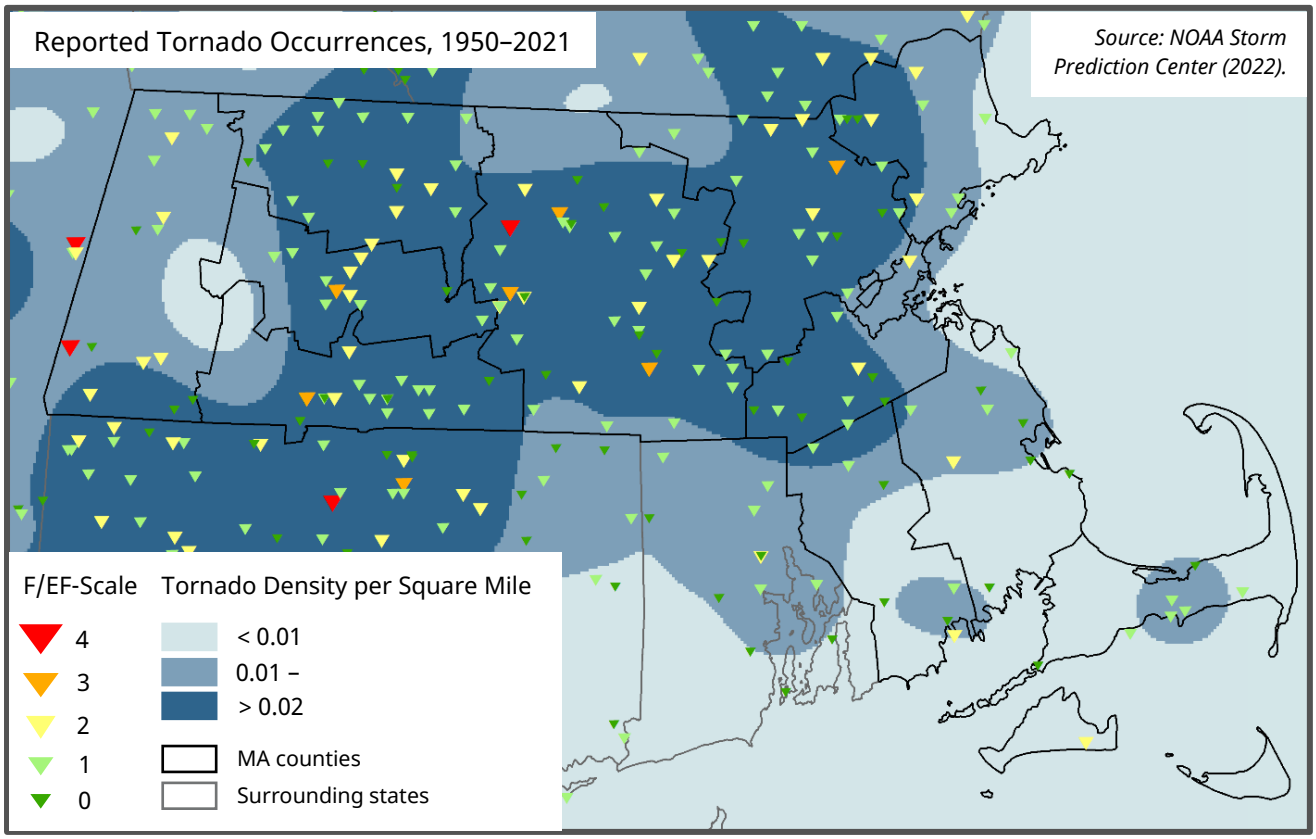
Natural Environment

Impacts to ecosystems and natural resources, and how plants and animals can thrive there.

- Damaged salt marshes and wetlands from severe winds, flooding, and decreased water quality, which can reduce coastal protection of natural systems during subsequent storms.
- Damaged forests from loss of tree cover, poor water quality, increased soil erosion, and changes in nutrient pathways from flooding.
- Decreased water quality from coastal erosion; landslides; and damage to wastewater facilities, overburdened stormwater systems, and sewers.
- Decreased spring river flows for aquatic ecosystems due to less spring snow melt.
- Increased vulnerability of 96 Massachusetts Department of Conservation and Recreation sites (out of 528 assessed) to coastal flooding from storms.

Tornadoes Hazard Profile

Massachusetts experiences an average of two to five tornadoes per year, compared with the average 1,200 tornadoes the United States experiences annually. Because tornadoes are relatively rare in the Commonwealth, residents are less likely to be prepared. Populations in manufactured housing such as mobile homes are more at risk. Tornadoes can affect all sectors and populations, and their primary effect is damage from high winds to structures and the environment. Any structure located in a tornado zone or path is at risk.



Most At-Risk Areas

All of Massachusetts is at risk for tornadoes. However, the greatest risk area for tornado touchdowns runs from south-central to northeastern Massachusetts (Hampden County through Worcester, Middlesex, and part of Essex County).

Cause

Thunderstorms have the potential to produce tornadoes. However, the type of storm that most commonly produces tornadoes is supercells: severe, long-lived thunderstorms. Approximately 20 percent of supercells produce tornadoes.

Historical Frequency and Recent Trends

Massachusetts averages two to five tornadoes per year. Only two tornadoes (1953 and 2011) received disaster declarations. Massachusetts has experienced 12 tornadoes since 2018 (EF0 to EF1). Massachusetts experienced six tornadoes in 2021 (EF0), causing under $50,000 in property damage.

Projected Effects of Climate Change

Current climate models predict an increase in severe thunderstorms, which have the potential to produce tornadoes. However, it is unclear if tornado frequency will increase with climate change. Some studies suggest there will be a decrease in the number of tornado days, but an increase in the number of tornadoes per day.

Secondary Hazards from Tornadoes:

Due to the high winds and subsequent damage from tornadoes, secondary hazards include:

- Significant areas of falling and downed trees and broader ecosystem damage.
- Spread of invasive species.
- Hail, which commonly accompanies tornadoes; heavy rain accompanies supercell storms and tornadoes.

Tornadoes Hazard Profile

Impacts to Sectors:

Human

Impacts to people's health, welfare, and safety.

- The entire population of Massachusetts is exposed to tornado hazard, and 3,563,721 people live in high tornado density zones. The largest number of people in a high tornado density zone is 1,359,837 in Middlesex County (1,632,002 residents in the county total).
- Populations who might have difficulty evacuating, individuals over the age of 65, households with young children, and people who reside in old or less stable housing are at risk.
- First responders responsible for evacuation and fire and medical response units are at risk. Hospital facilities and nursing homes are vulnerable.
- Individuals with limited internet or phone access or low English proficiency may not be aware of tornado warnings. People living in mobile homes, homes with aboveground foundations, or homes without basements are particularly vulnerable.

Infrastructure

Impacts to buildings, transportation systems, and electricity and water systems.

- All critical facilities and infrastructure are exposed to tornado events.
- Hail, rain, and wind can create flying debris and contribute to flash flooding, which can damage water infrastructure. Power lines are likely to be damaged in a tornado area.
- Flying debris can cause structural damage and severe injuries.
- There are 1,511 critical facilities in the high-hazard zone across 11 counties, with the highest numbers in Middlesex (367 critical facilities) and Worcester (335 critical facilities) Counties.

Economy

Impacts to people's ability to work and make a living due to damage to infrastructure, our natural environment, or people's health.

- All government buildings in Massachusetts are exposed to tornado events.
- There are 4,483 government buildings in the high-intensity tornado zone, 2,949 government buildings in the medium-intensity tornado zone, and 1,330 in the low-intensity tornado zone.
- The total replacement value of government buildings in the high-intensity tornado zone is over $34 billion.
- Tornadoes can impact emergency response coordinated by first responders, law enforcement and national guard. They can compromise the ability of first responders to provide shelter, food, and medical attention in the aftermath of a major event.

Governance

Impacts to state and local government–owned buildings, government finances, and the ability of the government to run effectively.

- Tornado events are typically localized and can have significant economic impacts, such as loss of business function, damage to inventory, wage loss, rental income loss, and loss of or damage to homes and communities.
- Recovery and clean-up costs can be significant. The total cost of property damage from tornadoes in Massachusetts was $49,000 in 2021.

Natural Environment

Impacts to ecosystems and natural resources, and how plants and animals can thrive there.

- High winds, heavy rains, and hail can uproot or down trees and significantly damage other large plants. A tornado-impacted neighborhood in Springfield went from 40 percent tree cover to 1 percent cover. Temperature increases of 4°F have been observed in tornado-affected neighborhoods due to tree loss.
- Heavy winds from tornadoes can transport hazardous materials and introduce them into the atmosphere or water supplies. High winds can also transport invasive species.
- Disturbances from high winds may impact biodiversity and the composition of forests. Disruptions to the ecosystem and biodiversity can allow for invasive plant species to establish in disrupted areas.

Tsunamis Hazard Profile

Coastal areas of Massachusetts are exposed to the threat of tsunamis; however, the probability of a tsunami occurring is relatively low compared to the Pacific Coast of the United States. Over 74 percent (5.2 million of 7.0 million) of Massachusetts residents live along the coastline. In the event of a local tsunami generated in or near the Commonwealth, there would be little warning time to evacuate to higher ground. Tsunami exposure along the Commonwealth's coast is unlikely; however, were an event to occur, it could have extensive and prolonged impacts to the economy, coastal ecosystems, and residents living along the coastline.

Most At-Risk Areas

All coastal areas of the Commonwealth are exposed to the threat of tsunamis. However, the probability of a tsunami is very low in Massachusetts.

Cause

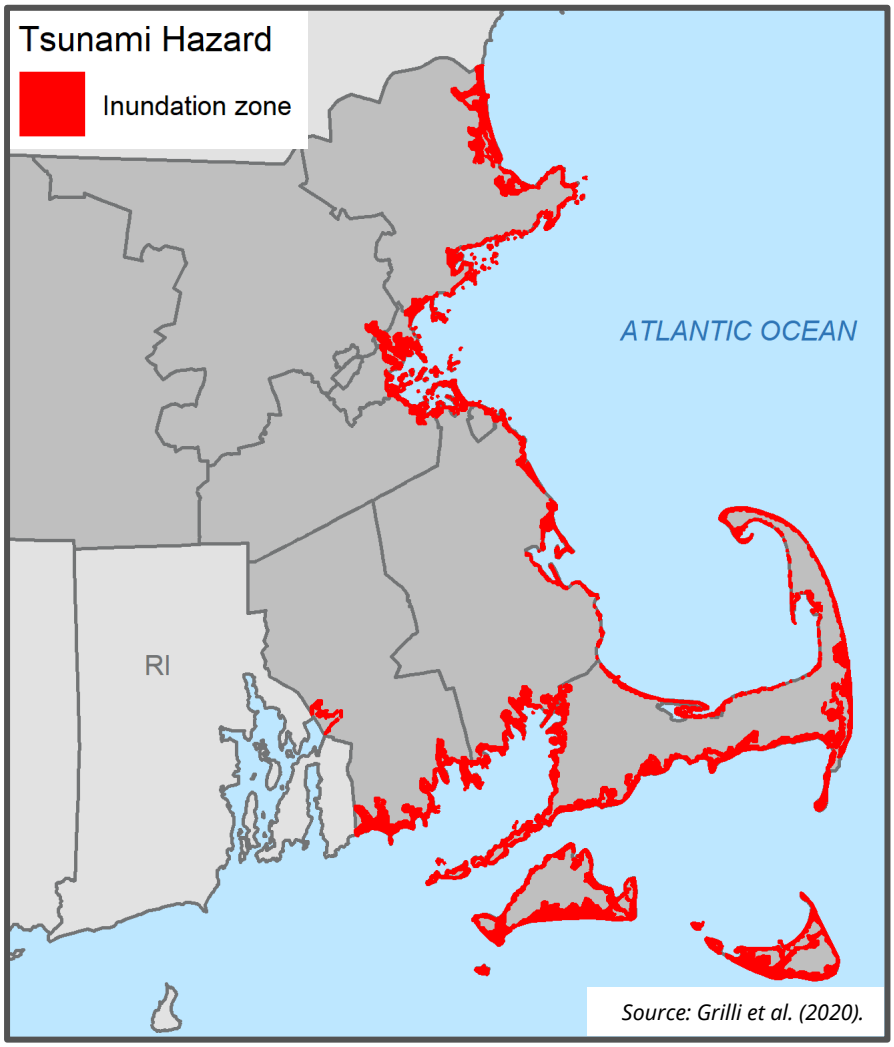
Tsunamis are caused by water displacement triggered by earthquakes, volcanic eruptions, landslides, glacier calving, or meteorite impacts.

Historical Frequency and Recent Trends

No significant tsunami has ever struck the Massachusetts coast. Historically, the frequency of tsunami or run-up events on the East Coast of the United States is approximately one event for every 29 years.

Projected Effects of Climate Change

Sea level rise and rising temperatures will accelerate ice melts and collapse of glaciers across the world, which may cause massive landslides (or glacial earthquakes) that may trigger tsunamis.



Secondary Hazards from Tsunamis:

- Episodes of coastal erosion.
- Widespread flooding along coastal areas.
- Increases in the propagation of invasive species along impacted ecosystems.

Impacts to Sectors:

Human

Impacts to people's health, welfare, and safety.

- Increased risks to people, infrastructure, and buildings within a 1-mile buffer of the coast.
- Increased risks to populations who are unable to evacuate quickly (people aged over 65 or under five), populations with mobility limitations, and rural residents with limited access to services.
- Potential loss of life for first responders and people living in the 1-mile buffer of the coast.
- Mental health impacts due to trauma and displacement.

Infrastructure

Impacts to buildings, transportation systems, and electricity and water systems.

- Damage to electric transmission and utility distribution infrastructure.
- Loss of energy production and resources.
- Damage to bridges, roads, and culverts. Potential loss or blockage of evacuation routes.
- Damages to rail and/or transit, potentially resulting in loss of service.
- Saltwater inundation in drinking water supplies and overburdening of stormwater and wastewater systems.
- Increased risks to the 149 critical facilities in tsunami hazard areas. The highest concentration of critical facilities at risk are in Plymouth County (50) and Suffolk County (48).

Economy

Impacts to people's ability to work and make a living due to damage to infrastructure, our natural environment, or people's health.

- Business interruption and closure.
- Port closure.
- Loss of tourism and tax base.
- Loss of or damage to general building stock and infrastructure, including communications located within 1 mile of the coast.

Governance

Impacts to state and local government–owned buildings, government finances, and the ability of the government to run effectively.

- Increased demand for state and municipal government services.
- Loss of or damage to state-owned buildings and infrastructure, including communications located within 1 mile of the coast.
- Increased risks to the 737 state-owned buildings in tsunami hazard areas. The highest concentration of these buildings is in Suffolk County (274) and Plymouth County (148).

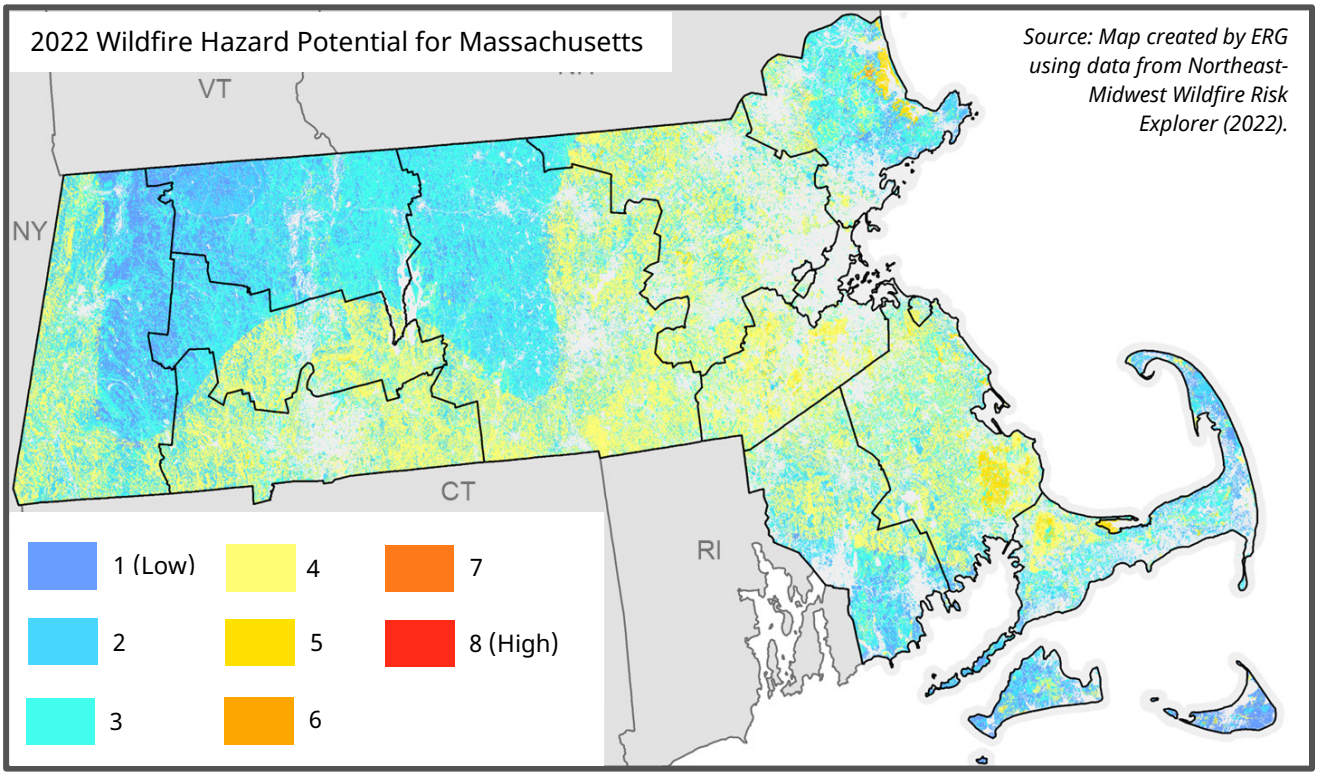
Natural Environment

Impacts to ecosystems and natural resources, and how plants and animals can thrive there.

- Inundation of typically dry areas, which can reshape the topography by scouring existing sediment and depositing sediment from other locations.
- Habitat loss and direct mortality to animals in affected areas.
- Core habitats and critical natural landscapes located along the coastline in the tsunami hazard zone, such as the wetlands of Cape Cod National Seashore, which can act as protective buffers and enhance resilience, may be significantly damaged by a tsunami.

Wildfire Hazard Profile

As demonstrated by the 2022 fire season, prolonged periods of severe drought, combined with multiple high-heat days with low dewpoints, increase the likelihood and intensity of wildfires and wildfire—a pattern that is predicted to continue. Fire-adapted ecosystems that cannot adapt to increased fire frequency, duration, or intensity that may result from climate change impacts (e.g., more frequent, or prolonged droughts, high heat) will be impacted, as well as timber harvest and production, recreation, and residents living near forested areas. Future fires in the Commonwealth will have negative impacts on ecosystems that aren't adapted to fires.



Most At-Risk Areas

Barnstable, Essex, Plymouth, Hampshire, Norfolk, and Hampden counties. Pitch pine and scrub oak communities are the most fire prone compared to other tree species in the state because they rely on fire to reproduce.

Cause

Wildfires can be caused by natural events (e.g., lightning), drought, extreme heat, forest management practices, invasive species, and human activity (e.g., smoking, campfires). In the Commonwealth, 98% of wildfires are human caused.

Historical Frequency & Recent Trends

Historical average of fewer than 50 fires per month during a regular fire season. As of November 28, 2022, 1,027 fires had burned 2,716 acres in 2022. Significant increase in acres burned in the U.S. from 1992 (around 2 million acres) to 2020 (over 10 million acres).

Projected Effects of Climate Change

Precipitation changes, prolonged drought, rising temperatures, and increased frequency of lightning are expected to contribute to increased frequency and severity of wildfire. As droughts become more frequent and severe, forest types that do not usually burn and are not fire adapted will be more likely to burn. Wildfires are projected to increase worldwide by 14% by 2030, 30% by 2050, and 50% 2100.

Secondary Hazards from Wildfire:

- Contamination of reservoirs due to ash and debris.
- Insect outbreaks in pine forest systems following a fire.

Impacts to Sectors:

Human

Impacts to people's health, welfare, and safety.

- People living at the wildland-urban interface (WUI) or intermix hazard areas, as well as infrastructure and buildings located in these areas, are most at risk. In the Commonwealth, 1,076,472 people live in majority moderate wildfire hazard zones.
- Populations who are unable to evacuate quickly (people aged over 65 or under five), populations with mobility limitations, and residents in rural areas with limited access to services.
- People lacking fire insurance or resources to repair and replace damaged structures.
- Health impacts due to poor air quality from smoke. Potential loss of life for first responders and people living in the WUI or intermix areas.

Infrastructure

Impacts to buildings, transportation systems, and electricity and water systems.

- Loss of energy production and resources. Damage or destruction to energy and communication transmission lines.
- Damage to roads, culverts, and potentially bridges. Potential loss or blockage of evacuation routes, which could challenge emergency personnel response.
- Out of 406 critical facilities in moderate wildfire hazard areas, there are 37 energy facilities, 25 waste management facilities, and 112 water resource facilities.
- The highest concentration of critical facilities in a majority moderate wildfire hazard area is in Norfolk County.

Economy

Impacts to people's ability to work and make a living due to damage to infrastructure, the natural environment, or people's health.

- Loss of or damage to state-owned buildings and infrastructure, including communications, located in the WUI or intermix area.
- Disruptions to the timber industry and its workers.
- Damage to and loss of homes and infrastructure.
- Costs associated with cleaning up and restoring natural and recreational areas. Costs of debris management and removal.
- 1,251 state-owned buildings are in moderate wildfire hazard areas. The total replacement value is $644,928,289.

Governance

Impacts to state and local government–owned buildings, government finances, and the ability of the government to run effectively.

- Increased demand for state and municipal government services to address impacts from loss and damage.
- Public safety personnel and equipment costs associated with wildfire preparation and response.
- Loss of or damage to state-owned buildings and infrastructure, including communications, located in the WUI or intermix area.
- 1,251 state-owned buildings are in moderate wildfire hazard areas. The highest concentration of these buildings is in Middlesex County (189 buildings).

Natural Environment

Impacts to ecosystems and natural resources, and how plants and animals can thrive there.

- Fire is important in maintaining the ecosystems of pitch pine, scrub oak, and oak forests in sandy, low-nutrient soil areas. However, drought, high heat, land use, and non-native species may increase the risk of high-intensity wildfires that can threaten these and other forest types.
- Forest health degradation due to increased frequency of wildfires in ecosystems not adapted to fire.
- The Massachusetts Department of Conservation and Recreation has 169 sites (out of 528 assessed) with moderate vulnerability and 32 sites with high vulnerability.

Chapter 6. State Agency Vulnerabilities

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Abbreviations

COOP	Continuity of Operations Plan
DCR	Department of Conservation and Recreation
DER	Division of Ecological Restoration
MassWildlife	Division of Fisheries and Wildlife
EOTSS	Executive Office of Technology Services and Security
IT	information technology
LST	Land-surface temperature
MassDOT	Massachusetts Department of Transportation
RMAT	Resilient MA Action Team
SHMCAP	MA State Hazard Mitigation and Climate Adaptation Plan

Definitions

- **State agency adaptive capacity:** The ability of state agencies (including their assets, functions, missions, and services/programs) to adjust or modify their operations, policies, assets, or other functions to reduce damage, disruption, or loss due to exposure from hazards and climate change impacts, both in the short and long term. For example, an agency that requires increased funding in its capital planning process to address increasing risks due to climate change by repairing infrastructure or constructing new infrastructure has built more adaptive capacity in its processes and budgets. Another example is an agency responsible for education services and facilities. If this agency has standards and procedures in place to reduce risks from extreme heat to students, families, employees, and teachers, then this agency will be more adaptable to the increasing number of high-heat days due to climate change.
- **Environmental justice populations:** In the Commonwealth, environmental justice populations (or neighborhoods) have been identified as Census block groups (i.e., divisions of larger Census tracts that are made up of about 600 to 3,000 people) that meet one or more of the following criteria:
    - The annual median household income is not more than 65 percent of the statewide annual median household income.

    - Minorities make up 40 percent or more of the population.
    - At least 25 percent of households identify as speaking English less than "very well."
    - Minorities make up 25 percent or more of the population and the annual median household income of the municipality in which the neighborhood is located does not exceed 150 percent of the statewide annual median household income.
- **Exposure:** The extent to which physical and nonphysical assets, functions, population groups, and geographic areas are in direct contact with hazards or their related climate change impacts. Exposure is often determined by examining the number of people or assets that are currently located within a geographic area, the number of people projected to be affected by a hazard, or the magnitude of the climate change impact. For example, measurement of flood extent, depth, and duration in a given area or the number of heat waves experienced by a county are measurements of exposure.
- **Functions:** The programs and services provided to ensure the health, safety, and welfare of Massachusetts communities and environments, such as planning, policy development, regulatory enforcement, research, permitting, grant-making, outreach and education, or stewardship of critical resources.
- **Nonphysical assets:** Power, internet connectivity, transit services, recreation services and programs, public K–12 education, emergency preparedness and response, public health and safety functions and services, waste management, youth programs and foster care services, animal shelter and safety services, cloud-based data, and more that provide critical services to people and environments.
- **Priority populations:** People or communities disproportionately impacted by climate change due to life circumstances that systematically increase their exposure to climate hazards or make it harder to respond to these hazards. 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. These factors are driven by underlying contributors such as racial discrimination, economic disparities, or accessibility barriers that create vulnerability. The term priority populations acknowledges that the needs of people with these experiences must take precedence when developing resilience solutions to reduce vulnerability to climate change.
- **Physical assets:** Infrastructure, utilities, buildings, parks and open space, agricultural lands, housing, schools, ports, airports, equipment, natural resources, and other tangible items that are needed by the people and environments in Massachusetts for their health and well-being.
- **Sensitivity:** Sensitivity refers to the impact on a system, service, or asset when exposed to hazards. For example, if a facility is exposed to storm surge, how will its

ability to function be affected? What are its most sensitive components: generators in the basement, salt-sensitive native habitat, elderly residents cared for within the facility, or something else? Sensitivity is often considered within the context of critical thresholds. Determining the threshold at which an agency, specific asset, function, or population group is affected by a hazard and what components cause that sensitivity can help identify the most effective and critical ways to reduce risk. If the critical threshold is not exceeded, even though the asset is exposed, then there are few or no sensitive components affected by the exposure.

- **Vulnerability** occurs when the people, assets, services, and built and natural environments in Massachusetts are likely to experience exposure, will have sensitivity to the exposure, and/or lack adaptive capacity to limit damage, disruption, or loss from the exposure.

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6.1 Introduction and Purpose

The purpose of this state agency vulnerability assessment is to identify areas where the Commonwealth of Massachusetts and its agencies are likely to be most vulnerable to the hazard and climate vulnerabilities and consequences identified in Chapter 5 (Risk Assessment) of the 2023 State Hazard Mitigation and Climate Adaptation Plan (MA SHMCAP). To determine the most critical vulnerabilities of state agencies and their associated physical assets, nonphysical assets, and functions, Massachusetts undertook the following actions:

- Assessed its current and future risk from natural hazards and climate change, as well as associated vulnerabilities, through Chapter 5 (Risk Assessment) and the 2022 Massachusetts Climate Change Assessment (hereafter referred to as the MA Climate Assessment).
- Conducted a survey of state agencies in fall 2022 to identify vulnerability of the physical and nonphysical assets, as well as functions, that they are responsible for. Eighty-five agencies (out of 94 who received the survey) responded. (See Appendix 4.B for the full state agency survey.)
- Reviewed and vetted results with state agencies through their review of draft versions of the chapter and brief presentation at a Resilient MA Action Team (RMAT) meeting.

The sections that follow highlight the overarching and crosscutting vulnerabilities in the Commonwealth, including: (1) physical and nonphysical assets and functions of greatest concern, (2) social vulnerabilities, (3) environmental vulnerabilities, and (4) trends in relation to state agency actions taken to reduce vulnerabilities. This chapter synthesizes information across other key components of the MA SHMCAP—such as Chapter 5 (Risk

Assessment) and Chapter 4 (State Capability and Adaptive Capacity Analysis)—as well as the MA Climate Assessment. Throughout the chapter, the vulnerabilities highlighted correspond to many of the five sectors detailed throughout the MA Climate Assessment, which include the human, infrastructure, natural environment, governance, and economy sectors. This chapter focuses on vulnerabilities to those five sectors in the following ways:

- The chapter discusses the **infrastructure sector** by detailing vulnerabilities of physical assets described by agencies in the survey, in addition to physical asset and infrastructure vulnerabilities identified in Chapter 5 (Risk Assessment) and the MA Climate Assessment.
- Vulnerability of the **human sector** is highlighted in relation to social and health vulnerabilities, as well as how vulnerabilities to state agency nonphysical assets and functions may impact communities these agencies serve.
- **Natural environment sector** vulnerabilities are assessed in relation to how core habitats and other natural areas in the Commonwealth will be impacted by climate hazards. Discussion of natural environment vulnerabilities includes consideration of the important services (e.g., clean water, air, food, natural protection) that the natural environment provides.
- The **governance** and **economy sector** vulnerabilities are interwoven throughout this chapter. The vulnerabilities of state agencies' physical and nonphysical assets and functions described throughout this chapter demonstrate many of the Commonwealth's governance vulnerabilities. Economic vulnerabilities are mentioned throughout the chapter where relevant (and economic risk and vulnerability is discussed in more detail in Chapter 5 [Risk Assessment]).

By highlighting vulnerabilities discussed in the MA Climate Assessment, Chapter 5 (Risk Assessment), Chapter 4 (State Capability and Adaptive Capacity Analysis)—as well as findings highlighted by state agencies in the survey—this chapter provides a foundation for developing strategies and actions to reduce risk. The final section of this chapter summarizes gaps in existing strategies and actions, and more detail regarding the MA SHMCAP strategies and actions can be found in Chapter 7 (State Strategy, Actions, and Implementation Plan).

For the purposes of this plan, the **vulnerability** occurs when the people, assets, services, and built and natural environments in Massachusetts are likely to experience exposure, will have sensitivity to the exposure, and/or lack the adaptive capacity to limit damage, disruption, or losses from the exposure. When assets, communities, environments, and services are exposed, this exposure is consequential if there is an underlying condition that causes damage, disruption, or loss to something critical or valuable. Examples of these types of underlying conditions include underground living spaces that are impacted in a flood, people with underlying health conditions that will be exacerbated during high-heat days, or an industry, community, or government (e.g., Native American Tribes, the commercial fishing industry) that relies on the presence of native species and is affected

when the native species are displaced by invasive species. There are two main types of **assets:**

- **Physical assets** include infrastructure, utilities, buildings, parks and open space, agricultural lands, housing, schools, ports, airports, equipment, natural and cultural resources, and other tangible items that are needed by the people and environments in Massachusetts for their health and well-being.
- **Non-physical assets** capture power, internet connectivity, transit services, recreation services and programs, public K–12 education programs, emergency preparedness and response operations, public health (e.g., healthcare services) and safety functions and services, waste management, youth programs and foster care services, elder and daycare services and programs, career services, animal shelter and safety services, cloud-based data, and more that provide critical services to people and environments.

Additionally, this analysis identifies which functions (with a focus on those of state agencies) are vulnerable to hazard and climate impacts that result in consequences that impede or impair critical functions. **Functions** are defined as the programs and services provided to ensure the health, safety, and welfare of Massachusetts communities and environments, such as planning, policy development, regulatory enforcement, research, permitting, grant-making, outreach and education, or stewardship of critical resources.

In combination with Chapter 5 (Risk Assessment) and Chapter 4 (State Capability and Adaptive Capacity Analysis), the analysis presented in this chapter:

- Helps assess ongoing actions taken by state agencies to reduce vulnerabilities.
- Summarizes existing vulnerabilities (with a focus on state agencies, as well as social and environmental vulnerabilities) that could result in significant consequences to Commonwealth's human, infrastructure, environment, economic, and governance sectors.
- **Supports the identification of specific actions** to include in the hazard mitigation and climate adaptation strategy to help the Commonwealth reduce risks and vulnerabilities identified in Chapter 5 (Risk Assessment) and this chapter.

6.1.1 Physical and Nonphysical Assets and Functions of Concern

6.1.1.1 State Phyiscal and Nonphysical Assets and Functions

Agencies in the Commonwealth are responsible for a variety of physical and nonphysical assets that may be impacted by the hazards described in Chapter 5 (Risk Assessment). Hazards can have consequences in relation to the function of any agency and impair an agency's ability to deliver services and perform critical functions. Agencies surveyed were responsible for a variety of physical and nonphysical assets and functions (see

Appendix 6.A for a list of agencies and associated asset and function responsibilities). Additionally, agencies have experienced a variety of past disruptions and damages to their assets and functions. Understanding the types of disruptions agencies have experienced from hazards and in relation to their assets and functions is critical for determining the potential consequences of future hazards and the vulnerability of assets and functions. These losses also have implications for the Commonwealth and the services that its residents receive. Of the agencies surveyed, about half had experienced previous damage, disruption, or loss due to unplanned events, such as weather-related closures or cessation of functions and emergency repairs. Agencies indicated that disruptions ranged from a few hours to multiple years (e.g., due to the COVID-19 pandemic), with most respondents citing an average disruption of a few days. In relation to specific disruptions experienced, respondents provided examples such as:

- **Losses and damages to physical assets** including limited ability to use buildings, delay in gaining access to agency buildings, minor to major damage to buildings (e.g., collapse of a roof due to the weight of snow and resulting pipe failure and flooding, window damage, water and mold damage from flooding) and equipment (e.g., loss of equipment and associated operations at fish hatcheries, damage to wiring, printer damage), loss of and damage to stored materials (e.g., archived historic items), and destruction and blockages of embankments, culverts, and roads.
- **Losses to non-physical assets** such as loss of network and database functions; disruption of administrative services; temporary loss of communications, internet, and wireless capability; and disrupted emergency response and recovery activities due to detours and impassable roads and bridges.
- **Losses to functions** including cessation or reduced ability of operations and functions, limited ability to complete construction and restoration projects for infrastructure and natural resource assets, inability to hold meetings and trainings, disruption of administrative services, disposal of contaminated records, and diversion of funds to address disruptions.

Table 6-1 below describes the categories of assets and functions and provides the percent of agencies for each asset and function category that have experienced past disruptions and damages. The table also offers examples—drawn from both the 2023 state capability, adaptive capacity, and vulnerability assessment survey and the MA Climate Assessment—of these losses and potential implications for the Commonwealth and its residents. See Appendix 6.A for more details regarding the various assets and functions for which agencies are responsible.

Table 6-1. Agency Responsibilities and Description (N = 85)

Category of Physical and Non-Physical Assets and Functions	Description Examples	Agencies (%) with Damage to Assets and Functions	Examples and Implications to the Commonwealth
Communication	Land line telephone systems, cable systems, cellular telephone antennae, underground communication conduits, and internet and telecommunications provision.	16%	• **Examples:** Disruption to network and agency databases, loss of communications among agency staff, delay in gaining access to buildings, service disruptions due to power failures. • **Implications:** Limited public access to online state services (e.g., customer inquiries, benefits).
Community	Day cares, food banks, grocery stores, senior centers, education and research institutions, youth and elder care, housing, courthouses, research, waste transfer stations, landfills, recycling and reclamation facilities, incinerators, waste collection and transfer, household hazardous waste collection sites, social or transitional services such as unemployment assistance, job placement, job centers, workers' compensation, and paid family/medical leave support.	21%	• **Examples:** Destruction of roof in warehouse and associated flooding, pause in community outreach and disruption of regularly planned events, disruptions to environmental health functions (e.g., licensing and regulatory inspections, childhood lead poisoning prevention surveillance screenings). • **Implications:** Limited ability of community members to access services provided by agencies, backlog of inspection activities, decrease in lead screening, increased prevalence of lead poisoning.
Critical facilities and services	Hospitals and medical facilities, prisons, animal care facilities, medical services, police stations, fire stations, safety and education services, public schools, emergency response services, critical infrastructure support, and workplace safety services.	29%	• **Examples:** Loss of communications among agency staff, disruptions and delays in emergency response services and recovery activities, physical damage to buildings (e.g., veterans housing), relocation of residents. • **Implications:** Impacts (including injuries and potential loss of life) to those accessing critical medical and mental health services

Category of Physical and Non-Physical Assets and Functions	Description Examples	Agencies (%) with Damage to Assets and Functions	Examples and Implications to the Commonwealth
			that are disrupted, potential issues in accessing emergency services and care needed, disruption to housing and shelter.
Hazardous material sites and contaminated lands	Hazardous materials, landfills, cleanup sites, hazardous waste disposal and transfer, and toxic and contaminant reduction.	9%	• **Examples:** Disruption to inspections for hazardous materials and waste sites, disruption of mosquito control operations. • **Implications:** Potential for increase in vector-borne mosquito diseases, backlogs in inspections and administrative functions that could result in potential environmental damage from compromised hazardous material or contaminated land sites.
Ports and maritime	Seaports and marine terminals, shipping and commerce services, seawalls and riprap, docks, and nature-based flood and storm water systems.	7%	• **Examples:** Shellfish harvest closures due to storms, disruption of port operations and businesses, supply chain interruption. • **Implications:** Decreased fish harvest and lost wages to fishers, decreased seafood product availability for local consumers, lost wages for port workers, supply chain disruption that impacts local and regional commerce, interruption of recreational activity.
Recreation, open space, natural areas, and working lands	Park and recreation facilities, designated open space, cultural and historic resources, bike/pedestrian trails, natural areas, agricultural and working lands, natural and working lands resource management, natural and working lands regulations and programs, recreational opportunities,	16%	• **Examples:** Damage to coastal areas from flooding and storm events, fish mortality in the wild and in hatcheries, impacts to construction for restoration projects, cessation of environmental monitoring. • **Implications:** Limited access to natural areas for anglers, hunters, nature enthusiasts, recreational boaters, and the general public;

Category of Physical and Non-Physical Assets and Functions	Description Examples	Agencies (%) with Damage to Assets and Functions	Examples and Implications to the Commonwealth
	wildlife habitat, and wildland-urban interface buffer provision.		decreased catch and lost wages for fishers; decreased seafood product availability for local customers.
Transportation and mobility	Local streets and roads, state highways, bus shelters, bus and train stations, bridges and tunnels, railroads and freight lines, transit services such as bus or light rail, ferry and boating services, movement of goods, bike/pedestrian routes, and airports.	15%	• **Examples:** Blown motors on railcars, damage to tracks and switches from snow and ice buildup, buckling tracks, damage to bus and rail stations, limited access to and damage to roads and evacuation routes. • **Implications:** Cessation of transportation service and inability to provide reliable public transportation, with particular impacts for individuals with no alternate forms of transportation.
Utilities and infrastructure	Reservoirs, dams, industrial and sanitary sewer systems, flood control infrastructure, stormwater systems, power utilities, fuel and natural gas pipelines, oil refineries, power provision, flood control, and drinking water provision.	13%	• **Examples:** Disruption, removal, reconstruction, and replacement of infrastructure; damage to and blockages of culverts and bridges; damage to electric transmission and utility distribution infrastructure. • **Implications:** Power outages and service delays, disrupted fish passage, interruption in utility services due to delays in construction and repair, economic losses due to power outages and business closure, potential food contamination from lack of refrigeration.
Other	Office equipment and supplies, consumer support services, geospatial data collection and distribution, library and cultural assets, legal databases,	9%	• **Examples:** Interrupted response time to consumer inquiries, increased need for death and management services, disrupted ability to file needed documents and reports.

Category of Physical and Non-Physical Assets and Functions	Description Examples	Agencies (%) with Damage to Assets and Functions	Examples and Implications to the Commonwealth
	land leases, disability accommodations and services, program approval, and more.		• **Implications:** Limited access to hearing rooms and accommodation support, delays in proceedings or document filings, difficulties for injured workers to receive needed benefits and compensation.

The MA Climate Assessment also detailed impacts to physical assets from hazards, with a focus on impacts to the infrastructure sector. The three most urgent impacts to infrastructure that the assessment identified were (1) damage to inland buildings from flooding, (2) damage to electric transmission and utility distribution infrastructure due to heat stress and extreme events, and (3) damage to rails and loss of rail and transit service due to extreme temperature events, storms, and sea level rise. Key findings related to these three most urgent impacts include:

- **Inland residential properties will become more vulnerable to hazards**, with projected property damage increasing 44 percent over baseline by 2050. These impacts will be more severe for low-income and linguistically isolated populations, who are respectively 24 percent and 39 percent more likely to live in areas that will be most impacted by hazards.
- **Electric transmission and utility distribution physical assets** will be vulnerable to increased damage and repair costs, with projected increases from $46 million per year in 2030 to $87 million per year by 2050.
- **Physical assets in the rail system are likely to experience increased damage** from exposure to extreme temperatures, with potential repair costs of $6 million per year by 2050 and $35 million per year by 2090.

Drawing on the data from the MA Climate Assessment, Chapter 5 (Risk Assessment) details the potential impacts of all hazards addressed to the infrastructure sector. Table 6-2 below summarizes these hazard-specific infrastructure vulnerabilities. (See Chapter 5 for more details, including specific physical assets that may be at risk.) These findings highlight a few key themes in relation to physical infrastructure vulnerabilities:

- **Geography.** Coastal counties like Barnstable, Plymouth, and Suffolk experience more vulnerability due to exposure to all hazards, including unique exposure to coastal hazards. All hazards are projected to increase in intensity, and some in frequency, due to climate change (e.g., sea level rise, coastal storms and surge, coastal erosion and flooding, hurricanes and tropical cyclones). Inland counties like Hampshire and Worcester are at risk from hazards such as tornadoes, extreme weather, wildfire, and drought, and some inland counties lack redundancy, resources, and capacity to address the risks efficiently. The MA Climate Assessment also detailed the most urgent infrastructure vulnerabilities and impacts to various regions, outlined below:
    - **Berkshires and Hilltowns Region** infrastructure will be most vulnerable to hazards related to changes in precipitation, which puts many inland buildings at risk due to exposure and vulnerability to inland flooding and associated groundwater rise. Electric transmission and distribution infrastructure, as well as clean water supply (particularly since many communities rely on groundwater supply), are projected to be most exposed and vulnerable to flooding impacts, and clean water supply could also be impacted by precipitation decreases and drought.

The electric transmission and utility distribution infrastructure will also be very vulnerable to failure associated with heat stress and extreme heat events.

- **Greater Connecticut River Valley Region** infrastructure is highly vulnerable to inland flooding, with inland buildings and the electric transmission and distribution infrastructure likely to be most at risk. Extreme temperature, severe weather events, and wildfire activity may also put electric transmission and distribution lines, poles, towers, and transformers at risk.
- **Central Region** infrastructure that is likely to be most vulnerable to hazards includes urban tree cover (from extreme heat, drought, and increased pests) and electric transmission and distribution infrastructure (due to extreme heat and associated heat stress). Roads and transportation infrastructure will also be vulnerable to damage from extreme heat and flooding caused by precipitation.
- **The Eastern Inland Region** has a considerable amount of rail infrastructure (including commuter lines and the subway that provides connections to the Boston area) that is vulnerable to extreme temperature, which could cause track buckling. Rail infrastructure in the region is also vulnerable to other extreme weather that results in flooding, erosion, downed lines and trees, and debris, as well as other events that would disrupt rail service or damage the infrastructure. The region's electric transmission and utility distribution infrastructure is also likely to be vulnerable to extreme temperature, flooding from precipitation, and coastal flooding.
- **The Boston Harbor Region** has rail and transit infrastructure (including commuter and freight rail lines, rail rapid transit, air travel, and subway and trolley lines) that is vulnerable to hazards including extreme heat, coastal flooding, and storms. Urban tree cover in the region will also be vulnerable to extreme heat, invasive species, and drought. The region also includes areas of fill, resulting in an increased risk of damage from earthquakes due to liquefaction.
- **North and South Shores Region** infrastructure will be most vulnerable to hazards from coastal flooding, hurricanes and tropical cyclones, and other extreme weather events. Electric transmission and utility distribution infrastructure will be very vulnerable to these hazards, as will coastal buildings and ports.
- **Cape, Islands, and South Coast Region** electric transmission and utility distribution infrastructure will be very vulnerable from many hazards, including extreme temperature, flooding from precipitation, coastal flooding, and wildfire. Clean water supply (e.g., public water supply, wells) will also be at risk due to flooding from precipitation, extreme temperatures, and drought.

- **Critical facilities.** Many healthcare facilities, correctional facilities, and shelters are in areas of increased risk, including from extreme temperatures and coastal flooding. Additionally, some critical facilities—such as the Massachusetts Information Technology Center, multiple State Police barracks and county prisons, and the

Massachusetts Department of Transportation (MassDOT) Highway Operations Center—are in soft clay soils and are thus likely to be more vulnerable to earthquakes.

- **Roads and transportation infrastructure.** Roads and transportation infrastructure throughout the Commonwealth are vulnerable to a variety of hazards, including flooding, wildfire, hurricanes, extreme heat, coastal erosion, extreme storm events, and sea level rise, with many of these vulnerabilities increasing due to climate change. For instance, low-lying roads that are most at risk from coastal erosion include Cranberry Highway in Cape Cod (located within 50 feet of shoreline that could erode from 2 to 8 feet, which could place the highway at risk of damage) and North End Boulevard in Salisbury, which is located on shoreline that could erode 5 or more feet. Additionally, the Central Artery tunnels, which provide a critical regional transportation link and are an important transportation corridor for the Boston metropolitan area, are at increased risk from coastal flooding.
- **Electric and utility infrastructure.** Both the aboveground and belowground electric transmission and utility distribution infrastructure located along coastal shorelines, rivers, and streams are vulnerable to increasing flood risk due to sea level rise, and the increased intensity of coastal and inland storm events. They are also at risk from other hazards such as extreme heat, extreme storms, and droughts, which can significantly change demand for heating, cooling, and energy—in addition to resulting in damage to this infrastructure during hazard events. Damaged water storage and treatment infrastructure facilities and pipelines can put water supply provisioning at risk due to exposure to contaminants or saline groundwater, or loss of pressure and volume.

Table 6-2. Hazards and Infrastructure Vulnerabilities

Hazard	Vulnerabilities to Infrastructure
Earthquake	• Certain areas of Boston are vulnerable to liquefaction. • Towns with higher proportions of older buildings that pre-date building codes will be more vulnerable to earthquake damage (e.g., buildings with unreinforced masonry). • Other infrastructure that is particularly vulnerable due to its extensive aboveground and belowground facilities include energy facilities, hospitals, and community health centers in areas susceptible to liquefaction; bridges; underground subway and highway tunnels; and water and wastewater utilities. • Many critical facilities are in soft clay soils, which are likely to be more vulnerable to earthquakes. Example facilities include the Massachusetts Information Technology Center, multiple State Police barracks and county prisons, the MassDOT Highway Operations Center, and multiple pump houses and stations.
Hurricanes and tropical cyclones	• Low-lying and linear infrastructure and utility networks are extremely vulnerable, especially buried sewer lines, wastewater treatment plants, stormwater systems, power and communication infrastructure and services, and roads, bridges, trails, and air and marine travel.

Hazard	Vulnerabilities to Infrastructure
	• Suffolk County has the highest number of exposed critical facilities, followed by Plymouth and Barnstable counties. • Barnstable County has the most road mileage that could be exposed to hurricane storm surge inundation. • Stormwater and sewage systems, particularly those that are inadequate or aging, could be vulnerable to heavy rainfall, resulting in combined sewer overflows or release of contaminants.
Invasive species	• State-owned recreation areas or facilities that rely on healthy ecosystems for services (e.g., outdoor recreation, recreational fishing) could be vulnerable to impacts by invasive species. • The agricultural sector is vulnerable to increased invasive species due to drought, as well as changing temperatures and growing seasons. • Physical maritime assets could be disrupted and damaged by invasive species. • Water storage facilities may be impacted by invasive aquatic species. These species may lead to reduced water quality, which could impact drinking water supplies and the cost of water treatment.
Coastal erosion	• Infrastructure near the shoreline, including transportation systems, housing, businesses, recreational areas, and shoreline protection structures (e.g., seawalls, revetements, armoring), will be vulnerable to coastal erosion. For instance, in Newburyport's Reservation Terrace community, many homes have already experienced damage and destruction due to coastal erosion. • Other types of infrastructure that are vulnerable to coastal erosion include energy infrastructure on the coastline; coastal roadways, bridges, and airports; and water infrastructure (e.g., pipes for septic systems, drinking water, stormwater, and wastewater). • Specific roads that are most at risk include Cranberry Highway in Cape Cod (located within 50 feet of shoreline that could erode from 2 to 8 feet and cause damage to the highway) and North End Boulevard in Salisbury, which is located on shoreline that could erode 5 feet or more. East Chop Drive in Oaks Bluff on Martha's Vineyard has also experienced closures due to erosion. • Many open space and natural areas are also at risk of erosion, such as Plum Island State Reserve, the Parker River National Wildlife Refuge, and Coskata-Coatue Wildlife Refuge.
Groundwater rise	• Below- or at-grade buildings, building foundations, and utilities (e.g., pipes, belowground electrical assets, water infrastructure) are vulnerable to flooding, unstable soils, groundwater rise, and saltwater intrusion along coastal areas. • Coastal roads will experience repeated damage from rising groundwater. • Agricultural lands may be vulnerable to changes in drainage and flooding due to groundwater rise.

Hazard	Vulnerabilities to Infrastructure
Extreme temperature	• High-value crops that rely on specific temperature regimes—such as apples, cranberries, and maple syrup—will be vulnerable to temperature increases, as will dairy and cattle production and crops such as sweet corn. • 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). • Twenty-nine percent of critical facilities are in high land-surface temperature (LST) areas. Among critical facilities in high LST areas, the largest proportion is residential buildings, followed by corrections facilities and energy facilities. • Many hospitals throughout the Commonwealth are in regions with high LST, including Worcester State Hospital, the University of Massachusetts Chan Medical Center, Taunton State Hospital, Soldiers Home in Holyoke and Chelsea, Newton Pavilion, and the Massachusetts Mental Health Center. • Shelters in Amherst, Lowell, Quincy, and Worcester and correctional facilities in Billerica, Boston, Bourne, Bridgewater, Chelsea, Chicopee, Framingham, Gardner, Greenfield, Lancaster, Ludlow, New Bedford, Norfolk, Northampton, Pittsfield, Plymouth, Shirley, West Boylston, and Worcester are also in high-LST regions.
Tornado	• State-owned, municipal, and residential buildings constructed prior to current building codes may be more vulnerable to tornado-related damages. • Middlesex, Worcester, and Hampshire Counties have the highest numbers of critical facilities located in zones with high tornado hazard. • Other types of infrastructure that could be vulnerable to tornadoes include forestry and agricultural crops, livestock, equipment, and infrastructure; power lines and poles; public safety facilities and equipment; roads, bridges, and rail systems; and water infrastructure such as storage tanks and hydrants.
Wildfire	• Infrastructure located in the wildland-urban interface and intermix area will be vulnerable to wildfire. • Building types most prominent in moderate wildfire hazard zones are water resources facilities, residential buildings, and energy facilities. • Norfolk, Middlesex, and Plymouth counties have the most critical facilities located in moderate wildfire hazard zones. • Other types of vulnerable infrastructure include forestry and agriculture industry infrastructure, energy distribution and transmission lines in wildfire risk zones, and roads, bridges and rail systems that may become blocked due to fire and debris.
Drought	• Agricultural land and infrastructure will be particularly vulnerable to drought. Franklin, Plymouth, and Hampshire Counties have the highest acreage of agricultural land in the Commonwealth. • Energy production plants that rely on water for cooling will be uniquely vulnerable to drought, as could hydropower plants.

Hazard	Vulnerabilities to Infrastructure
	• Groundwater sources and smaller surface water supplies will also be vulnerable to drought due to reduced rates of replenishment.
Coastal flooding	• The Boston Harbor region is particularly vulnerable to coastal flooding due to projected sea level rise and its existing development footprint. • Other infrastructure that is vulnerable to coastal flooding includes ports and marinas throughout the Commonwealth, coastal rapid rail transit (e.g., trolley and subway systems), and solar energy production resources that lie within the existing or potential future Federal Emergency Management Agency 100-year coastal flood plain. • Based on available MassGIS data, at least four healthcare facilities (including nonacute care hospitals and community health centers) are most at risk to a 100-year flood event. • Critical facilities including the Suffolk Sheriff's Department in Chelsea and the Department of State Police Special Operations Marine Division in Boston are also in zones that are most at risk of exposure from a 100-year flood event. If these facilities have been retrofitted to withstand this exposure—such as elevating them, removing all sensitive equipment and workspaces from belowground or at-grade spaces, or designing and having a plan to deploy temporary flood measures—then they will have reduced their risk from direct exposure. However, the function will be disrupted during a flood event and access to and from the buildings will likely be compromised, as well as power, water, and other services, which would impede the services these facilities can provide to the community. • Many state-operated coastal roads are likely to be at risk from coastal flooding. One significant asset at risk is the Central Artery tunnels, which provide a critical regional transportation link and are an important transportation corridor for the Boston metropolitan area.
Flooding from precipitation	• Both residential and state-owned properties are vulnerable to riverine flooding, with the Eastern Inland and Greater Connecticut River Valley regions likely to experience the largest annual increases in damage to residential structures by 2090. • Solar energy production infrastructure may be vulnerable to riverine flooding, as 26% of current solar production is located within a Federal Emergency Management Agency 100-year floodplain. • Other infrastructure that is vulnerable to riverine flooding includes aging culverts and bridges, due to potential flood impacts such as bridge scour, overtopping, culvert blowout, and road embankment destabilization. • The Greater Connecticut River Valley and Central regions are most likely to experience the highest projected annual economic impacts from dam overtopping and breaching.
Landslide and mudflows	• Infrastructure (e.g., farmlands and soils, crops and critical equipment, energy transmission lines, transportation infrastructure) in areas with steep slopes or exposure to extreme precipitation, wildfire, drought, or flood is likely to be most vulnerable to landslides or mudslides.

Hazard	Vulnerabilities to Infrastructure
	• Highly vulnerable infrastructure includes mountain roads, coastal roads, and transportation infrastructure and utilities adjacent to such roads.
Tsunami	• Hospitals, elder care facilities, prisons, animal care facilities, and elementary schools and preschools are most vulnerable during a tsunami as they require special levels of care and coordination. • Plymouth, Suffolk, and Barnstable counties have the highest numbers of critical facilities vulnerable to tsunami exposure. • Other infrastructure that could be vulnerable includes cropland and livestock (which could be devastated by flooding), aboveground utilities like power lines and radio/cellular communication towers, power generation facilities, state-owned police facilities and fire departments, roads and bridges, and water and wastewater treatment plants located in tsunami inundation zones.
Severe winter storms	• Worcester County contains the highest number of critical facilities in areas likely to experience the most days with 5 inches or more of snow. • Coastal buildings and ports are vulnerable to storm surge and high winds from nor'easters, which will be exacerbated by sea level rise and coastal erosion. • Other types of infrastructure that are vulnerable include low-lying agricultural areas that could be impacted by flooding, power lines and other aboveground energy infrastructure, public safety buildings (e.g., police, fire, and medical facilities), roadways, public transit, and water and wastewater treatment plants.
Other severe weather	• Buildings that are particularly vulnerable include residential structures, wood and masonry buildings, and high-rise buildings. • Forestry species and agricultural crops, equipment, and infrastructure may be directly damaged by high winds. • Other infrastructure that may be vulnerable includes power and aboveground communication lines, utility infrastructure (e.g., power lines, gas lines, electrical systems, communications), public safety facilities and equipment, and water infrastructure, including water supply, stormwater, dams, and wastewater systems. • Roads, bridges, cargo and passenger rail, and transit may be vulnerable to disruptions from falling trees, landslides, downed power and communication lines, flooding, or debris.

6.1.1.2 Specific Impacts to Agency Functions and Services

Beyond the general details regarding how past hazard events resulted in disruption of functions, agencies also described past and potential consequences of damage and disruption to agency functions. Agencies provided specific examples of concerning impacts to their services, such as:

- **Communications service impacts** such as disruption of emergency services and infrastructure, as well as information technology (IT) and security services.

- **Community service impacts** such as potential limited access to job placement and employment benefit services, interruption of community health screening, cessation of community outreach and information events, impacts to mosquito control operations, and damage and destruction to residential facilities that would impact the ability of these facilities to provide community services.
- **Critical service impacts** such as limited ability to conduct facilities inspections, interruptions in child protection visits, disruption to medical service provision, and interrupted emergency services coordination.
- **Hazardous material and contaminated land services impacts,** including disruptions to site cleanup activities and potential inability to access and repair damage to hazardous material facilities.
- **Port and maritime service impacts,** such as disruptions to the fish and seafood supply chain, processing operations, and seafood transportation, as well as supply chain interruption and limited distribution of other goods imported and exported through ports.
- **Recreational, open space, natural area, and working land service impacts,** including temporary loss of recreational fishing and boating access, impacts to habitat in natural areas that could limit access for recreational users, and loss of protected open space that could negatively affect species living in these areas. (See box above.)
- **Transportation and mobility service impacts** such as lack of access to emergency routes, disrupted transportation due to damage to roads and bridges, and disruption of transportation services (e.g., trains, boats, buses).
- **Utilities and infrastructure service impacts,** including disruption of gas, electric, water, stormwater, and wastewater services due to facility damage.

Spotlight: Impacts from Loss to Services

The Division of Ecological Restoration (DER) is responsible for leading projects that help restore and protect rivers, wetlands, and watersheds in Massachusetts. Loss of DER operations—which may occur from hazards such as flooding, drought, and storms—could result in delay or total cessation of restoration projects. Work stoppage could lead to loss of funds and difficulty remobilizing the project team once activities can resume. If DER operations cease, DER and partners would not be able to move forward on restoration projects and would not have the funds to support local businesses. Additionally, loss of DER operations may result in the delay of permitting a project and may increase the cost of permitting due to the delay. Recovery from these impacts may be a matter of days, weeks, or months depending on the severity of impact to DER operations.

The survey also asked agencies to indicate specific types of critical services that would be impacted following loss of an agency's operations, as well as how long it would take for the resource to be impacted and the time it would take to recover following impacts. Over half of the agencies that responded to the survey indicated that public health and safety

services would be impacted due to a loss of operations, with impacts felt immediately and recovery times ranging from days to months. Table 6-3 summarizes responses to these questions and the various ways critical services will be impacted by hazard events.

Table 6-3. Agency Responsibilities and Description (N = 85)

Types of Services Impacted	% of Agencies with Impacts	Examples of Length of Time to Experience Impacts and Recover
Education	28%	• Immediate impacts on educational programs and training and systems that impact education (e.g., housing, transit). • Recovery time could be as quick as few hours but could also take days to months and even result in permanent changes.
Food support and security	27%	• Could experience both immediate and delayed impacts to food (e.g., dairy and milk supply), services, and programs (e.g., food provided through shelters or public housing, food stamp program). • Response times would vary depending on disaster and severity, as well as ability to coordinate within and among agencies.
Goods movement	16%	• Some immediate impacts due to loss of power and internet, but operations could be restored as soon as these services resume. • Potential for immediate impacts due to loss of transportation infrastructure, with highly variable recovery times based on event severity.
Health services	33%	• Potential immediate impacts to services due to impacted facilities and need to transport residents to alternative sites. • Potential immediate impacts to programming (e.g., mental health services, background checks for volunteers and employees, veteran care, pharmacy and medical benefits) with potential recovery of a few days or longer depending on severity.
Local businesses	34%	• Potential immediate or short-term impacts on contractors, employment agencies, and employers, as well as potential impacts to work and projects performed by businesses and contractors. • Recovery could take weeks to months depending on the severity of the event.
Natural resource management and protection	19%	• Potential for immediate impacts, including loss of infrastructure and natural resources and inability to perform project work. • Recovery time varies highly based on the event.

Types of Services Impacted	% of Agencies with Impacts	Examples of Length of Time to Experience Impacts and Recover
Permits	27%	• Potential inability to or delay in issuing permits for projects and potential impacts to permitting, though impacts may be mitigated through online permitting systems.
Public health and safety	49%	• While there could be potential minor disruptions to 9-1-1 data centers, calls would still be answered, and disruptions would be minimal due to backup data centers and systems. Recovery, reinstallation, and reconfiguration of equipment could take years. • Potential for impacts within days to weeks if there are disruptions to mosquito control operations. Time to recover would be contingent on severity of the event and the number of mosquito control districts impacted. • Potential immediate impacts to housing, emergency shelters, or utilities, with variable recovery times.
Recreational opportunities	25%	• Immediate impacts to and curtailment of recreational activities until the event had been resolved. • Could take months to recover depending on impacts to natural areas and associated infrastructure.
Regulatory programs	27%	• Potential immediate impacts to services that cannot be performed remotely, such as in-person site visits, inspections, and licensing, with some ability to continue regulatory functions (e.g., review, hearings) online depending on power and internet. • Recovery time would likely depend on severity of the event, potentially varying from multiple days to weeks.
Transit and transportation	26%	• Immediate curtailment of transit or transportation activities until event resolution. • Potential loss of transportation networks if construction on maintenance projects is delayed (and roads remain closed for longer than anticipated), and elevated risks of flood damage and loss of life if aging infrastructure fails during a storm or flooding event. • While agencies (e.g., MassDOT) would take immediate steps to implement temporary solutions, full recovery from impacts could take days, weeks, or months depending on the severity of the impact to operations.
Youth services	19%	• Potential immediate impacts to infrastructure that supports youth services (e.g., family housing, emergency shelters) depending on the event. • Resolution would depend on the severity of the issue, but could take at least two weeks or be permanent, depending on location and event severity.

6.1.2 Social Vulnerability

6.1.2.1 Populations at Risk

Within the Commonwealth, many populations are more at risk from hazards due to a variety of factors, such as geographic location, resources available, and socioeconomic characteristics. Chapter 5 (Risk Assessment) outlines potential vulnerabilities of each hazard to the human sector, and the MA Climate Assessment details the most urgent impacts of hazards to the human sector. Understanding which characteristics make communities more vulnerable to specific hazards—as well as potential disproportionate impacts that may occur—can help the Commonwealth design actions to best mitigate vulnerabilities and reduce risk to human communities.

In the survey, agencies described their primary concerns regarding impacts to populations from hazard events. Table 6-4 lists examples of populations of concern and disproportionate impacts according to the categories of assets and functions for which agencies are responsible. Responses regarding impacted populations varied greatly, from concerns about impacts to the public (e.g., disruption of critical and transportation services) to more specific impacts for certain populations such as veterans, people with disabilities, and people dependent on public transportation.

Table 6-4. Populations of Concern and Disproportionate Impacts

Asset and Function Category	Example Populations of Concern	Examples of Disproportionate Impacts of Concern
Communication	• Residents, business, and municipalities. • Municipal, campus, hospital, and environmental police and deputy sheriffs.	• Delays in court date proceedings and filings. • Extended response times. • Impacts to communities reliant on public transportation from disruptions related to offline services.
Community	• Building occupants. • People with disabilities. • Job seekers. • Mosquito Control District member municipalities.	• Loss of in-home or facility support and services for at-risk adults. • Impacts to those in agricultural sector from hazards.
Critical	• Veterans. • People with disabilities. • At-risk youth. • General public (e.g., hospital patients, school children).	• Food insecurity impacts due to crop damage. • Environmental justice and other priority population families and children. • Employees in at-risk facilities.

Asset and Function Category	Example Populations of Concern	Examples of Disproportionate Impacts of Concern
Hazardous material sites and contaminated lands	• Adjacent neighborhoods and communities affected by environmental injustices. • Farmers.	• Neighborhoods adjacent to cleanup sites (particularly environmental justice communities). • Delays in staff services to farmers.
Ports and maritime	• Adjacent neighborhoods and communities affected by environmental injustices. • Seafood-consuming public. • Public dependent on imported goods. • Traveling public and employees.	• Loss of business. • Supply chain disruptions and associated local and regional economic losses. • Potential impacts felt throughout all communities, particularly coastal communities.
Recreation, open space, natural areas, and working lands	• General public (e.g., hikers, park users, recreational fishers, and others). • Visitors. • Landowners that manage open space and restoration projects.	• Potential impacts felt throughout all communities. • Open space users with disrupted access to natural areas.
Transportation and mobility	• Communities reliant on public transportation. • Motorists. • Emergency service providers. • Traveling public and employees.	• Potential impacts felt throughout all communities. • Environmental justice populations dependent on disrupted transportation services. • Coastal communities impacted by damage to roads from flooding and erosion.
Utilities and infrastructure	• Motorists and emergency services in hazard vicinity. • Utility service users.	• Environmental justice populations with disrupted utility services. • Potential impacts felt throughout all communities.
Other	• Insurance customers. • Injured workers.	• Limited access to hearing rooms and disrupted support from agencies. • Delays in proceedings or document filing.

The survey also asked agency respondents to detail how disruptions to their services from unplanned hazard impacts would result in consequences to directly impacted populations, public health and safety, climate-vulnerable populations, and associated costs due to damage, disruption, and loss. Table 6-5 summarizes these responses. Understanding the

social consequences of hazard-related disruptions, damage, and loss can help state agencies consider types of populations and areas for focusing adaptation efforts, and these consequences were used to help determine actions and strategies highlighted in Chapter 7 (State Strategy, Actions, and Implementation Plan) of the MA SHMCAP.

Table 6-5. Populations Impacted and Social Consequences of Hazard-Related Disruptions, Damage, and Loss

Category	Examples of Populations Impacted and Consequences
Populations affected	• Incarcerated people, their visitors, and staff. • Workers, businesses, and public agencies. • Recreational boaters and fishermen, anglers, hunters, students, nature enthusiasts. • Construction contractors. • Veterans.
Public health and safety impacts	• Reduced oversight of workplace safety and health. • Loss of life and severe injury. • Delayed response by emergency and essential personnel. • Air quality impacts from reduced public transit use.
Disproportionate impacts	• Disproportionate impacts to elderly and youth populations. • Populations affected by environmental injustices are likely to be disproportionally affected, particularly if they rely on public transit that is disrupted. • Inability for veterans and families with disabilities to receive assistance. • Subsistence fishers are vulnerable to the effects of prolonged fishing closures.
Economic impacts	• Costs associated with infrastructure for remote work (e.g., laptops, monitors, docking stations, software licenses). • Undefined loss of revenue from missed hunting and fishing license sales. • Loss of work hours. • Repair and recovery costs.

6.1.2.2 Environmental Justice and Other Priority Populations

Overall, while the provided examples mentioned various populations that could be impacted, many respondents cited potential disproportionate impacts to environmental justice and other priority populations. The Commonwealth characterizes environmental justice populations as those that meet one or more of the following criteria:

1. The annual median income is 65 percent or less of the statewide annual median household income.
2. Minorities make up 40 percent or more of the population.
3. At least 25 percent of households identify as speaking English less than “very well.”

4. Minorities make up 25 percent or more of the population and the annual median household income of the municipality in which the neighborhood is located does not exceed 150 percent of the statewide annual median household income.

Beyond environmental justice populations, other priority populations include people or communities who are disproportionately impacted 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. This disproportionate impact is driven by underlying contributors such as racial discrimination, economic disparities, or accessibility barriers that create vulnerability. The term priority populations acknowledges that the needs of people with these experiences and expertise must take precedence when developing resilience solutions to reduce vulnerability to climate change.

Within the Commonwealth, environmental justice populations are distributed throughout all counties (Figure 6-1, Table 6-6). Suffolk County has the highest percentage of residents that are considered part of an MA Environmental Justice community, followed by Hampden and Middlesex. Actions to reduce hazard vulnerability—especially within these counties, but also throughout the Commonwealth—will need to consider how to respond to the needs of these populations.

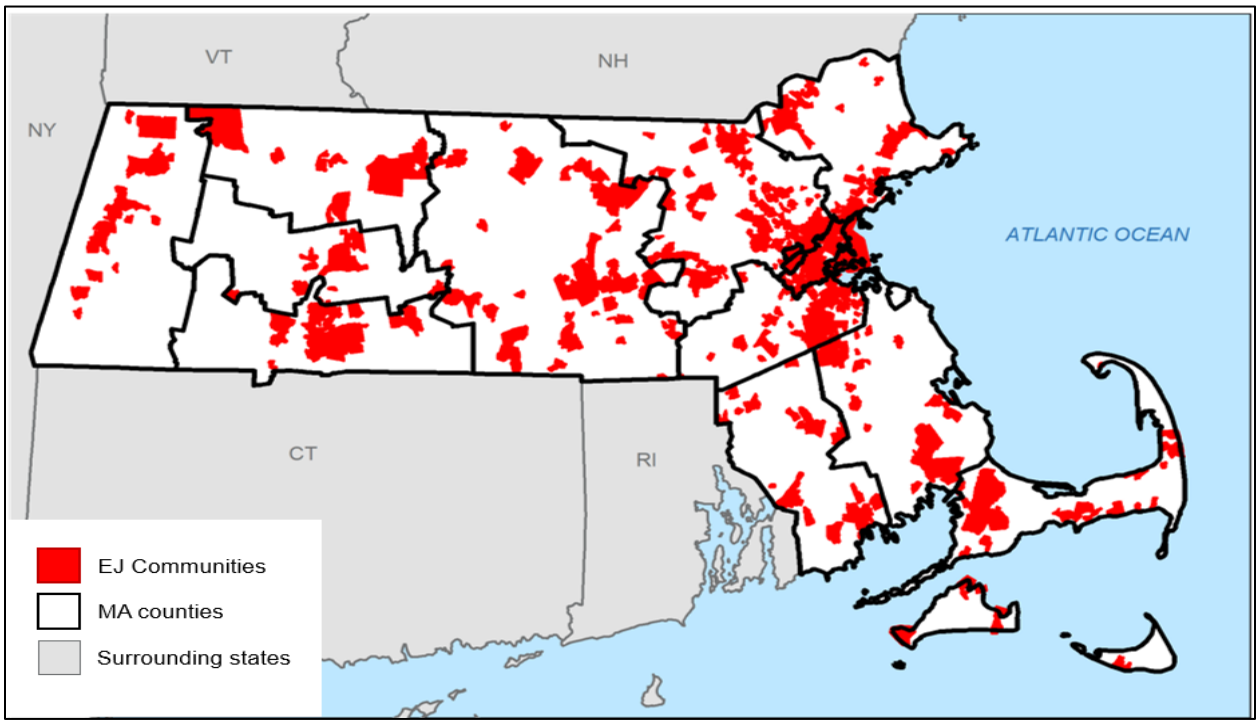


Figure 6-1. MA Environmental Justice populations.

Table 6-6. Percentage of Counties with Environmental Justice Populations

County	County Population	Percent of County in Environmental Justice Population
Barnstable	214,445	20%
Berkshire	127,975	41%
Bristol	561,037	40%
Dukes	17,312	25%
Essex	783,676	43%
Franklin	77,602	30%
Hampden	**467,871**	**58%**
Hampshire	162,778	37%
Middlesex	**160,0842**	**44%**
Nantucket	11,168	8%
Norfolk	700,437	38%
Plymouth	515,303	26%
Suffolk	**796,605**	**80%**
Worcester	824,772	42%

Note: Counties with the top three highest percentages of environmental justice populations are in bold.

A particular category of environmental justice and other priority populations likely to be at risk from impacts of hazards to state agency assets, functions, and services are those that depend on state agencies for shelter, transportation needs, or other critical social services. For instance, agencies that provide services or shelter to environmental justice and other priority populations—such as the elderly, very young, incarcerated, housing or transportation cost-burdened individuals, renters, people without a car, or people with animals—will need to have clear plans in place to ensure they can shelter in place or safely evacuate and relocate, if necessary. Only 15 percent of agencies that responded to the survey indicated they provide shelter or services to these populations; however, those that responded provided many examples of the plans they have in place in case of hazard impacts to ensure the well-being of these populations. Respondents highlighted plans and actions such as:

- Collaborative, multi-agency crisis plans to provide shelter to individuals.
- Facility-specific procedures and policies for shelter-in-place or evacuation and relocation depending on event severity.
- Emergency preparedness guidelines for local housing authorities.
- Plans for transferring shelter residents, if shelters are compromised due to weather or other emergencies, to facilities that are not at risk.
- Contingency plans for using public health hospitals as shelters or cooling and warming centers for those experiencing homelessness and those most dependent on home health services.
- Detailed Continuity of Operations Plans (COOPs) that are continually updated and include contingencies such as processes for relocation, alternate facility operations, leadership and delegation of authority, and virtual coverage of essential functions.

Spotlight: Loss of Services to Youth

The Department of Youth Services serves many youths that are socially vulnerable. Services include food provided through kitchens in its facilities, social services like site and home visits, shelter, and more. Disruption of operations due to hazard impacts would require the department to find alternate means for food and other services and could impact its service continuum and the outcomes and effectiveness of its programming.

The MA Climate Assessment analyzed impacts to the human sector related to people's health, welfare, and safety. It found that the three most urgent impacts to the human sector were health and cognitive effects from extreme heat, health effects from degraded air quality, and emergency services response delays and evacuation disruptions. There are a variety of populations most vulnerable to these urgent impacts. Overall, these results reflect the findings of the survey and the increased vulnerability of environmental justice and other priority populations. Specifically:

- **The linguistically isolated** are highly vulnerable to extreme heat and are 28 percent more likely to experience mortality related to extreme heat.
- **Black and African American individuals** are at higher risk of health effects from degraded air quality, as they are 40 percent more likely to live in areas with the highest projected asthma incidences and highest projected increase in childhood asthma diagnoses.
- **All classifications of environmental justice Census block groups** are likely to experience greater impacts to disruptions to emergency service response delays and evacuations than non–environmental justice populations across the Commonwealth.

6.1.3 Environmental Vulnerability

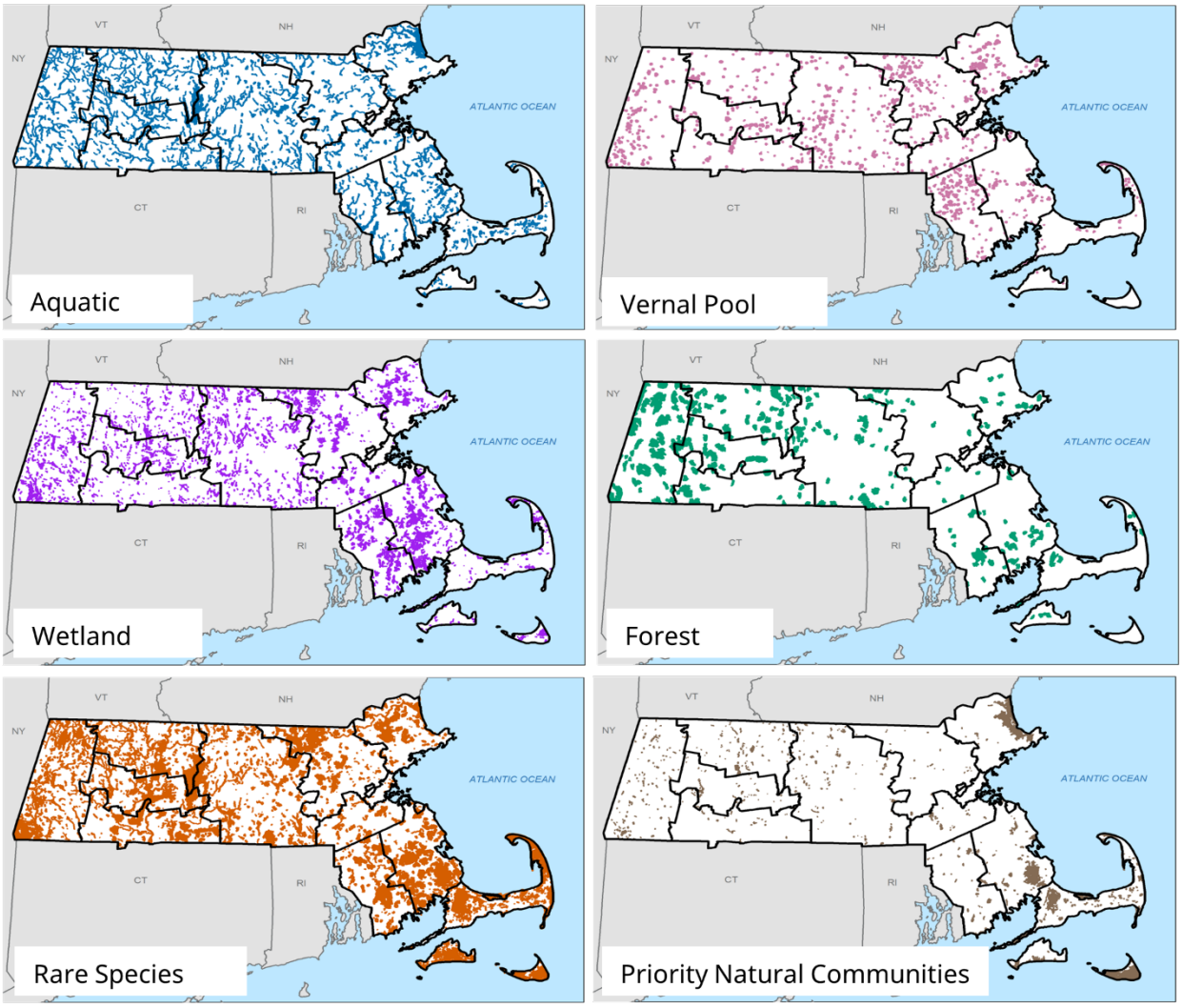
6.1.3.1 Core Habitats in the Commonwealth

The Commonwealth has a rich diversity of natural ecosystems, including forests, wetlands, rivers, grasslands, and coastline. Besides sustaining important habitat for plants and animals, they also provide many important ecosystem services, such as carbon storage, water filtration, and flood risk reduction. Understanding the system scale vulnerability of these ecosystems to natural hazards is a key consideration for determining the resilience of the Commonwealth as a whole. BioMap, a tool used for biodiversity conservation in Massachusetts, identifies core habitats, which are areas that are critical for the long-term persistence of rare species, exemplary natural communities, and resilient ecosystems across the Commonwealth (MassWildlife & The Nature Conservancy, 2022). These core habitats consist of 1.52 million acres, of which about 49 percent are protected. These habitats are described in Table 6-7 and mapped in Figure 6-2.

Table 6-7. Descriptions of BioMap Core Habitat

Core Habitat	Description
Aquatic core	Intact aquatic habitats (i.e., rivers, streams, lakes, and ponds) supporting a diversity of aquatic species and important physical and ecological processes.
Vernal pool core	Clusters of ecologically significant pools and intact surrounding upland habitat to ensure connectivity between pools.
Wetland core	The most intact, least disturbed wetlands within resilient, less developed landscapes, with fewer stressors such as pollution.
Forest core	The most intact forests of Massachusetts, least impacted by development and essential for animals and plants dependent on remote habitat.
Rare species core	Areas critical to the long-term conservation of our most vulnerable species and their habitats.
Priority natural communities	Assemblages of plant and animal species with limited distribution and the best examples of common assemblages.

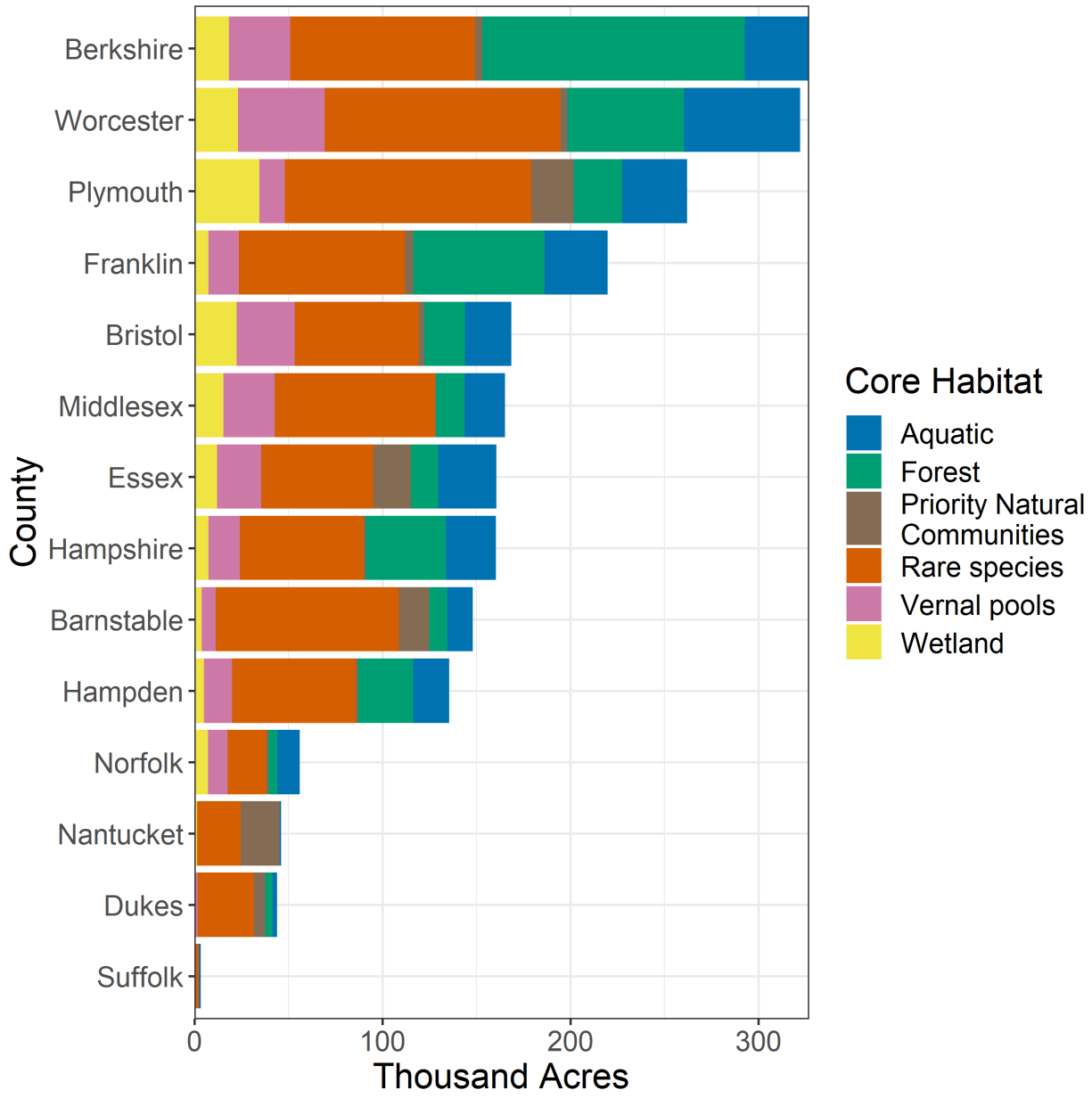
Source: MassWildlife & The Nature Conservancy (2022).



Source: MassWildlife & The Nature Conservancy (2022).

Figure 6-2. BioMap core habitats.

These core habitats are of high importance for conservation efforts, as they are key areas for safeguarding the Commonwealth's biodiversity. Figure 6-3 shows that Berkshire, Plymouth, and Worcester counties have high percentages of almost all core habitats. This is an important consideration for conservation planning and for identifying potential habitats that may be most vulnerable to hazards. For instance, about 32 percent of forest core habitat in the Commonwealth is in Berkshire County, which also is at a relatively higher risk for landslides and currently has medium wildfire hazard potential.



Source: MassWildlife & The Nature Conservancy (2022).

Figure 6-3. Acres and percent of each BioMap core type in each county.

6.1.3.2 Vulnerability of Natural Areas

As part of the state agency vulnerability assessment survey, Massachusetts state agencies were asked whether their agency manages, provides, or protects habitat for threatened or endangered species. Of the 83 total respondents, only 12 percent said their agency did manage these habitats. (However, note that these agencies, such as the Department of Conservation and Recreation, Department of Fisheries and Wildlife, and Department of

Ecological Restoration, are responsible for managing a large percentage of these state-owned lands.) Most of these respondents also said that the habitat they managed was scarce in their region. Two habitat types that were specifically mentioned included butterfly wildflower habitat and eelgrass. Respondents also agreed that most of the habitats they managed were relatively unique to their regions and could not be established in other areas if they were to be damaged by natural hazards. A few of the reasons habitats would be difficult to establish elsewhere include:

- Impacts to existing species
- Funding
- Permitting
- Time required for planning and implementing long-lasting and effective restoration projects
- Staff capacity
- Scarcity of suitable habitats for species to be established in

As endangered or threatened habitat may not easily be established in other areas, there are a variety of species and ecosystem benefits that are vulnerable and could be lost if the threatened habitat was destroyed or altered. Sensitive species with limited abundances and distributions are the most likely to be lost, which can lead to a loss of ecosystem services and natural heritage. Some specific habitats and species that respondents identified as threatened are listed below, many of which are part of BioMap's aquatic or wetland cores:

- Salt marsh habitat and the unique plants and animals that inhabit them (e.g., salt marsh sparrow)
- Eels and river herring
- Coldwater fisheries habitat and other rare fish and shellfish species
- Unique or rare types of freshwater plant communities such as Atlantic white cedar bogs
- Important habitat for several commercially and recreationally managed finfish and shellfish species
- Eelgrass

An example of a critical natural area that is vulnerable to multiple hazards is The Great Marsh, which spans the northeastern region of the Commonwealth. The marsh is considered one of the most important coastal ecosystems in northeastern North America and has been designated a Critical Natural Landscape, Long Term Ecological Research Network site, Important Bird Area of Global Significance, Western Hemisphere Shorebird Reserve Network site, and an Area of Critical Environmental Concern (Schottland et al., 2017). Additionally, communities surrounding the marsh rely on it to buffer storm

damages, reduce coastal erosion, and dampen flooding. However, sea level rise, coastal erosion, hurricanes, or winter storms threaten to damage or destroy areas of this critical marsh habitat. Large areas of the marsh may become inundated with just 1 foot of sea level rise, and future storms on top of this can further inundate or erode habitat (Schottland et al., 2017). As detailed Chapter 5 (Risk Assessment), Section 5-5 (Coastal Flooding), the greatest statewide loss of high and low marsh habitat is predicted to occur between the years 2070 and 2100, with 98 percent of today's combined high and low marsh habitats transitioning to tidal flat by 2100.

Table 6-8 summarizes environmental risks detailed for each hazard. One common concern in the aftermath of many hazards is the total disruption or destruction of a habitat. This can completely eradicate important biodiversity hotspots and lead to increased vulnerability or total loss of already endangered or threatened species. Additionally, large disturbances can create conditions favorable for the spread of invasive species, which can outcompete native communities, displacing many native species and causing widespread economic and environmental damage. Contamination from debris and pollutants can also occur after a variety of hazards and may seriously degrade ecosystems or kill off species in the area. As pollutants can remain long after a hazard, taking steps to preemptively plan for and reduce potential debris creation is important.

Table 6-8. Potential Environmental Impacts from Each Hazard Type

Hazard	Impacts and Vulnerabilities to Natural Areas
Earthquake	• Disturbance and displacement of the physical foundation of an ecosystem can disrupt the balance of species and leave the area more vulnerable to the spread of invasive species. • Damage to gas and fuel pipes may cause explosions or leaks, which can discharge hazardous materials into the local environment or watershed if rivers are contaminated. • Fires caused by earthquakes can cause extensive damage to ecosystems.
Hurricanes and tropical cyclones	• Flooding and wind can damage trees and other vegetation. • Coastal storm surge often results in significant damage to tidal estuaries and can alter the salinity of these systems. • Priority natural communities, coastal adaptation areas, and tern foraging habitats have some of the highest portions of their habitats exposed to hurricane-related storm surge.
Invasive species	• Reduced diversity of native plants and animals. • Degradation of water quality. • Degradation of wildlife habitat. • Local and complete extinction of rare and endangered species.
Coastal erosion	• Potential damage to or loss of area for salt marshes, mudflats, beaches, coastal banks, and uplands that support native species and provide for inland migration.

Hazard	Impacts and Vulnerabilities to Natural Areas
	• Loss or change of wetland and salt marsh shoreline functions, including habitat for native species, filtering pollutants, retaining and trapping sediment, and shoreline buffers. • Loss of biodiversity, natural and cultural resources, and disruption to networks and systems of habitat along the Massachusetts coast.
Groundwater rise	• Saltwater intrusion and inundation of aquifers, wetlands, and ecosystems unable to adapt to new conditions. • Mobilization of contaminants into habitats, vegetation, and wetlands. • Coastal plain ponds, freshwater wetlands, and fish hatcheries are likely to be at risk of saltwater intrusion that will result from groundwater rise, which could alter their function and allow for persistence and proliferation of invasive species. • Areas with higher exposure to polluted water, such as locations near septic systems and overburdened sewer systems or contaminated sites, are at higher risk of exposure to contaminated water.
Extreme temperature	• Warming of freshwater, coastal wetland, and marine ecosystems are the most urgent impacts (as identified by the 2022 Climate Change Assessment) to the natural environment in Massachusetts. • Warming temperatures threaten freshwater ecosystems through increased growth of aquatic plants and algae, as well as shifting habitats. • Warming temperatures increase the risk of algal blooms, including cyanobacteria (a harmful variety of algae). • High temperatures and evapotranspiration rates could lead to habitat loss and wetlands drying out at least seasonally. • As the climate warms, species will shift north and to higher elevations away from their historical ranges, leading to the loss of species that play key ecosystem roles, or the range expansion of invasive species that previously did not extend into these habitats. • Shifting habitat from temperature changes may result in a geographic mismatch between the location of conserved land and the location of critical habitats and species the conserved land was designed to protect. • Changes in timing of flowering, growth, and reproduction of native plants may result in impacts to the health and viability of insects, birds, and other wildlife. • Forests stressed from rising temperatures may have reduced capacity to provide ecosystem services like carbon storage and water filtration. Trees, soil, streams, and rivers work as a system, and damage to any component due to drought or heat

Hazard	Impacts and Vulnerabilities to Natural Areas
	results in damage to the whole system. Rising temperatures result in degraded soils, damaged trees, habitat shifts, and the movement of water out of the environment. They also result in forests emitting carbon rather than storing it. These factors lead to increased wildfire risk, which leads to carbon emissions and air quality impacts.
Tornado	• Damage and disruption to native species and habitats can occur if a tornado event uproots and transports vegetation and habitat. • As felled trees decompose, the increased dry matter may increase the threat of wildfire in vegetated areas. • The loss of root systems from vegetation removal increases the potential for soil erosion. • Disturbances created by blowdown events may also impact the biodiversity and composition of forest ecosystems. • Invasive plant species are often able to quickly capitalize on the resources (e.g., sunlight) available in disturbed and damaged ecosystems.
Wildfire	• Frequent wildfires can eradicate native plant species and encourage the growth of both highly flammable and fire-resistant invasive species. • If invasive species establish themselves after a wildfire, they can outcompete the native species, which can lead to a decrease in overall biodiversity of a site or ecosystem and threaten or cause extinction of these species over time, as well as increasing the cost of managing these non-native species. • Wildfires and the ash they generate can distort the flow of nutrients through an ecosystem, reducing the biodiversity that the ecosystem can support.
Drought	• Loss of fish and wildlife habitat, including reduction of stream flows to downstream rivers, estuarine habitats, reservoirs, lakes, and ponds. • Animal mortality due to lack of water resources. • Decreased plant growth and productivity. • Increased wildfires. • Greater insect outbreaks. • Increased local species extinctions. • Changes in the timing, magnitude, and strength of mixing (i.e., stratification) in coastal waters due to changes in freshwater inputs and increased temperatures. • Increased potential for hypoxia (i.e., low oxygen) events. • Direct and indirect effects on goods and services provided by habitats, such as timber, carbon sequestration, recreation, and water quality.

Hazard	Impacts and Vulnerabilities to Natural Areas
	• Limited fish migration or breeding due to dry streambeds or fish mortality caused by dry streambeds. • Wind and water erosion of soils. • Pests and diseases may have a greater impact in a drier world, as they will begin feeding and breeding earlier in the year.
Coastal flooding	• If coastal ecosystems (e.g., tidal flats, salt marshes) are not able to build elevation to keep pace with sea level rise, or if they migrate landward or into other wetlands, then existing habitat (e.g., salt marshes) could experience transitions to mudflat habitat. • Total inundation can also lead to the complete loss of tidal wetland, mudflats, and other intertidal habitats as they become open water habitats and the species that rely on them can no longer survive if they need upland refugia. • Conversion of salt marshes to other wetland types, including tidal flats, could result in a loss or change of critical ecosystem services such as carbon sequestration, recreation, cultural value, and storm protection, as well as nursery, feeding, and nesting areas for fish and wildlife.
Flooding from precipitation	• Intense precipitation events scour and erode stream channels. • Increased runoff from impervious surfaces increases nutrient and contaminant concentrations in freshwater bodies. • Increased freshwater flow could affect coastal environments by changing the chemistry of the system, which could lead to biodiversity loss, an increase in invasive species, and other ecosystem impairments.
Landslide and mudflows	• Following a landslide, soil and organic materials may enter streams, reducing the potability of the water and the quality of the aquatic habitat. • Mass movements of sediment may result in the stripping of forests, which in turn degrades the habitat quality of those forests. • Nearby flora may struggle to re-establish following a significant landslide because of a lack of topsoil. • Landslides and mudflows can lead to increased susceptibility of natural areas and habitat to invasive species due to disturbed surfaces.
Tsunami	• The inundation of typically dry areas can reshape the topography of an area, both by scouring existing sediment and by depositing sediment from other locations. • A tsunami can uproot trees and other plants in its path, causing habitat loss.

Hazard	Impacts and Vulnerabilities to Natural Areas
	• A tsunami can cause animal mortality due to drowning, and marine animal mortality as a result of chemicals or contaminants swept into the ocean. • Chemicals and contaminants, as well as saltwater, can remain in aquifers or can percolate into groundwater supplies after a tsunami recedes, causing extensive and prolonged environmental devastation.
Severe winter storms	• More intense winds and precipitation will increase tree mortality, which can increase soil erosion rates, impact the water quality of aquatic ecosystems, and alter the forest landscape. • Flooding from storms can alter soil nutrient pathways, reducing the productivity of forest ecosystems. • Nor'easters can reduce growth rates in coastal forests for about three years after a storm. • The flooding that can occur when snow and ice melt can also cause extensive environmental impacts. • Severe storms can cause direct damage to species and ecosystems, habitat destruction, and damage from the distribution of contaminants and hazardous materials throughout the environment. • Changes in snowmelt can lower spring river flows of aquatic ecosystems and impact the health and abundance of freshwater fish. • While coastal storms can be an important driver of available sediments for salt marsh systems, the associated severe winds, flooding, and impaired water quality can also damage and erode salt marshes and other wetlands, reducing their ability to provide coastal protection in subsequent storms. When storms occur with historic intensities and frequencies, they can result in much needed sediments that restore and build marshes. However, storms occurring at increased intensities and frequencies in altered or urbanized habitats may not result in the same historic benefits of storms feeding natural systems.
Other severe weather	• Severe weather events result in significant damage to forests, with downed trees, defoliated forest canopies, and structural changes within an ecosystem that destabilize food webs. • Direct damage to plant species includes uprooting or destroying trees and an increased threat of wildfire in areas with tree debris. • High winds erode soils, which damages both the ecosystem from which soil is removed as well as the system on which the sediment is ultimately deposited.

Hazard	Impacts and Vulnerabilities to Natural Areas
	• Extreme precipitation events often cause soil erosion and the growth of excess fungus or bacteria. • Lightning tends to strike free-standing, tall structures, such as trees, which results in tree damage and fires. The intense heat from lightning vaporizes the water inside a tree, creating steam that can blow apart the tree in a small explosion. • If lightning strikes a vegetated area experiencing dry conditions or a dead tree, it can start a wildfire. This risk occurs even when accompanied by rain, as the dry air below a storm front can cause rain to evaporate quickly as it falls.

6.1.4 Actions Taken to Reduce Vulnerabilities

6.1.4.1 State Agency Actions

To address the vulnerabilities described throughout this chapter—as well as all hazards described in detail in Chapter 5 (Risk Assessment)—agencies have taken and are continuing to refine an array of actions. Survey respondents were asked to describe the major updates, improvements, repairs, or replacements and relocations since 2018 that agencies have made to reduce vulnerabilities. Responses provided by agencies included the following:

- **Enhanced remote work capabilities** through actions such as providing staff with laptops to facilitate remote work and allowing for hybrid office work and telework options.
- **Updated IT systems** through actions such as transferring physical files to cloud storage systems and creating new networks and systems for staff and clients.
- **Relocation of office and equipment,** including moving or expanding services to new buildings.
- **Updated or repaired critical physical assets,** such as replacing, repairing, and updating critical infrastructure (e.g., sewage system updates, police facility renovations, agency office modernization, roof replacements) and equipment (e.g., power plant boilers, emergency generators, fire alarms, energy and heating, ventilation, and air conditioning systems) and restoring natural physical assets.
- **Revised policies to procedures,** including updated plans, policies, and protocols that reflect climate change and hazard mitigation considerations.
- **Strengthened staff capacity** to respond to hazard events through training staff (e.g., on topics such as climate change, adaptation, and response), hiring of new staff skilled in emergency management, and cross-training staff to ensure continuity of work and services if some staff are unable to work due to hazards.

For agencies responsible for managing critical assets and services, survey respondents described many examples of actions that their agencies have taken to provide alternate access to critical physical assets or redundancies in services in the event of damage or disruption due to a hazardous event. For instance, respondents stated that they have equipment to maintain or restore **access to critical roads, emergency lifelines, and community facilities**. Respondents also provided examples of actions they had taken to ensure the resilience of critical physical infrastructure, such as replacing boilers, changing the siting of emergency generators and main electrical services to be above projected sea level rise, and establishing new office buildings. To reduce vulnerability of critical facility and transportation infrastructure, Massachusetts Port Authority completed a risk assessment, hardened critical facilities, and developed a Floodproofing Design Guide, as well as Logan Airport and Maritime Flood Operations Plans.

In relation to access routes and roads, other respondents noted that there are multiple means of egress and emergency routes available that are included in their COOP and other emergency management plans that can help direct their operations in the event of hazard impacts. Agencies that provide **services to transit-dependent communities** also described redundancies in their services that they are working to formalize within their strategic and operating plans, such as the potential for bus service if other transit (e.g., rail) is disrupted, as well as virtual tools available to help facilitate communication and provision of services (e.g., remote hearings, email communications to reschedule visits) to transit-dependent communities.

Agencies that provide **power services** have taken many actions to ensure redundancy of services, such as emergency backup generators and power services on site and remotely, relocation plans, institution of solar power and battery backup energy systems, and transfer of critical IT infrastructure to multiple, more resilient third-party facilities. Agencies indicated that most employees are regularly trained and updated on these plans and procedures and that plans (e.g., COOPs) are updated annually.

In the survey, agencies responsible for nonphysical assets and functions described many ways their agencies have included goals and objectives to reduce risks and provide for climate adaptation through their plans, policies, mission, and partnerships, including:

- **Expanding telework and hybrid** work policies for staff.
- **Using cloud data storage** to provide backups of critical data and create IT redundancies.
- **Establishing or strengthening partnerships** with other agencies to assist in planning, emergency response, supplementary staff capacity for partner agencies with similar staff capabilities, and hazard mitigation strategies.
- **Encouraging outreach and education** within and between state agencies to raise awareness of climate hazards and potential mitigation and adaptation options (e.g.,

through establishing the RMAT in 2019 and the RMAT Climate Resilience Design and Standards Tool).

- **Incorporating targeted mitigation, adaptation, and risk reduction strategies** into agency plans, including plans for agencies such as the Office of Preparedness and Emergency Management, DER, MassDOT, Department of Energy Resources, and Department of Fish and Wildlife. Plans with these considerations that agencies cited included COOPs, architectural plans, restoration and habitat management guidelines, design standards, and strategic and capital plans.

In addition to the actions described within the survey, as detailed in the Chapter 4 (State Capability and Adaptive Capacity Analysis), agencies have been working on actions identified in the 2018 MA SHMCAP and tracked through the SHMCAP Action Tracker. Over 60 percent of actions are complete or in progress, close to 30 percent are in development, and only about 10 percent have either been deferred or not started. (See the Chapter 4 [State Capability and Adaptive Capacity Analysis] for more detail on action status.) Actions completed since 2018 mostly focus on strengthening understanding of climate hazards and building state agency capacity to respond to hazard events. However, a few of the actions have directly helped the Commonwealth reduce vulnerability. Highlights include:

- The Executive Office of Energy and Environmental Affairs worked with staff across many agencies to review and update design standards to consider climate change projections. The new Climate Resilience Design Standards provide recommendations for design criteria and implementation that will help ensure new agency facilities, roads, parkways, and other infrastructure are less vulnerable to climate impacts.
- The Division of Fisheries and Wildlife (MassWildlife) successfully removed two dams (Welsh Pond Dam and Putnam Pond Dam) that provide significant recreational benefits. These projects are reducing vulnerability and improving resilience of the agency's resources by improving the hydraulic capacity of the roadway stream crossings and reducing solar heating of Singletary Brook.
- The Department of Conservation and Recreation (DCR) developed an updated State Forest Action Plan to incorporate strategies to deal with future conditions presented by a warming planet. The plan is reducing vulnerabilities to forest systems by outlining strategies to reduce risks, address climate threats, and ensure the continued vitality of forest ecosystems.
    - DCR's Office of Water Resources has begun working with other state and federal agencies to develop a statewide floodplain management plan. This plan will be coordinated across all levels of stakeholders: federal partners, state agencies, local governments, academia, nonprofit organizations such as river and watershed alliances, flood-vulnerable populations, and others.
- The Executive Office of Technology Services and Security (EOTSS) migrated the EOTSS Human Resources Compensation Management System and Massachusetts Management Accounting and Reporting System to the cloud, removing the need to

maintain and protect on-premise servers for these systems. Following the migration of these systems, EOTSS was able to decommission physical servers, thus reducing the Commonwealth's hardware footprint and the vulnerabilities of these systems to climate hazards.

6.1.4.2 Gaps in Actions Taken

The Commonwealth's agencies have made progress in addressing hazard and climate vulnerabilities and designing and implementing plans to reduce risk. However, there are still gaps in relation to actions taken, as well as the capabilities and capacity of state agencies to undertake mitigation actions. The MA Climate Assessment reviewed adaptation gaps in relation to each of the most urgent impacts per sector. Additionally, Chapter 4 (State Capability and Adaptive Capacity Analysis) outlined the key challenges state agencies face to effectively address hazard mitigation and climate adaptation. To help identify the types of actions needed to address hazards and vulnerabilities—in addition to categorizing actions that are already occurring—Massachusetts identified a series of sectors adapted from the MA Climate Assessment that it used to group the priority impacts and additional vulnerabilities. These sectors include environmental health, human health, infrastructure, buildings, natural and working lands, government services, and statewide cultural assets. (See the MA Climate Assessment for more information on the most urgent impacts and Chapter 7 of this MA SHMCAP [State Strategy, Actions, and Implementation Plan] for more details on the action and strategy categories.)

Based on a comparison of gaps and challenges to vulnerabilities identified by the MA Climate Assessment, Chapter 5 (Risk Assessment), and Chapter 4 (State Capability and Adaptive Capacity Analysis), major gaps in relation to actions, capabilities, and capacity organized by the identified subsectors include:

- **Environmental health (with linkages to natural and working lands).** Given the number of natural areas within the Commonwealth, a relatively small number of agencies are responsible for managing a large amount of land. The natural environment and health of natural lands is critical to hazard and climate resilience efforts, as these lands provide important climate protection and buffering services. Mitigation actions will need to consider how to best promote coordination among these agencies and ensure sufficient staff capacity to protect and restore these valuable areas in the event of hazards, as well as identifying ways to ensure continued stewardship in a changing climate.
- **Government services.** In the survey, agencies described how they have or are beginning to take actions to train staff and create redundancies and increase staff capacity. Many agencies, however, still lack adequate staff capacity and availability to address hazard mitigation and climate adaptation due to limited financial resources to support additional staff, hiring challenges, and general staffing shortages. Ongoing limited staff capacity will make it challenging for agencies to create redundancies among staff and ensure that all staff have the skills needed to address potential

hazard events and associated impacts. In relation to services that government agencies can provide, Chapter 4 (State Capability and Adaptive Capacity Analysis) also found a need for more data and information about climate-specific impacts, adaptation, and risk. Similarly, the MA Climate Assessment emphasized the need for robust and reliable data and information to inform new modelling and model development, which could help identify and prioritize which planning activities are most critical for ecosystem adaptation. The survey also highlighted that agencies are lacking data in relation to projected vulnerabilities and recovery times following disruptions. These findings illustrate the need for agencies to gain increased access to climate-specific data and technical capacity (e.g., through educational institutions, offices, and staffing organizations) that can help them develop plans based on the best available and most up-to-date climate information.

- **Human health.** A recurring theme throughout the vulnerability assessment component of the survey was the potential for disproportionate impacts to environmental justice and other priority populations. This theme is also highlighted extensively throughout the MA Climate Assessment. These populations are highly vulnerable and have limited resources to reduce risk. While state agencies are currently thinking about the vulnerabilities of these populations and how to address them, as they move forward with developing specific mitigation actions, they will need to engage communities and consider carefully how to reflect the needs and vulnerabilities of these populations within state agency plans and mitigation actions.
- **Infrastructure and buildings.** Currently, a gap exists related to direct actions to strengthen the resilience of physical assets. Throughout the survey, agencies highlighted many concerns related to potential damage and disruptions to physical assets and the associated services these assets and agencies provide. The MA Climate Assessment also emphasized the need for direct adaptation actions to address potential impacts to physical infrastructure and highlighted these actions as an adaptation gap in relation to many of the urgent impacts. Upgrading, remediating, and replacing physical infrastructure is costly. Chapter 4 (State Capability and Adaptive Capacity Analysis) found that agencies have limited capital and operating budgets to address hazard mitigation and climate adaptation, and they need more coordination and funding to implement these types of efforts.
- **Natural and working lands.** The MA Climate Assessment found that, for many hazards, nature-based solutions are good options to strengthen resilience. Many nature-based solutions may require new and traditional technical knowledge and skills—which, according to Chapter 4 (State Capability and Adaptive Capacity Analysis), can be challenging for many agencies. Additionally, projects to strengthen resilience and increase ecosystem protection—such as coastal wetland restoration and strategic land acquisition and conservation—are costly and need considerable technical expertise and knowledge, financial capacity, and coordination to implement. Even when implemented, as highlighted in the survey, these types of projects can still be at

risk from climate impacts and require careful plans to ensure their continuation following a hazard event.

6.1.5 Conclusions

The Commonwealth is at risk from a variety of hazards that have and will continue to impact the physical assets, nonphysical assets, and functions of its state agencies and the communities and environments they serve. Potential vulnerabilities are wide ranging and include risk of damages to physical infrastructure and associated services, losses of network and database function and administrative services, disruptions to the ability of agencies to provide critical services to vulnerable populations, and further loss of critical natural resources that will result in greater risks to Massachusetts. State agencies have taken many actions—as described throughout this chapter and in Chapter 4 (State Capability and Adaptive Capacity Analysis)—to reduce vulnerabilities and develop clear plans to guide operations in the event of a disaster. However, given uncertainties in relation to the timing, magnitude, and consequences of hazards, determining strategies to reduce vulnerabilities will continue to be challenging for state agencies. In addition to the findings highlighted in the previous section related to gaps, there are a few additional factors state agencies could consider in working to reduce their vulnerabilities to hazard and climate risks, as outlined below. These recommendations are overarching across the sectors described in the previous section, and the Commonwealth used these to help consider the detailed actions described in Chapter 7 (State Strategy, Actions, and Implementation Plan). Recommendations include the following:

- **Identify strategies to promote enhanced interagency collaboration.** It will be critical for state agencies to work together to address geographic and issue area risks, in addition to ensuring that risks to infrastructure, the environment, and governance are addressed jointly. By coordinating efforts, state agencies can better leverage funding, physical improvements, and opportunities to increase resilience, which will help the Commonwealth develop integrated adaptation strategies. Strengthened state agency coordination will also help agencies leverage resources and address many of the most urgent impacts identified through the MA Climate Assessment, including an increased demand for state and municipal government services, increased costs of responding to climate migration, and reduction in state and municipal revenues.
- **Regularly assess vulnerabilities.** The survey agencies responded to as part of the MA SHMCAP process helped each agency consider its vulnerabilities to hazards and climate change and outline actions they have taken to reduce risks. Updating vulnerability assessments at regular intervals (e.g., annually, biennially) and tracking the actions taken to reduce risks would allow agencies to communicate progress and identify areas that need further work.
- **Consider clear strategies to address social vulnerabilities.** Survey results highlighted the potential disproportionate impacts of risks to environmental justice and other priority populations and how these populations are likely to experience

greater impacts due to damage and disruptions to physical assets and agency services. Similarly, the MA Climate Assessment noted a range of urgent impacts for communities, including health and cognitive effects from extreme heat, health effects from degraded air quality, and the potential for delayed emergency services and disrupted evacuations. Agencies have developed many plans to address continuation of services to populations throughout the Commonwealth, with a focus on environmental justice and other priority populations. However, agencies need to assess the sustainability of these plans and resources available to implement them. Agencies also need to advance projects to reduce risk and increase hazard and climate resilience in socially vulnerable communities. Additionally, strong interagency coordination is likely necessary to ensure limited impacts of services and functions.

- **Determine adaptation actions to strengthen resilience of ecosystems, particularly in aquatic areas.** In discussing vulnerabilities of endangered and threatened habitat and species, survey respondents highlighted vulnerabilities of species and habitat that are part of BioMap's aquatic or wetland cores. These ecosystems and species are at risk from a variety of hazards. The MA Climate Assessment highlighted the many potential impacts to the natural environment sector, with the most urgent impacts encompassing degradation to freshwater, marine, coastal, and forest ecosystems and habitats—all of which will occur from a range of natural hazards. Agencies are already implementing many projects to protect and restore these ecosystems and should consider coordinating with other agencies responsible for land use and infrastructure, as well as private landowners and researchers, to develop and evaluate cost-effective strategies to reduce vulnerabilities of these systems.
- **Evaluate efficacy of actions taken to reduce vulnerabilities.** As described in Chapter 4 (State Capability and Adaptive Capacity Analysis), state agencies should build on the MA SHMCAP Action Tracker to include metrics that track progress. Agencies should also work to ensure they are not only tracking which actions they have implemented, but also evaluating the effectiveness of these actions in terms of reducing risks and vulnerabilities.

If agencies in the Commonwealth continue to assess their vulnerabilities and work together to design and implement strategies to reduce risk and vulnerability, the Commonwealth will be able to build its resilience to hazards and associated consequences. While the exact nature of hazard impacts is difficult to predict, by better understanding their vulnerabilities, state agencies can develop adaptation plans that can help prepare them to respond to climate impacts, as well as mitigate impacts to their assets and the individuals that they serve throughout the Commonwealth.

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Chapter 7. State Strategy, Actions, and Implementation Plan

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Abbreviations

GHG	Greenhouse gas
RMAT	Resilient Massachusetts Action Team
SHMCAP	State Hazard Mitigation and Climate Adaptation Plan

7.1 Introduction

This chapter presents the Commonwealth's strategy for hazard mitigation and climate adaptation through the implementation of actions developed by state agencies through the Resilient Massachusetts Action Team (RMAT) in collaboration with local municipalities, regional organizations, community organization representatives, and federal partners. This chapter is based on findings from Chapter 4 (State Capability and Adaptive Capacity Analysis), Chapter 5 (Risk Assessment), and Chapter 6 (State Agency Vulnerabilities). The strategy is built on the integration and collaboration of various actions to be taken at the state, regional, and local levels to advance hazard mitigation and climate adaptation. This chapter also presents the steps for implementation and ongoing plan maintenance, including future considerations for implementation pathways in addition to steps and a schedule for ongoing maintenance.

Together, the actions described present a comprehensive strategy for the Commonwealth: a means to reduce risk, mitigate hazards, protect populations, and ensure the implementation of an intentional and effective 2023 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (2023 MA SHMCAP).

7.1.1 2023 MA SHMCAP Strategy Mission and Goals

The RMAT developed the following mission and goals to guide the development and implementation of the 2023 MA SHMCAP.

The mission:

> *Increase the capacity of the Commonwealth to prepare for, mitigate against, adapt to, and reduce the risk of natural and other hazards and climate impacts through the development of a comprehensive and integrated hazard mitigation and climate change adaptation program. This program will prepare the Commonwealth to reduce risks from hazards and climate change impacts through an equitable and just approach to advance wellbeing in an equitable and sustainable manner; reduce loss of life; protect social, environmental, and economic wellbeing; and ensure health and safety of those living and visiting Massachusetts, including the built and natural environment that sustains it.*

The goals:

- **Collaboration, communication, funding, and engagement.** Strengthen collaboration, communication, and federal and non-federal funding strategies between state agencies, all levels of government (including Tribes, communities, and diverse partners). Work together to form strategic, effective, and inclusive policies, programs, funding, and projects that demonstrate a unity of government approach to address hazards that pose the most risk to the Commonwealth. Ensure the accessibility of this plan to all populations across the state to provide for an engaged, educated, aware, involved, and safe population, including language accessibility and environmental justice and other populations to empower them to take actions to mitigate risks and improve resilience.
- **Science-based and informed decision-making**. Develop programs to support, collect, and disseminate hazard and climate data and findings on frequency, intensity, and duration in the near, medium, and long terms to improve the effectiveness of mitigation and adaptation strategies and increase the capacity and participation of all sectors and scales.
- **Resilient state assets and services.** Reduce risks to critical natural and built state assets and services—including infrastructure, housing, public safety, and natural and cultural resources—to preserve and enhance safety, cultural assets, and quality of life. Reduce risks to critical assets and lifelines from high-consequence vulnerabilities such as high-hazard dams, inland and coastal flooding, wildfire, and extreme temperature through improved building codes; resilient design and build standards; land use and zoning requirements; and targeted conservation, restoration, and land management strategies. Measure progress through annual assessment of all state activities that will reduce risk using 2023 performance metrics.
- **Implement adaptation actions for communities and ecosystems.** Increase community resilience, environmental health, ecosystem functions, and biodiversity by implementing actions that can adapt over time to reduce increasing risks to the most vulnerable natural and human communities. Reduce risk of injury and loss of life by focusing on pre-disaster mitigation actions and prioritizing socially vulnerable or

underserved communities most at risk from all high-consequence vulnerabilities such as high-hazard dams, inland and coastal flooding, wildfire, and extreme temperature.

- **Climate mitigation.** Ensure that actions to reduce hazard and climate risks consider greenhouse gas (GHG) reduction and carbon sequestration and storage measures that would reduce climate change and therefore, its risks and impacts in alignment with the goals of the Commonwealth's 2025, 2030, and 2050 Clean Energy and Climate Plans. Ensure that nature-based solutions are prioritized and used where deemed effective. Measure progress through annual assessment of all state activities that will reduce risk using 2023 performance metrics.
- **Resilient and equitable infrastructure, ecosystems, and communities.** Promote meaningful and collaborative participation in and benefit from the 2023 MA SHMCAP to ensure a plan that provides risk reduction for the communities and assets that are most at risk based on social vulnerability factors and Risk Assessment findings. Hazard mitigation and climate adaptation actions should result in equitable community and environmental resilience for the natural and built environments, improve community safety and well-being, and address past disproportionate provision of burdens and benefits. Ensure that nature-based solutions are prioritized and used where deemed effective to promote community and ecosystem health in recognition that healthy ecosystems are critical to the provision of community and environmental resilience. Measure progress through annual assessment of all state activities that will reduce risk using 2023 performance metrics.

7.1.2 2023 MA SHMCAP Strategy Themes

The development of the 2023 MA SHMCAP benefited from ongoing key efforts designed by the state, including the RMAT, the inclusion of climate change in the 2018 MA SHMCAP, and the *2022 Massachusetts Climate Change Assessment* (MA Climate Assessment). As highlighted in Chapter 2 (Planning Process), state agencies in partnership with subject matter experts developed the 2023 MA SHMCAP building on these efforts and centering around the following themes:

- **Collaboration and support for a whole-of-government approach**. The need for robust collaboration among partners was acknowledged by all participants in the 2023 MA SHMCAP process. To better communicate the need for and commitment to partnership and collaboration, many of the actions are organized under action topics. These are actions that address similar risks and consequences but are led by different state agencies. For example, "Action Topic 1: Assess heat vulnerabilities, develop an outreach strategy, and address heat related human health risks" is presented under the state agency actions. This action topic is supported by four different actions led by four different state agencies within their areas of responsibility. Grouping these actions together, as well as identifying key partners for each individual action, makes the need for a whole-of-government approach to the risks posed to human health by extreme heat more apparent.

- **Focus on most consequential hazards.** Based on the Risk Assessment findings, the most consequential current and future hazards across the Commonwealth include inland flood risk caused by extreme precipitation, coastal flood risk caused by storm surge and sea level rise, extreme heat, and invasive species. Other hazards that are consequential regionally include coastal erosion and drought. The 2023 MA SHMCAP focuses on the most consequential statewide hazards by design and identifies actions that directly respond to priority impacts and vulnerabilities.
- **Resilience building through conservation, restoration, and management**. Given the state's wealth of natural features, including forests and coastlines, there is a great emphasis on protecting and conserving these resources. Many agencies and partners proposed actions related to conservation, restoration, and management strategies to reduce risks and provide social and ecological benefits. In addition to risk reduction, actions addressing natural and working lands can reduce greenhouse gas (GHG) emissions through compact development patterns, carbon storage and sequestration, and reduced energy and water demands.
- **Environmental justice and other priority populations**. Throughout nearly every stage of developing the 2023 MA SHMCAP, various agencies and partners identified the need to reduce risks to environmental justice and other priority populations, which are reflected in the actions.

These themes are reflected in Section 7.1.6 (Cross-government Actions) and Section 7.1.7 (State Agency Actions).

7.1.3 Future Considerations

Effective hazard mitigation and climate adaptation planning necessitates the evaluation and identification of potential gaps and strategic and inclusive means to address those gaps to increase resilience. Therefore, as the Commonwealth begins to implement the 2023 MA SHMCAP actions, the RMAT will evaluate opportunities to strengthen and support collaboration and partnership at all scales. Implementation pathways to further address these vulnerabilities may include engaging representatives, advocates, agencies, and subject matter experts to incorporate these vulnerabilities in existing actions (see below) and creating new actions during the annual maintenance meetings for the MA SHMCAP. Current actions that begin to address or could be expanded to address these impacts include:

- **Cross-government action**: Develop and implement new heat flag system.
- **Cross-government action**: Identify opportunities to improve cooling standards in buildings to address extreme heat impacts.
- **State agency action**: Provide municipal and local health climate equity training and technical support.
- **State agency action**: Implement resilience strategy at state-aided public housing.

7.1.4 Approach

Action development is a key component of designing and implementing an actionable and effective plan to mitigate hazards and impacts to communities throughout the Commonwealth. The 2023 MA SHMCAP development process led to the creation of two types of actions:

- **Cross-government actions.** These are cross-cutting agency actions that largely occur at a statewide scale and address multiple priority impacts and high-consequence vulnerabilities.
- **State agency actions.** These are specific actions to be taken by state agencies based on their mission.

The approach to developing the state agency actions for 2023 differed from the one used for the 2018 MA SHMCAP in that the priority impacts from the MA Climate Assessment and the high-consequence vulnerabilities from the 2023 Risk Assessment were used as the starting point of action development. Specifically, during the three rounds of action development, agencies were asked to consider which priority impacts and high-consequence vulnerabilities their actions addressed. As action development proceeded, agencies were asked to evaluate the gaps in priority impacts and consider ways to modify actions to align with the identified gaps. The process and sets for action development are summarized in Chapter 2 (Planning Process).

7.1.5 2023 MA SHMCAP Strategy

7.1.5.1 Overview of Hazard Mitigation and Climate Adaptation Actions

The 2023 MA SHMCAP Strategy is made up of different types of actions that are based on impacts and vulnerabilities, as well as an understanding of the issues and factors that contribute to those impacts and vulnerabilities. In some cases, Massachusetts has data and information to support taking direct actions, such as changing regulations, and codes, carrying out structure and infrastructure retrofits, or providing capital planning dollars to invest in resilience to state-owned buildings, infrastructure, lands, and waters. For example, agencies are aware of the need to address flood risks, water supply and quality concerns, and ecosystem damage associated with culverts, dams, and bridges and have developed actions to do so.

In other cases, more research, consensus-building, or planning and policy work to frame direct actions needs to occur. In those cases, actions such as assessments, research, modeling, outreach, education, and planning and policy development are the appropriate next steps.

Finally, the authority and responsibility of the state in hazard mitigation and climate adaptation planning means that, in some cases, the Commonwealth's appropriate role is to guide, fund, and provide technical assistance to support local, regional, community, and advocacy organizations. This includes developing state funding sources and seeking federal funding sources to support efforts at local and regional scales; providing technical assistance and support for municipalities that want to act but lack the capacity and capabilities to do so; and creating and sharing climate and hazard data, science, and modeling to support local and regional analysis. The 2023 MA SHMCAP Strategy includes many actions to support and catalyze local and regional actions. Through the implementation of the plan, this will ensure a whole-of-government approach to increasing resilience in the Commonwealth at the local, regional, and statewide scales.

7.1.5.2 Cross-Government Actions

The cross-government actions are characterized as multi-agency actions that rely heavily upon engagement, collaboration, and coordinated efforts. They focus on addressing gaps identified by RMAT participants, community focus groups, and municipal and non-governmental entities to mitigate hazards and increase resilience statewide.

There are a total of 15 cross-government actions, which are organized based on alignment with the 2023 MA SHMCAP goals, as presented in Table 7-1.

Table 7-1. Summary of Cross-Government Action Counts by Goal

Goal 1: Collaboration, Communication, Funding, and Engagement	Goal 2: Science-Based and Informed Decision-Making	Goal 3: Resilient State Assets and Services	Goal 4: Implement Adaptation Actions for Communities and Ecosystems	Goal 5: Climate mitigation	Goal 6: Resilient and Equitable Infrastructure, Ecosystems, and Communities
4	4	2	4	0	1

7.1.5.3 State Agency Actions

Priority impacts identified in the MA Climate Assessment and high-consequence vulnerabilities identified through the 2023 Risk Assessment are the organizing framework for the state agency actions presented in Section 7.1.7. There are a total of 127 state agency actions, which are organized first by the sectors from the MA Climate Assessment (human, infrastructure, natural environment, governance, and economy) and then by the priority impact or high-consequence vulnerability that is best addressed by the action.

7.1.6 Cross-Government Actions

The cross-government action developed by the RMAT for the 2023 MA SHMCAP are presented in the following pages.

Goal 1: Collaboration, Communication, Funding, and Engagement		
Cross-government ACTION 1: Convene a climate resilience stakeholder working group		
Create a Resilient Massachusetts Action Team subgroup to increase external stakeholder engagement and partnership for resilience programs.	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	Leads: EEA, MEMA	All
	Priority Impact Addressed	**Timeframe**
	All	3 – 5 years
Cross-government ACTION 2: Increase funding to support municipal and agency resilience actions and access to funding opportunities		
Identify new and sustainable revenue streams to increase funding to municipal, agency, and NGO resilience actions. Develop a “one stop” funding portal for climate resilience-related state grant programs.	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	Leads: EEA, A&F Partners: DPH	All
	Priority Impact Addressed	**Timeframe**
	Emergency Service Response Delays; Reduction in State and Municipal Revenues	Less than 3 years
Cross-government ACTION 3: Develop a framework for statewide resilience progress tracking		
Through a stakeholder process, identify statewide climate resilience goals and associated metrics that the Commonwealth can use to track progress statewide. These metrics should inform agency and municipal funding strategies and environmental permitting and reviews, including MEPA.	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	Leads: EEA, Partners: MEMA, A&F	All
	Priority Impact Addressed	**Timeframe**
	Increase in demand for state and municipal government services	Less than 3 years
Cross-government ACTION 4: Launch a statewide Climate Communications Campaign		
Launch a statewide Climate Communications Campaign targeting climate action for decarbonization and resilience, sharing key findings from statewide reports, and expanding awareness of and access to resources for taking critical action.	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	EEA	All
	Priority Impact Addressed	**Timeframe**
	Increase in demand for state and municipal government services	Less than 3 years

Goal 2: Science-Based and Informed Decision-Making		
Cross-government ACTION 5: Launch an Office of Climate Science		
Launch an office of climate science that serves as an authoritative resource and provides subject matter experts on statewide climate data and models and supports consistent application across agencies. Convene the academic climate science community and identify opportunities to partner with universities on climate science needs and next steps.	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	Lead: EEA Partners: TSS, MassDOT, DMF	All
	Priority Impact Addressed	**Timeframe**
	Increase in Demand for State and Municipal Government Services	Less than 3 years
Cross-government ACTION 6: Create a tool for loss avoidance studies and future mitigation projects		
Create a tool for Loss Avoidance Studies to advance understanding of the effectiveness of local and state level hazard mitigation and climate adaptation work. The tool will also aid in the development of state and local cost-benefit analyses and identification of cost-effective mitigation projects.	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	Lead: MEMA Partner: EEA	All
Other priority impacts addressed by action: Reduced ability to work; economic losses from commercial structure damage and business interruptions; damage to tourist attractions and recreation amenities; damage, disruption, or loss of coastal infrastructure such as seaports, airports, and maritime industries; and all priority impacts listed under the Governance sector.	**Priority Impact Addressed**	**Timeframe**
	Inability to carry out mission and services due to damage, disruption, or loss of state assets and services	Less than 3 years
Cross-government ACTION 7: Statewide Floodplain Regulatory and Coordination Framework		
Develop a statewide floodplain management framework that coordinates state floodplain development processes, as well as state agency collaboration for best floodplain management practices across the Commonwealth that considers climate change data and impacts. Identify best practices for municipalities to adopt to increase resilience standards for residential and/or non-residential construction in their communities. Advance opportunities within the building code to enhance resilience. Develop a Floodplain Management Plan that prioritizes actions that can be taken statewide to address and mitigate floods and their impacts.	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	Lead: EEA Partners: DCR, other agencies	Inland flooding, coastal flooding and storm surge, dam overtopping, coastal erosion, groundwater rise, landslides, and other severe weather

Other priority impacts addressed by action: Emergency service response delays and evacuation disruptions; increase in costs of responding to climate migration; health effects from aeroallergens and mold; loss of life or injury due to high vulnerability dams, hurricanes, wildfires, extreme flooding, or extreme temperatures; increased risk of dam overtopping or failure; damage to inland buildings; increase in demand for state and municipal government services; damage to inland state and municipal buildings and land; and priority impacts listed under the Natural Environment sector.	**Priority Impact Addressed**	**Timeframe**
	Damage to Roads and Loss of Road Service; Increase in Need for State and Municipal Policy Review and Adaptation Coordination; Reduced Ability to Work	3-5 years
Cross-government ACTION 8: Enhance consideration of resilience in Develop a local option "Stretch Flood Code" for residential and/or non-residential construction		
Develop an appendix of above-code flood standards for integration to the statewide building code—also referred to as a "Stretch Flood Code"—which municipalities may voluntarily adopt to prescribe more resilient standards for residential and/or non-residential construction in their communities.	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	Lead: EEA/EOED Partners: DCR, OPSI, DOER	Inland flooding, coastal flooding and storm surge, dam overtopping, coastal erosion, groundwater rise, landslides, and other severe weather
Other priority impacts addressed by action: Emergency service response delays and evacuation disruptions; increase in costs of responding to climate migration; health effects from aeroallergens and mold; loss of life or injury due to high vulnerability dams, hurricanes, wildfires, extreme flooding, or extreme temperatures; increased risk of dam overtopping or failure; damage to inland buildings; increase in demand for state and municipal government services; damage to inland state and municipal buildings and land; and priority impacts listed under the Natural Environment sector.	**Priority Impact Addressed**	**Timeframe**
	Health Effects of Extreme Storms and Power Outages	3-5 years

<table>
<tr><th colspan="3">Goal 3: Resilient State Assets and Services</th></tr>
<tr><td colspan="3">Cross-government ACTION 9: Expand evaluation of climate resilience for state capital investments</td></tr>
<tr><td rowspan="2">Expand utilization of the RMAT's Climate Resilience Design Standards Tool to ensure climate vulnerability and resilient design is an evaluation criterion in determining state capital planning processes.</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Lead: A&F
Partners: EEA, MEMA, EOED, MassDOT</td><td>All</td></tr>
<tr><td rowspan="2">Other priority impacts addressed by action: Damage to inland buildings; damage to coastal buildings and ports; reduced ability to work; damage, disruption, or loss of coastal infrastructure such as seaports, airports, and maritime industries; damage to inland state and municipal buildings and land; damage to coastal state and municipal buildings and land.</td><td>Priority Impact Addressed</td><td>Timeframe</td></tr>
<tr><td>Inability to carry out mission and services due to damage, disruption, or loss of state assets and services</td><td>Less than 3 years</td></tr>
<tr><td colspan="3">Cross-government ACTION 10: Formalize MEPA resiliency policy to ensure consideration of climate change during MEPA reviews</td></tr>
<tr><td rowspan="2">Expand application of the RMAT’s Climate Resilience Design Standards Tool to environmental permitting and reviews through MEPA process.</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Lead: EEA
Partners: DCR, MassDOT, EOED</td><td>All</td></tr>
<tr><td rowspan="2">Other priority impacts addressed by action: Damage to inland buildings; damage to coastal buildings and ports; reduced ability to work; damage to cultural resources; damage, disruption, or loss of coastal infrastructure such as seaports, airports, and maritime industries; damage to inland state and municipal buildings and land; damage to coastal state and municipal buildings and land; and priority impacts listed under the Natural Environment sector.</td><td>Priority Impact Addressed</td><td>Timeframe</td></tr>
<tr><td>Inability to carry out mission and services due to damage, disruption, or loss of state assets and services</td><td>Less than 3 years</td></tr>
<tr><th colspan="3">Goal 4: Implementation of Adaptation Actions for Communities and Ecosystems</th></tr>
<tr><td colspan="3">Cross-government ACTION 11: Develop and implement a new Heat Flag System</td></tr>
<tr><td rowspan="2">Identify methods to obtain additional data on heat and ways to effectively communicate heat risk to the public across agencies. Develop and implement new Heat Flag system in alignment with NOAA's Heat Advisory Criteria for New England, to identify days of extreme heat to urge preparedness and caution to people outdoors, particularly children, elderly.</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Lead: HHS
Partners: LWD, DPH, MEMA</td><td>Extreme temperatures</td></tr>
</table>

Other priority impacts addressed by action: Emergency service response delays and evacuation disruptions; increase in mental health stressors; disproportionate impacts on unhoused populations from extreme temperatures or extreme flooding; reduced ability to work.	**Priority Impact Addressed**	**Timeframe**
	Health and Cognitive Effects from Extreme Heat	Less than 3 years
Cross-government ACTION 12: Develop a coastal resilience strategy		
Develop a coastal resilience strategy that considers climate resilient development and standards in vulnerable areas, develops best practices for coastal adaptation, and explores managed retreat.	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	Lead: EEA, CZM Partners: EOED, MassDOT, DMF, DER	Coastal erosion, coastal flooding and storm surge, hurricane/ tropical cyclone, landslide, other severe weather
Other priority impacts addressed by action: Coastal erosion; inability to carry out mission and services due to damage, disruption, or loss of state assets and services; damage, disruption, or loss of coastal infrastructure such as seaports, airports, and maritime industries; emergency service response delays and evacuation disruptions.	**Priority Impact Addressed**	**Timeframe**
	Damage to Coastal Buildings and Ports	Less than 3 years
Cross-government ACTION 13: Protect 30 percent of land and ocean by 2030 (to align with the global 30x30 goal)		
Implement EEA's Resilient Lands Initiative and incorporate the Healthy Soils Action Plan. Develop a statewide approach and collaborative efforts to preserve and enhance forest health and conservation to enhance resilience and provide carbon sinks for GHG mitigation, including coastal sources.	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	Lead: EEA Partners: DCR, DMR, DER, DMF, DFG, MDAR	All
Other priority impacts addressed by action: Damage to inland buildings, damage to coastal buildings and ports; damage or loss to homes and critical facilities in the wildland urban interface; and all priority impacts in the Natural Environment sector.	**Priority Impact Addressed**	**Timeframe**
	Forest Health Degradation	5+ years
Cross-government ACTION 14: Identify opportunities to improve cooling standards in buildings to address extreme heat impacts.		
A multi-agency team will assess opportunities to promote cooling in residential buildings and mitigate extreme-heat risks to renters and remote workers.	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	Lead: HHS / HLC Partners: LWD, DPH	Extreme temperatures
Other priority impacts addressed by action: Increase in need for state and municipal policy review and adaptation coordination; health effects from aeroallergens and mold; reduced ability to work.	**Priority Impact Addressed**	**Timeframe**
	Health and Cognitive Effects from Extreme Heat	Less than 3 years

<table>
<tr><th colspan="3">Goal 5: Consideration of Climate Mitigation (when designing hazard reduction actions)</th></tr>
<tr><td colspan="3">All actions implemented as part of the 2023 MA SHMCAP will evaluate the opportunity to reduce GHG emissions and when applicable will select options that have the lowest GHG emissions possible. This includes considering the use of generators, pumps, and other common adaptation strategies and designing those strategies to reduce rather than increase emissions. Refer to the state agency actions, which are sorted by Priority Impact/Vulnerability, for additional actions the Commonwealth plans to take to address the goal.</td></tr>
<tr><th colspan="3">Goal 6: Resilient and Equitable Infrastructure, Ecosystems, and Communities</th></tr>
<tr><td colspan="3">Cross-government ACTION 15: Update school curriculum to include climate science and green workforce development.</td></tr>
<tr><td rowspan="2">Implement a pilot clean energy innovation pathway for high school students focused on helping students get applied learning experience in the clean energy and climate sector. The initial clean energy innovation pathway pilot will provide data to inform growth to additional schools.</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Lead: EOE
Partners: Workforce Skills Cabinet (EOED, LWD, EHS)</td><td>All</td></tr>
<tr><td rowspan="2">Other priority impacts addressed by action: Damage to electric transmission and utility distribution infrastructure; damage to rails and loss of rail/transit service; loss of energy production and resources; health effects of extreme storms and power outages; reduction in state and municipal revenues; increase in demand for state and municipal government services; economic losses from commercial structure damage and business interruptions.</td><td>Priority Impact Addressed</td><td>Timeframe</td></tr>
<tr><td>All</td><td>5+ years</td></tr>
<tr><td colspan="3">Refer to the state agency actions, which are sorted by Priority Impact/Vulnerability, for additional actions the Commonwealth plans to take to address the goal.</td></tr>
</table>

7.1.7 State Agency Actions

The following state agency actions are organized by sector, priority impact/high-consequence vulnerability, and action topic, where applicable. The most urgent priority impacts are the first 2-3 priority impacts presented in the beginning of each sector and are organized by the following color coding:

Orange: Urgent Priority Impact
Green: Priority Impact/High-Consequence Vulnerability

Human

Human Sector			
Urgent Priority Impact: Health and Cognitive Effects from Extreme Heat			
Action Topic 1: Assess heat vulnerabilities, develop an outreach strategy, and address heat related human health risks			
Description: This action topic focuses on addressing the priority impact of Health and Cognitive Effects from Extreme Heat to populations across the Commonwealth. Together, the following actions will mitigate risk associated with extreme heat through identifying populations vulnerable to heat stress, providing education and outreach to communities about heat risk, inventorying state assets, and making improvements to increase resilience against extreme heat. The action topic aligns with the cross-government actions regarding the development and implementation of a new heat flag system and identifying regulatory opportunities to improve cooling standards in buildings. **Partners:** LWD, DCR, DCAMM, MassDEP, DPH, and AGO **Other priority impacts addressed by action topic:** Increase in mental health stressors; reduced ability to work; health effects from degraded air quality; and reduction in state and municipal revenues; loss of life or injury due to high vulnerability dams, hurricanes, wildfires, extreme flooding, or extreme temperatures; disproportionate impacts on unhoused populations from extreme temperatures or extreme flooding.			
ACTION 1a: Workforce Heat Exposure Outreach			
Develop and provide annual outreach information to employers and employees on the dangers of exposure to environmental heat, and strategies for minimizing the risks posed by such exposures. Outreach to be done by email, and in-person and virtual presentations. Collaborate with internal and external stakeholders on the efforts.	**Scale**	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	Statewide, Workforce	Lead: DLS Partners: DPH, AGO	Extreme heat
	Goal(s) Addressed		**Timeframe**
	1, 3, and 6		Less than 3 years
ACTION 1b: Address risk of extreme heat to building occupants			
Identify buildings in areas designated by RMAT-supported climate data sets as being at high risk of extreme heat and track these vulnerabilities in an asset management system (CAMIS). Refer to this information with client agencies during capital planning and at the outset of new projects to address risks of extreme heat to occupants, especially at buildings that house vulnerable populations within the DCAMM portfolio, when feasible. Prioritize use of heat pumps for heating and cooling.	**Scale**	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	Statewide, Buildings	DCAMM	Extreme heat
	Goal(s) Addressed		**Timeframe**
	2, 4, and 6		5+ years

<table>
<tr><td colspan="4">ACTION 1c: Inventory and categorize shade shelters on DCR sites, and strategically improve shading and cooling structures in parks, prioritizing those located in environmental justice communities</td></tr>
<tr><td rowspan="3">Use DCR's Asset Management Modernization Program to inventory shade shelters and cooling structures that exist on DCR sites. Work to increase and/or improve shade and cooling structures, prioritizing Environmental Justice communities that experience disproportionate exposure to extreme heat.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Park Assets</td><td>DCR</td><td>Extreme heat</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">2, 3, and 4</td><td>Less than 3 years</td></tr>
<tr><td colspan="4">Urgent Priority Impact: Health Effects from Degraded Air Quality</td></tr>
<tr><td colspan="4">No specific actions are tagged for this priority impact. The following action is broadly applicable.</td></tr>
<tr><td colspan="4">ACTION 2: Develop outreach materials for climate change and health</td></tr>
<tr><td rowspan="3">Leverage existing educational content, data tools, and resources to develop new web-based and public-facing outreach materials focused on prevention of climate-related health impacts in high-risk populations. Topics to include extreme heat and poor air quality, extreme storms and power outages, tick- and mosquito-borne diseases, worker health and safety, and the presence of harmful bacteria and algae in recreational waterbodies. If sufficient funding becomes available, this Action will include convening a DPH Stakeholder Advisory Group that supports representatives from community-based organizations in Environmental Justice areas to evaluate and provide feedback on DPH outreach materials and messaging about climate and health. This Action will include equitable community engagement activities that centers the lived experience of community members and elevates the knowledge and expertise of community-based organizations in Environmental Justice communities in the development and dissemination of culturally and linguistically appropriate DPH outreach materials and messaging about climate and health.
Other priority impacts addressed by action topic: Increase in mental health stressors; reduced ability to work; health effects from degraded air quality; and reduction in state and municipal revenues; loss of life or injury due to high vulnerability dams, hurricanes, wildfires, extreme flooding, or extreme temperatures; disproportionate impacts on unhoused populations from extreme temperatures or extreme flooding.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Environmental Justice</td><td>Lead: DPH
Partners: DOC, MDAR</td><td>All hazards addressed</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1 and 2</td><td>3 – 5 years</td></tr>
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<table>
<tr><th colspan="4">Urgent Priority Impact: Emergency Service Response Delays and Evacuation Disruptions</th></tr>
<tr><td colspan="4">ACTION 3: Integration of climate change adaptation into EOPSS agencies programs, policies, and procedures</td></tr>
<tr><td rowspan="4">EOPSS in coordination with MEMA will work with all EOPSS agencies to establish a process by which agencies can consider climate change to the maximum extent possible. The following approaches could be considered: trainings, strategic planning, and other approaches to effectively integrate climate change and hazard mitigation into EOPSS agencies. A final product will be a how-to guide that can be used across all executive branch agencies to integrate climate change adaptation.
Other priority impacts addressed by action: All priority impacts listed in the Human sector.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Internal Capacity Building</td><td>Lead: EOPSS
Partner: MEMA,</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 2, 3, and 4</td><td>Less than 3 years</td></tr>
<tr><td colspan="4">ACTION 4: Statewide emergency management training needs assessment</td></tr>
<tr><td rowspan="4">To ensure the State's public safety officials are sufficiently trained to handled future emergencies, MEMA will need to understand what trainings are missing and which need enhancing to ensure natural hazards especially those exacerbated by climate change are woven into curriculum as appropriate. In addition, the assessment will ensure climate migration is a consideration when assessing training needs.

Once the Training Needs Assessment above is completed, MEMA will need assistance with course design, development, and then additional resources for course delivery.

MEMA recently launched the Northeast Emergency Management Training & Education Center (NEMTEC), designed to strengthen regional response to emergencies including those due to natural hazards exacerbated by climate change. This comprehensive training program will provide advanced education and expanded resources to New England’s emergency management professionals, who face evolving challenges due to the increasing complexity and frequency of natural disaster and climate change. Extreme storms cause delays in response time, potentially leading to loss of life. Extreme coastal storm surge events and inland flooding could flood evacuation routes, trapping residents, leading to increased loss of life and injuries.
Other priority impacts addressed by action: Emergency service response delays and evacuation disruptions; increase in demand for state and municipal government services; damage to electrical transmission and utility distribution infrastructure;</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Internal Capacity Building</td><td>Lead: MEMA</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1 and 6</td><td>Less than 3 years</td></tr>
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<tr><td>inability to carry out mission and services due to damage, disruption, or loss of state assets and services.</td><td></td><td></td></tr>
<tr><td colspan="3">ACTION 5: Increase energy resilience of critical assets identified in the State Energy Security Plan</td></tr>
<tr><td rowspan="4">Work with state agencies responsible for critical physical assets to develop strategies to increase energy resilience. Consider including non-state assets that carry out critical statewide functions such as schools, hospitals, and public safety agencies. Fund vulnerability assessments for critical facilities and identify high priority energy resilience projects to fund and implement.
Other priority impacts addressed by action: Damage to electrical transmission and utility distribution infrastructure; emergency service response delays and evacuation disruptions; increase in demand for state and municipal government services; inability to carry out mission and services due to damage, disruption, or loss of state assets and services.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, energy assets</td><td>Lead: DOER
Partner: EEA</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">All</td><td>3 – 5 years</td></tr>
<tr><td colspan="3">Priority Impact: Reduction in Food Safety and Security</td></tr>
<tr><td colspan="3">ACTION 6: Prioritize project proposals within the Food Security Infrastructure Grant Program (FSIG) that specifically support climate change mitigation and proposals that seek to address long-term resilience to drought or extreme weather events</td></tr>
<tr><td rowspan="4">In the FY24 round, $1 million was set aside for project proposals that specifically support climate change mitigation by reducing equipment energy use or generating renewable energy and $2 million was set aside for project proposals that seek to address long-term resilience to drought or extreme weather events, including by reducing water use or enhancing a water supply. For future rounds, conduct a survey to determine the effects of climate change on each sector and their food production and build out RFR to require projects to meet at least one of these objectives. Other priority impacts addressed by action: Soil erosion; decrease in agricultural productivity.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide,</td><td>Lead: EEA</td><td>Drought, extreme weather</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">All</td><td>Less than 3 years</td></tr>
<tr><td colspan="3">Priority Impacts: Increase in Mental Health Stressors</td></tr>
<tr><td colspan="3">ACTION 7: Provide municipal and local health climate equity training and technical support</td></tr>
<tr><td rowspan="2">Produce a Massachusetts-specific training module for local health officials to increase awareness about the disproportionate health impacts of exposure to climate change hazards, including impacts on mental health and unhoused populations, leveraging DPH’s existing relationships with local public health officials and experience and meaningfully engaging communities most vulnerable to climate impacts. The training</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Local Capacity Building</td><td>Lead: DPH
Partners: DOC, MDAR</td><td>All hazards</td></tr>
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<tr><td rowspan="2">module will cover a variety of climate hazards, including extreme temperatures, flooding, and mold, and will provide examples of environmental health interventions that local health officials can leverage as part of their work.
Other priority impacts addressed by action: Disproportionate impacts on unhoused populations from extreme temperatures or extreme flooding; health effects from aeroallergens and mold; reduced ability to work; reduction in food safety and security.</td><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 2, 4, and 6</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">Priority Impact: Health Effects from Aero Allergens and Mold</td></tr>
<tr><td colspan="4">ACTION 8: Strengthen DPH capacity to address health impacts of moisture and mold in public buildings, including schools</td></tr>
<tr><td rowspan="4">Develop focused outreach materials for operators of public buildings and schools that describe interventions for preventing and safely remediating moisture and mold growth inside the building envelope during extended periods of hot, humid weather, acknowledging the impact of climate change. The culturally and linguistically appropriate materials will be made publicly available on the DPH website and distributed according to a robust dissemination plan, which includes building managers as part of public building inspections and reports produced by the DPH Bureau of Environmental Health, Indoor Air Quality Program and other DPH tools and resources, including the DPH Bureau of Community Health and Prevention’s Clearing the Air Toolkit: An Asthma Toolkit for Healthy Schools.
Other priority impacts addressed by action: Health and cognitive effects from extreme heat; health effects from degraded air quality; increase in vector borne diseases incidence and bacterial infections; inability to carry out mission and services due to damage, disruption, or loss of state assets and services.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Public Buildings, Schools</td><td>Lead: DPH</td><td>Extreme heat, flooding, extreme precipitation</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 2, 3, and 4</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">Priority Impact: Health Effects of Extreme Storms and Power Outages</td></tr>
<tr><td colspan="4">Covered by actions for the following priority impacts:
Emergency Service Response Delays and Evacuation Disruptions
Loss of life or injury due to high vulnerability dams, hurricanes, wildfires, extreme flooding, or extreme temperatures
Damage to Electric Transmission and Utility Distribution Infrastructure
Inability to carry out mission and services due to damage, disruption, or loss of state assets and services</td></tr>
</table>

Priority Impact: Damage to Cultural Resources

Action Topic 9: Develop an inventory of cultural resources and evaluate their vulnerability to hazards and climate change

Description: This action focuses on addressing the priority impact of Damage to Cultural Resources in addition to those listed below. The action will be implemented by performing the following actions, including conducting a vulnerability assessment of coastal cultural resources and creating repositories of information regarding the location of cultural resources. The action also considers promoting best practices for resource protection during disaster response and recovery and being inclusive of cultural resources that are currently underrepresented in the Massachusetts Cultural Resources Information System (MACRIS).

Partners: CZM, DCR, MHC, MOTT, MA Board of Underwater Archaeological Resources, and Mass Cultural Council

Other priority impacts addressed by action topic: Damage to tourist attractions and recreational amenities and priority impacts listed in the Natural Environment sector.

ACTION 9a: Assess vulnerability and preservation potential of coastal cultural resources from sea level rise and erosion

Coordinate with the MA Historical Commission, MA Board of Underwater Archaeological Resources, coastal communities, and federally- and state-recognized Tribes to support a vulnerability assessment of cultural resources along the coast including built resources, archaeological sites (pre- and post-contact period), and inundated and exposed coastal landforms. State agency, municipal, and tribal consultation is critical to increase our understanding of coastal cultural resource types, locations, and their vulnerability to identify opportunities for shoreline restoration and adaptive management responses to preserve these valuable natural resources.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Coastwide, Local	Lead: CZM Partners: MHC, MA Board of Underwater Archaeological Resources	Flooding, coastal erosion
Goal(s) Addressed		**Timeframe**
1, 2, 3, 4, and 6		Less than 3 years

ACTION 9b: Complete and integrate DCR's Cultural Resource Inventory

DCR's Office of Cultural Resources and GIS Program developed a GIS-based data layer and data collection app to enable DCR to inventory and map the cultural resources under its stewardship, with a goal of identifying those sites most vulnerable to climate change impacts. DCR will integrate its Cultural Resource Inventory data with the Asset Management Modernization Program to assist the agency with planning and prioritization efforts. DCR will share results of its inventory with CZM for consideration and integration into their Coastal Cultural Resources Vulnerability Assessment.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Statewide, Internal Capacity Building	Lead: DCR Partner: CZM	All hazards
Goal(s) Addressed		**Timeframe**
2 and 3		Less than 3 years

<table>
<tr><td colspan="4">ACTION 9c: Preserve vulnerable cultural resources</td></tr>
<tr><td rowspan="4">DCR’s Office of Cultural Resources will launch a pilot study to identify cultural resources under DCR’s care that are most vulnerable to climate change impacts. This pilot program will design and implement up to two protection measures, relocate, or/remove sensitive resources and/or interpret for future generations. DCR will thoroughly document Best Practices.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Cultural Resources</td><td>Lead: DCR</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">2 and 3</td><td>Less than 3 years</td></tr>
<tr><td colspan="4">ACTION 9d: Promote best practices when planning for historic and cultural resources</td></tr>
<tr><td rowspan="4">Promote best practice guidance to reduce risk to historic and cultural resources from current and future hazards to other organizations and property owners and use internally. Best practices have been developed by organizations such as the National Park Service's "Guidelines on Flood Adaptation for Rehabilitating Historic Buildings" and "Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings". Incorporate a disaster response section into the sample local historic district bylaw produced by the MHC based on guidance from the National Park Service and National Alliance of Preservation Commissions. This will allow for faster response to disasters in local historic districts while still protecting historic resources.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Regional, and Local</td><td>Lead: MHC</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 2, and 3</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">ACTION 9e: Update grant scoring to prioritize underrepresented and threatened resources</td></tr>
<tr><td rowspan="4">Explore amending the scoring for the MHC's Survey & Planning Grant program to encourage the documentation of underrepresented and threatened resources. This might include additional points for projects focused on environmental justice areas, floodplains, and cultures and resources currently underrepresented in the MHC's Inventory of the Historic and Archaeological Assets of the Commonwealth and the Massachusetts Cultural Resources Information System (MACRIS).</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Regional, Local, Environmental Justice</td><td>Lead: MHC</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">4</td><td>3 – 5 years</td></tr>
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<tr><td colspan="4">Priority Impact: Increase in Vector Borne Diseases Incidence and Bacterial Infections</td></tr>
<tr><td colspan="4">ACTION 10: Host DPH internal climate equity working group</td></tr>
<tr><td rowspan="4">Convene internal agency working group tasked with assessing disproportionate impacts of climate change on program-specific assets and functions and developing an agency-wide rubric to guide pilot assessments and intervention projects that address inequities and promote climate justice in vulnerable populations served by DPH. Climate hazards and risks to be assessed include extreme temperatures, extreme weather (e.g., hurricanes), and inland and coastal flooding. Action may address food safety and security, chronic disease, and increase in vector borne disease, depending on which offices, bureaus, and programs engage in climate resilience activities through the DPH working group.
Other priority impacts addressed by action: Disproportionate impacts on unhoused populations from extreme temperatures or extreme flooding; health effects from aeroallergens and mold; reduced ability to work; reduction in food safety and security.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Disproportionate Impacts</td><td>Lead: DPH
Partners: DOC, MDAR</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 2, 3, and 6</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">High-Consequence Vulnerability: Loss of Life or Injury due to High Vulnerability Dams, Hurricanes, Wildfires, Extreme Flooding, or Extreme Temperatures</td></tr>
<tr><td colspan="4">ACTION 11: Wildfire Management Infrastructure Improvements</td></tr>
<tr><td rowspan="4">Undertake a modernization of wildfire facilities and infrastructure used to support local fire departments with wildfire suppression and wildfire risk mitigation (prescribed fire). Project will include design and construction of a Wildfire Management Operations Facility at Hopkinton State Forest, Wildfire Management Operations Facility at Douglas State Forest, and a comprehensive facility climate resiliency needs assessment. The existing Hopkinton facility was destroyed by snow loads in 2013. The existing Douglas facility is incompatible with the growing need for wildfire support services and lacks basic sanitary facilities. Design of the Hopkinton facility create a standard plan set for Douglas and additional future facility replacements. Climate smart building materials including local engineered hemlock cross laminated timber developed by EEA, UMass, UNH, UMaine and the USFS will be used to demonstrate building with long lived wood products in support of the Clean Energy and Climate Plan.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide</td><td>Lead: DCR
Partner: DCAMM</td><td>Wildfire</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 3, 5, and 6</td><td>3 – 5 years</td></tr>
</table>

Other priority impacts addressed by action: health and cognitive effects from extreme heat; health effects of extreme storms and power outages; disproportionate impacts on unhoused populations from extreme temperatures or extreme flooding; Damage or loss to homes and critical facilities in the wildland urban interface; forest health degradation		
High-Consequence Vulnerability: Disproportionate Impacts on Unhoused Populations from Extreme Temperatures or Extreme Flooding		
The following priority impacts/high-consequence vulnerabilities pertain to extreme temperatures and flooding but do not specifically address vulnerabilities for "unhoused populations." • Increase in Mental Health Stressors • Increase in Vector Borne Diseases Incidence and Bacterial Infections • Damage to Inland Buildings • Damage to Coastal Buildings and Ports • Loss of Urban Tree Cover • Health and Cognitive Effects from Extreme Heat • Loss of life or injury due to high vulnerability dams, hurricanes, wildfires, extreme flooding, or extreme temperatures.		

Infrastructure

Infrastructure Sector			
Urgent Priority Impact: Damage to Inland Buildings			
Action Topic 1: Reducing flood risk and supporting equitable restoration projects with communities			
Description: The action topic focuses on reducing flooding risk to communities in an equitable manner for Environmental Justice and Other Priority Populations. The actions address the Damage to Inland Buildings priority impact but are more broadly applicable to the hazards of inland and coastal flooding, coastal flooding and storm surge, coastal erosion, in addition to drought and enhancing stormwater management. Together, the collection of actions focusses on moving communities, structures, and assets from the floodplain to reduce risks and vulnerabilities and increasing equitable community access to grants for increasing resilient and improving water quality. **Partners:** MEMA, DCR, CZM, EEA, DER, and state and local floodplain managers and communities. **Other priority impacts addressed by action topic:** Increase in costs of responding to climate migration; emergency service response delays and evacuation disruptions; disproportionate impacts on unhoused populations from extreme temperatures or extreme flooding; reduction in clean water supply.			
ACTION 1a: Acquisition/Buyout program study			
MEMA will hire a vendor to study other successful state buyout programs such as NJ, OH and districts in NC as well as Florida's Wind Mitigation Program to understand best practices, gaps and opportunities of improvement. The study will result in a set of recommendations that best suits Massachusetts government structure to help us identify properties and create a program that best supports coastal and riverine cities and towns making it easier for them to obtain funding. Acquisition/Buyout programs are one method of property acquisitions in which private lands are purchased, existing structures demolished, and the land maintained in an undeveloped state for public use in perpetuity. Acquisition of a property in a floodway is intended to reduce the risk of future flooding for the property and/or those adjacent. A voluntary property acquisition/buyout program can enable homeowners to leave high-risk areas. This can be an especially important option for EJ and other priority populations who may not have the financial means to move or to repair/rebuild after floods.	**Scale**	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	Statewide, Local, Site-Specific	Lead: MEMA Partners: DCR, State Floodplain Manager, local communities	All hazards
	Goal(s) Addressed		**Timeframe**
	1, 2, 3, 4, and 6		Less than 3 years

<table>
<tr><td colspan="4">ACTION 1b: Address impacts of flooding to infrastructure, natural resources and groundwater through better understanding of climate change</td></tr>
<tr><td rowspan="4">Main components of this action include: (1) Address flood vulnerability and (2) Enhance understanding of groundwater flooding. Part (1) includes developing flood map overlays to show increased flood vulnerabilities across the Commonwealth and in particular where these intersect with EJ populations and identifying areas of repeated flooding across the state, overlaying with EJ data, overlaying with potential causes (e.g., geology, land use and overlaying with potential mitigation options such as upland recharge areas, improved stormwater infrastructure, and removing impervious surfaces or similar. Advance implementation through pilot projects in prioritized areas. Part (2) includes continuing study of groundwater flooding, refining statewide groundwater model, applying output from EEA's Climate and Hydrologic Risk Project, and conducting recharge modeling to run new climate change scenarios and add sea level rise inputs for coastal areas.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Utilities</td><td>Leads: EEA and DCR-OWR</td><td>Drought, groundwater rise, inland flooding, coastal flooding, and storm surge</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 2, 3, 4, and 6</td><td>Less than 3 years</td></tr>
<tr><td colspan="4">ACTION 1c: Develop and implement recommendations to increase community access and equity for grants targeting coastal water quality, habitat, and resilience</td></tr>
<tr><td rowspan="4">Undertake an equity analysis of grant funded projects to date through the Coastal Pollutant Remediation, Coastal Habitat and Water Quality, and Coastal Resilience grant programs. The analysis will include a review of previously funded projects, participating municipalities, stakeholders, and regions in addition to an assessment of potential barriers to funding. The analysis will inform the development of recommendations to increase equity and access to grant funding that will be implemented in future funding rounds of the Coastal Habitat and Water Quality and Coastal Resilience grant programs, which will help build capacity to improve and protect water quality, habitat, and resilience in underserved communities.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Coastwide, Local, Environmental Justice</td><td>Lead: CZM</td><td>Flooding, coastal erosion</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">3, 4, and 6</td><td>Less than 3 years</td></tr>
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<tr><td colspan="4">ACTION 1d: Update DER's environmental justice strategy</td></tr>
<tr><td rowspan="4">Review and improve how DER integrates environmental justice into its grant programs, restoration practices, policies, and other activities, as approximately 60% of DER's restoration-adaptation projects are in communities with EJ populations. The result of this action will be an updated DER EJ strategy consistent with DFG's and EEA's strategies. The strategy will identify new approaches and best practices and will guide DER in maximizing benefits of restoration-adaptation to underserved and disadvantaged communities statewide.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Restoration, Environmental Justice</td><td>Lead: DER</td><td>All</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 4, and 6</td><td>Less than 3 years</td></tr>
<tr><td colspan="4">ACTION 1e: Increase funding, eligibility, and focus on environmental justice to and within municipal and agency resilience action</td></tr>
<tr><td rowspan="4">Launch MVP Planning 2.0 program and develop update to MVP 2.0 Action Program that addresses stakeholder feedback and improves program access and support to best practices.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Local, Environmental Justice</td><td>Lead: EEA</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">All</td><td>Less than 3 years</td></tr>
<tr><td colspan="4">ACTION 2: Complete buildout of Statewide Hydraulic Model</td></tr>
<tr><td rowspan="4">Create a Statewide River Hydraulic Model, using paper printouts, microfiche, and modern LIDAR. This project will allow for projection of future river elevations for both high and low flows and will aid in estimating the effects of projects on river flooding. Phases 1, 2, and 2a included a feasibility study, tool development pilot in the Squannacook River Basin, and model calibration at additional sites. The last project phase (Phase 3) will complete the statewide model buildout.

The model will facilitate future updates to FEMA maps, including providing the ability to project the effects of changing and more intense hydrologic patterns on flooding elevations as well as project the river elevations during droughts. Other priority impacts addressed by action: Damage to roads and loss of road service; damage to coastal buildings and ports; damage, disruption, or loss of coastal infrastructure such as seaports, airports, and maritime industries; damage to rails and loss of rail/transit service.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Flood Modeling of Riverine Flood Risks</td><td>Lead: MassDEP</td><td>Flooding</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">2 and 3</td><td>Less than 3 years</td></tr>
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<tr><th colspan="4">Urgent Priority Impact: Damage to Electric Transmission and Utility Distribution Infrastructure</th></tr>
<tr><td colspan="4">ACTION 3: Resilient siting of new or modified jurisdictional transmission facilities</td></tr>
<tr><td rowspan="3">Ensure that new or substantially modified jurisdictional electric transmission facilities are designed, built, and operated for resiliency regarding flooding/sea level rise; severe weather events; and physical/cyber security threats. Refine use of forward-looking approval conditions that require periodic review of updated data and science, potential mitigation measures; required actions/modifications.
Other priority impacts addressed by action: Health effects of extreme storms and power outages; reduced ability to work; inability to carry out mission and services due to damage, disruption, or loss of state assets and services; increase in demand for state and municipal government services; reduction in state and municipal revenues.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Utilities</td><td>Lead: DPU
Partners: MEPA, MassDEP, CZM,</td><td>Flooding, extreme temperatures, hurricane tropical cyclone, winter storms/nor-easter, tornado, tsunami, other severe weather</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">2, 5, and 6</td><td>Less than 3 years</td></tr>
<tr><td colspan="4">ACTION 4: Ensure electric sector modernization plans consider climate impacts</td></tr>
<tr><td rowspan="3">On September 12, 2022, the DPU directed the investor-owned electric distribution companies’ electric sector modernization plans that will be filed with the Grid Modernization Advisory Council in September 2023 and with the DPU in January 2024 consistent with the requirements of the 2022 Climate Act (St. 2022, c. 179). The electric sector modernization plans will include a five-year plan for preparing for future climate-driven impacts on the transmission and distribution systems, including proposed improvements to the electric distribution system to increase reliability and strengthen system resiliency to address potential weather-related and disaster-related risks. The DPU will review the plans when filed in January 2024 and issue a decision within seven months of the submission of the plan.
Other priority impacts addressed by action: Health and cognitive effects from extreme heat; emergency service response delays and evacuation disruptions; health effects of extreme storms and power outages; Inability to carry out mission and services due to damage, disruption, or loss of state assets and services, loss of energy production and resources.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, electrical infrastructure</td><td>Lead: DPU</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">3, 4, 5, and 6</td><td>5+ years</td></tr>
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<tr><td colspan="4">ACTION 5: Develop regulations to create a clean heat standard for heating fuels</td></tr>
<tr><td rowspan="4">The 2025/2030 Massachusetts Clean Energy and Climate Plan (CECP) tasks MassDEP with developing a Clean Heat Standard. MassDEP will initiate a stakeholder process with a goal of finalizing regulations in 2023 and implementing the requirements as early as 2024. The Commission on Clean Heat endorsed the creation of a Clean Heat Standard in its final report (https://www.mass.gov/info-details/commission-on-clean-heat-issues-final-report). The standard will incentivize electrification of the building sector, which will reduce GHG emissions and improve comfort of residents during extreme heat. It will reduce risk of fossil fuel/oil spills by reducing transport and delivery accidents. Reducing GHG emissions from the building sector supports resiliency.
Other priority impacts addressed by action: Health and cognitive effects from extreme heat; loss of energy production and resources.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Buildings</td><td>Lead: MassDEP
Partners: DOER, MassCEC, EOED</td><td>Extreme temperatures</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">4, 5, and 6</td><td>Less than 3 years</td></tr>
<tr><td colspan="4">ACTION 6: Prioritize mobile solar energy systems for emergency response</td></tr>
<tr><td rowspan="4">Shift from generators to investments in mobile solar energy storage systems that can be used during emergencies.
Other priority impacts addressed by action: Health effects of extreme storms and power outages; loss of energy production and resources; emergency service response delays and evacuation disruptions.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Emergencies</td><td>Lead: EEA
Partners: DOER, MEMA</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">3, 5, and 6</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">ACTION 7: Work with utilities to ensure solar and storage proposals address climate risk and vulnerability</td></tr>
<tr><td rowspan="4">Work with investor-owned electric and gas utilities to review geotargeted solar paired with energy storage proposals developed pursuant to the 2021 Climate Act (St. 2021, c. 8, section 77) designed to assist a municipality, including those with environmental justice communities, at high risk from the effects of climate change. The proposals must be supported by the municipality and designed to improve climate adaptation and resiliency.
Other priority impacts addressed by action: Health effects of extreme storms and power outages; loss of energy production and resources; emergency service response delays and evacuation disruptions.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide</td><td>Lead: DPU</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">3, 4, 5, and 6</td><td>3 – 5 years</td></tr>
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<tr><td colspan="4">ACTION 8: Work with electric utilities to assess critical infrastructure for climate vulnerability</td></tr>
<tr><td rowspan="4">Ensure that investor-owned electric utilities continue to appropriately assess critical infrastructure, high risk hazards, and system vulnerabilities in vegetation management plans, pre-storm assessments and through their emergency response plans.
Other priority impacts addressed by action: Health effects of extreme storms and power outages; loss of energy production and resources; emergency service response delays and evacuation disruptions.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide</td><td>Lead: DPU</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">3 and 6</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">ACTION 9: Integrate adaptation goals in clean energy projects</td></tr>
<tr><td rowspan="4">Assess Massachusetts’ clean energy projects to determine opportunities to increase adaptation and reduce risks by including hazard mitigation and climate adaptation goals wherever possible.
Other priority impacts addressed by action: Health effects of extreme storms and power outages; loss of energy production and resources; emergency service response delays and evacuation disruptions.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, energy assets and infrastructure</td><td>Lead: EEA
Partner: DOER</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">All</td><td>Less than 3 years</td></tr>
<tr><td colspan="4">Urgent Priority Impact: Damage to Rails and Loss of Rail/Transit Service</td></tr>
<tr><td colspan="4">Action Topic 10: Assess risks to transportation assets and services and develop approaches to reduce risk</td></tr>
<tr><td colspan="4">Description: This action topic is focused on evaluating the risk to assets and services from hazard and climate change and methods for increasing resilience. The action topic primarily addresses the Damage to Rails and Loss of Rail/Transit Service priority impact but also addresses other priority impacts as highlighted below. Together, the actions focus on conducting vulnerability studies, utilizing live data to inform operational decisions, and identifying priorities for resilience projects to protect assets and services. The actions also focus on conducting research on resilience approaches and adopting standards to incorporate resilient design at the onset of projects.
Partners: MBTA, MassDOT, and EEA
Other priority impacts addressed by action topic: Damage to roads and loss of road service; inability to carry out mission and services due to damage, disruption, or loss of state assets and services; and emergency service response delays and evacuation disruptions; reduced ability to work.</td></tr>
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<tr><td colspan="4">ACTION 10a: Conduct climate vulnerability assessments</td></tr>
<tr><td rowspan="4">Complete a Vulnerability Assessment of Critical Locations Across Commuter Rail System (esp. Historical flood locations) and assess the vulnerability of all 3 major Commuter Rail Facilities. Finish conducting Cabot Yard Vulnerability Assessment, and complete additional bus facility vulnerability assessments (in coordination with the Bus Modernization Program).</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Regional, Commuter Rail</td><td>Leads: MBTA</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">3 and 6</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">ACTION 10b: Updating the MBTA's emergency response plans and GIS viewer for real-time storm response</td></tr>
<tr><td rowspan="4">The MBTA will revise and update its Severe Weather Operations Plan, as well as its Snow + Ice Plan to reflect both the latest climate science and expectations about operating in severe weather. The completion of an updated Comprehensive Emergency Management Plan (CEMP) is underway as part of the MBTA's Tunnel Flood Mitigation program. The updated CEMP, which accounts for all climate hazards, will directly inform an update to the Severe Weather Operations plan, as well as the Snow + Ice Plan. The Severe Weather Operations Plan that is currently in place requires more robust coordination between different MBTA departments, and a verification that the resources that each department says it plans to rely upon, will be available in the event of a major storm. Having a GIS viewer for real-time storm response (a deliverable that is part of the Tunnel Flood Protection Program) will help with this coordination and revision of the plans.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Regional, Internal Capacity Building</td><td>Leads: MBTA/MassDOT Security & Emergency Management Dept</td><td>Extreme temperatures, hurricane, tropical cyclone, winter storms/nor’easter, tornado, tsunami, other severe weather</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">3 and 6</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">ACTION 10c: Tunnel Flood Mitigation program</td></tr>
<tr><td rowspan="4">The MBTA's Tunnel Flood Mitigation program, which began in 2021, is presently working on conceptual designs for flood protection of the Alewife Storage Tracks and the Airport Portal. The program is also seeking to address upgrades to track dewatering pump rooms. By protecting portals the MBTA is seeking to keep coastal flood water out. Improving the pump rooms that handle everyday water on the tracks will help mitigate flooding internally. The next steps in this program will be addressing the D Street Portal on the Silver Line in the Seaport (designing flood protection), and addressing flood protection for the MBTA's lowest critical flood locations (especially the ones exposed to coastal flooding in the near term), such as vent shafts, manholes, emergency egresses, etc.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Regional, Transit Assets and Services</td><td>Leads: MBTA/Office of the Chief Engineer</td><td>Flooding, groundwater rise</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">3</td><td>5+ years</td></tr>
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ACTION 10d: MBTA design standards update

The MBTA Office of the Chief Engineer is in the process of updating its design standards for the entire system. The design standards have been drafted to incorporate climate resiliency in all the standards. However, going into this year significant editing and revisions will be needed, as well as stakeholder engagement from departments across the MBTA. When this project is finally complete, the goal is to have climate resiliency considerations such as designing for extreme temperatures, managing stormwater for both improved water quality and resilience, addressing coastal flooding, designing for high winds, etc., incorporated into the design requirements. These will be the requirements that all new construction at the MBTA (and retrofits) must adhere to.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Regional, transit assets and services	Leads: MBTA/Office of the Chief Engineer	All hazards
Goal(s) Addressed		**Timeframe**
2 and 3		Less than 3 years

ACTION 10e: Resilient design research and planning

Research best practices and leading examples of transportation asset resilient designs and standards to inform future MassDOT initiatives and design guidance. Prepare a summary of findings.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Statewide, Transportation Assets	Lead: MassDOT	All hazards
Goal(s) Addressed		Timeframe
2, 3, and 6		3 – 5 years

Priority Impact: Damage to Roads and Loss of Road Service

Action Topic 11: Evaluate rockfall and landslide hazards

Description: The action topic is focused on evaluating hazards associated with rockfall and landslides to inform decision making, which overlaps with multiple priority impacts including those related to disruption of services and damages to assets as highlighted below.

Other priority impacts addressed by action topic: Damage to rails and loss of rail/transit service; inability to carry out mission and services due to damage, disruption, or loss of state assets and services; and emergency service response delays and evacuation disruptions; reduced ability to work; damage to inland buildings; damage to coastal buildings and ports.

<table>
<tr><td colspan="4">ACTION 11a: Identification of rockfall hazards</td></tr>
<tr><td rowspan="3">Identify rockfall hazards in MA, particularly along major state roads. With increased rainfall and more cycling of freezing and thawing under climate change, rockfall hazards poses an increased risk. Assess whether existing hazard rating systems could be employed to identify and prioritize this risk.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Rockfall, Landslide</td><td>Lead: MA Geological Survey</td><td>Landslides</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">3</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">ACTION 11b: Update and produce a landslide inventory for Massachusetts to help identify vulnerable resources and infrastructure</td></tr>
<tr><td rowspan="3">The landslide susceptibility map completed in 2012 is outdated. With the availability now of 1 meter LiDAR statewide and expected delivery of 1/2 meter LiDAR in eastern MA shortly, conduct a comprehensive landslide inventory statewide.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Landslides</td><td>MA Geological Survey</td><td>Landslides, coastal erosion</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">3</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">Action Topic 12: Screen for and incorporate resilience in transportation projects</td></tr>
<tr><td colspan="4">Description: This action topic focuses on addressing the Damage to Roads and Loss of Road Services priority impact and incorporates various actions proposed by MassDOT and partners. Together, these actions identify a strategy for screening projects for resilience aspects and incorporating them into projects to increase resilience and continuity of service.
Partners: MassDOT, MEMA, EEA, regional organizations, MVP program, and communities
Other priority impacts addressed by action topic: Damage to rails and loss of rail/transit service; inability to carry out mission and services due to damage, disruption, or loss of state assets and services; and emergency service response delays and evacuation disruptions; reduced ability to work; damage to inland buildings; damage to coastal buildings and ports.</td></tr>
<tr><td colspan="4">ACTION 12a: Resilience improvement prioritization</td></tr>
<tr><td>Screen and prioritize resilience improvements in vulnerable roadway/bridge assets utilizing information from the MassDOT Resilience Improvement Plan evaluation, CAVA, MaPIT, and similar sources. Coordinate with other agencies and engage stakeholders, as applicable, through the project development process. Ensure transparency to communities on process.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Roads, Bridges</td><td>Lead: MassDOT
Partners: municipalities and jurisdictions, regional organizations, MVP program</td><td>All hazards</td></tr>
</table>

<table>
<tr><td></td><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td></td><td colspan="2">1, 2, 3, and 6</td><td>5+ years</td></tr>
<tr><td colspan="4">ACTION 12b: Enhance resiliency screening in project development</td></tr>
<tr><td rowspan="4">Evaluate opportunities along the project development process to track or screen climate resilience, climate mitigation, hazard mitigation, and environmental justice data elements to support climate-informed project design and ensure alignment with funding sources and MassDOT goals. This includes evaluating the MassDOT MaPIT application inputs. Collaborate with EEA on similar efforts.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide</td><td>Lead: MassDOT
Partners: MEMA and EEA</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">2, 3, 4, and 6</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">ACTION 12c: Utilize TRB’s self-assessment tool in project development</td></tr>
<tr><td rowspan="4">Review the Transportation Research Board (TRB)'s self-assessment tool to identify opportunity to incorporate components into the project review process. This will focus on incorporating opportunities for reducing hazards and climate change concerns into the project screening and implementation process.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide</td><td>Lead: MassDOT</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">2, 3, 4, 5, and 6</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">ACTION 13: Complete climate change vulnerability assessment of DCR’s parkways system to support the DCR Parkways Master Plan</td></tr>
<tr><td rowspan="4">The Parkways Climate Vulnerability Assessment will provide a critical first step planning-level flood risk information specific for the historic DCR Parkways system by identifying risks from flooding under future climate scenarios, aligning with the 2022 Massachusetts Climate Assessment. This assessment will supplement the 2020 DCR Parkways Master Plan to add long-term considerations in the context of the exposure to extreme weather and climate effects, and adaptive capacity. The assessment will inform DCR's planning efforts to make these parkways resilient to the effects of climate change.
Other priority impacts addressed by action: Damage to inland buildings; damage to tourist attractions and recreation amenities.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Regional, Parkways</td><td>Lead: DCR
Partners: municipalities</td><td>Flooding, groundwater rise</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">2, 3, 4, 5, and 6</td><td>Less than 3 years</td></tr>
<tr><td colspan="4">ACTION 14: Develop the foundation for a Resilience Improvement Plan</td></tr>
<tr><td rowspan="2">Evaluate and prepare an outline for a statewide Resilience Improvement Plan, building upon asset resilience information in the MassDOT Climate Adaptation and Vulnerability Assessment (CAVA), Massachusetts Project Intake Tool (MaPIT), and other sources. Coordinate with other agencies as applicable to identify opportunities to collaborate.
Other priority impacts addressed by action: Damage to inland buildings; damage to</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Transportation</td><td>Lead: MassDOT
Partners: CZM, EEA, DCR,</td><td>All hazards</td></tr>
</table>

<table>
<tr><td rowspan="3">tourist attractions and recreation amenities; emergency service response delays and evacuation disruptions; increase in demand for state and municipal government services; inability to carry out mission and services due to damage, disruption, or loss of state assets and services.</td><td>Assets and Services</td><td>municipalities, regional organizations</td><td></td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">2, 3, and 6</td><td>Less than 3 years</td></tr>
<tr><td colspan="4">ACTION 15: Climate change adaptation training and guidance</td></tr>
<tr><td rowspan="3">Invest in internal and external training, including continuation of the fluvial geomorphology based "Rivers & Roads" training program which provides guidance on bridge and culvert design interaction with emerging fluvial geomorphology practices. Coordinate with resource agencies on this effort, as needed. Update existing guidance documents to ensure proposed bridge and culvert projects are appropriately sized. Conduct internal staff training to ensure compliance with the Massachusetts Stream Crossing Standards.
Other priority impacts addressed by action: Damage to inland buildings; emergency service response delays and evacuation disruptions; increase in demand for state and municipal government services; inability to carry out mission and services due to damage, disruption, or loss of state assets and services.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Bridges and Culverts</td><td>Lead: MassDOT
Partners: DCR, EEA, MassDEP</td><td>Inland Flooding</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 2, 3, 4, and 6</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">Priority Impact: Loss of Urban Tree Cover</td></tr>
<tr><td colspan="4">ACTION 16: Expand DCR’s Greening the Gateway Cities Program into four environmental justice communities to mitigate heat island effects as well as combat adverse effects of climate change, reduce energy costs, absorb and filter pollutants, and decrease water runoff</td></tr>
<tr><td rowspan="3">The Greening the Gateways Cities Program is currently in 23 out of the 26 Gateway cities. Within the next five years, the program will expand into additional cities that are EJ communities with low urban canopy cover. In total, the program’s ten tree planting and maintenance teams will be planting 400 trees per year, with an overarching goal to plant at least 4,000 trees per year in EJ neighborhoods within the Gateway cities.
Other priority impacts addressed by action: Health and cognitive effects from extreme heat; health effects from degraded air quality; increase in mental health stressors; loss of biodiversity, habitats, and native species due to climate change impacts; and other priority impacts in the Natural Environment sector.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Local, Environmental Justice</td><td>Lead: DCR
Partners: municipalities</td><td>Flooding, extreme temperatures</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">3, 4, 5, and 6</td><td>3 – 5 years</td></tr>
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<table>
<tr><th colspan="4">Priority Impact: Damage to Coastal Buildings and Ports</th></tr>
<tr><td colspan="4">ACTION 17: Develop guidance on flow path analyses and impacts of channelized flow to buildings</td></tr>
<tr><td rowspan="3">Terrain alterations (e.g., fill and landscaping walls) can impact how floodwaters flow through floodplains. Low-cost methods for conducting flow path analyses through developed areas will be reviewed. Thresholds (e.g., velocities and depths) for damages to buildings due to channelized flow will be identified. This information will be presented in a guidance document or fact sheet for project proponents, consultants, and reviewers.
Other priority impacts addressed by the action: Damage, disruption, or loss of coastal infrastructure such as seaports, airports, and maritime industries; damage to coastal state and municipal buildings and land; and damage to inland buildings; and coastal erosion.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Coastwide, Buildings</td><td>Lead: CZM
Partners: EEA, DCR,</td><td>Flooding, coastal erosion</td></tr>
<tr><td colspan="2">Goal(s) Addressed
2 and 3</td><td>Timeframe
Less than 3 years</td></tr>
<tr><td colspan="4">ACTION 18: Develop best practices for the redesign of seawalls and revetments</td></tr>
<tr><td rowspan="3">Coastal structures like seawalls and revetments exist to protect buildings and infrastructure along the coast. Over 1,300 publicly owned coastal structures need to be repaired or reconstructed. Beaches, coastal banks, and other coastal landforms associated with these structures have also eroded. CZM will convene an interdisciplinary work group with expertise in coastal engineering, geology, ecology/nature-based approaches, and planning to: (1) review design plans for coastal structures at risk of failure and those recently repaired or reconstructed, and (2) recommend best practices for redesign of critical coastal structures and those with the potential for improvement of landform function. Structure height with respect to sea level rise and storm surge projections will be a focus of the review and recommendations. There will be opportunities for engagement with coastal communities.
Other priority impacts addressed by the action: Damage, disruption, or loss of coastal infrastructure such as seaports, airports, and maritime industries; damage to coastal state and municipal buildings and land; and damage to inland buildings; coastal erosion.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Coastwide, Shoreline Management Infrastructure</td><td>Lead: CZM
Partners: EEA Dam & Seawall Grant Program, DCR Waterways</td><td>Flooding, coastal erosion</td></tr>
<tr><td colspan="2">Goal(s) Addressed
2 and 3</td><td>Timeframe
Less than 3 years</td></tr>
</table>

Priority Impact: Reduction in Clean Water Supply

Action Topic 19: Evaluate and increase the resilience of drinking water supplies to drought

Description: This action aims to address the Reduction in Clean Water Supply priority impact and hazards associated with drought and water quality. The action topic focuses on improving hydraulic monitoring networks and information sharing to evaluate various vulnerabilities to drought and groundwater flooding, identify causes of low stream flow conditions, and develop approaches to increasing resilience to drought, including implementing water restrictions, and developing water conservation and drought management plans.

Agencies: MassDEP, EEA, DCR

Other priority impacts addressed by action topic: Freshwater ecosystem degradation; decrease in agricultural productivity; and other priority impacts related to the Natural Environment sector.

ACTION 19a: Enhance and make more robust and comprehensive hydrologic monitoring networks

Assess monitoring networks used for the Drought Indices to make them more robust and comprehensive (e.g., spatial representation, regional representation, hydrogeologic representation). Conduct a network analysis and expand the network by acquiring and installing new equipment.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Statewide, Regional, Utilities	Lead: EEA	Drought
Goal(s) Addressed		**Timeframe**
2 and 3		Less than 3 years

ACTION 19b: Identify causes of low stream flows (therefore decreased water availability) during a drought

Launch a study to identify the causes for low stream flows such as land use change, climate change, water use, etc. to identify and prioritize mitigation measures.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Statewide, Aquatic Resources	Lead: EEA	Drought
Goal(s) Addressed		**Timeframe**
2, 3, and 4		3 – 5 years

ACTION 19c: Utilize consistent climate change data and projections to complete a Division of Water Supply Protection (DWSP)–specific climate vulnerability assessment by 2028

Utilizing the latest climate data from the 2022 Massachusetts Climate Assessment and the DCR Climate Change Vulnerability Assessment, the DCR's Division of Water Supply Protection (DWSP) will initiate a sub-watershed scale assessment adding data for sensitivity and adaptive capacity measurements to match DWSP's specific mission and management goals. This assessment will inform prioritization of capital planning decisions and designs, identify opportunities for resilience and climate

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Statewide, Regional Sub watershed, Utilities	Lead: DCR Partners: MWRA,	All hazards

<table>
<tr><td rowspan="2">adaptation, and identify hazards and constraints at the sub-watershed level. This assessment is the first step to make our water supply lands climate resilient.</td><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">2, 3, 4, and 6</td><td>5+ years</td></tr>
<tr><td colspan="4">ACTION 19d: Develop a statewide database and dashboard of water resources data</td></tr>
<tr><td rowspan="4">Develop a statewide database on water use and management in multiple sectors, such as municipal, district, commercial, institutional, industrial, public sector to help with water needs forecasts, streamflow analysis, TMDLs, etc. This would pull data from across agencies (such as MassDEP) to increase efficiency and timeliness of compilation and analysis of water capacity, allocations, and use.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Local, Utilities</td><td>Lead: EEA
Partner: MassDEP</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 2, and 3</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">CTION 19e: Ensure resilient current and future water supplies</td></tr>
<tr><td rowspan="4">Launch a study to assess and map vulnerability of private wells and public water supply wells to stresses such as droughts. This project will assess and map these contributing areas for use as criteria in EEA land conservation programs.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, local, utilities</td><td>Lead: EEA</td><td>Drought</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">2 and 3</td><td>Less than 3 years</td></tr>
<tr><td colspan="4">ACTION 19f: Implement Water Management Act regulatory updates (including water restrictions during droughts)</td></tr>
<tr><td rowspan="4">Implement newly promulgated Water Management Act regulations for addressing water restrictions by issuing registrations with new water conservation conditions for registered withdrawers during declared droughts (conservation). When a drought is declared by the Secretary, affected registrants will be required to implement conservation measures. MassDEP will provide technical assistance to registrants and oversee and ensure compliance.

Approximately 800 registrations must be renewed by April 2023 will include conservation requirements for next ten-year term. MassDEP will continue to phase in adding conservation requirements into Water Management Act permits as they are renewed. Conservation requirements began to be added to permits in 2003.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Utilities</td><td>Lead: MassDEP
Partners: Registered water users, permittees</td><td>Drought</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 2, 3, 4, and 6</td><td>5+ years</td></tr>
</table>

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<tr><td colspan="4">ACTION 19g: Increase water use efficiency through technical and financial assistance at the local level</td></tr>
<tr><td rowspan="4">Provide technical and financial assistance to cities and towns to develop better water conservation plans and drought management plans that meet state guidelines provided by EEA, establish water rate structures that promote conservation and efficiency, conduct statewide water/sewer rate surveys, enhance local capacity to perform system wide water audits; address and minimize outdoor water use; invest in enhanced education and outreach to the public and water suppliers and in particular to EJ communities and under-resourced communities on water efficiency and water conservation.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Local, Utilities, Environmental Justice</td><td>Lead: EEA</td><td>Drought</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 2, 3, 4, and 6</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">Priority Impact: Loss of Energy Production and Resources</td></tr>
<tr><td colspan="4">ACTION 20: Update the State Energy Security Plan</td></tr>
<tr><td rowspan="4">Update the 2023 State Energy Security Plan (SESP) in 2026 to include updating the state energy profile, the energy sector vulnerability and risk assessment, hazard mitigation approach and energy emergency response plan. This update will allow the Commonwealth to capture changes to the energy system (electric, natural gas and delivered fuels) as we work to decarbonize the economy, highlight shifting vulnerabilities and risks based on those changes, in addition to climate risks, and further develop a hazard mitigation approach as we get closer to 2030. As part of the SESP update process, DOER will work with DPU and MEMA on the update and development of a table-top exercise in 2026 to validate the plan.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide,</td><td>Lead: DOER
Partners: EEA, DPU, MEMA</td><td>All</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">2, 3, 5, and 6</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">ACTION 21: Expand MassGIS capabilities to map land for renewable energy or space for other transformative climate adaptation infrastructure</td></tr>
<tr><td rowspan="4">MassGIS can collaborate with agencies, including MEMA and EEA agencies, to harness the MassGIS skills and existing mapping capabilities to meet the strategic objectives and requirements of climate adaptation projects. In particular, MassGIS is able to gather relevant data on topography, land use and infrastructure. This may involve using tools such as sustainability analysis, spatial analysis and 3D representation.
Other priority impacts addressed by action: Damage to electric transmission and utility distribution infrastructure and inability to carry out mission and services due to damage, disruption, or loss of state assets and services.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, energy planning</td><td>Lead: TSS
Partners: EEA, MEMA</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">2 and 5</td><td>3 – 5 years</td></tr>
</table>

Priority Impact: Increased Risk of Dam Overtopping or Failure

Action Topic 22: Implement programs to mitigate risk from dams and improve dam safety, including dam removal and repair, and emergency preparedness for downstream communities

Description: This action is meant to address the priority impact Increased Risk of Dam Overtopping or Failure and to reduce flooding and risks associated with dams. The action topic focuses on MEMA and DCR working in coordination with EEA/Dam Safety to evaluate and mitigate dam risks, strengthen dam response planning, and implement related flood risk reduction and resilience projects, when feasible.

Agencies: MEMA, DCR, and EEA.

Other priority impacts addressed by the action topic: The action topic also addresses some elements of the loss of life or injury due to high vulnerability dams, hurricanes, wildfires, extreme flooding, or extreme temperatures; damage to coastal buildings and ports; and damage to inland buildings priority impacts. Where feasible, these actions may provide ecological restoration benefits and habitat connectivity, aligning with the priority impacts in the Natural Environment sector.

ACTION 22a: Finalize development of prioritization decision-making methodology to repair or remove dams to implement FEMA's High Hazard Potential Dam Program

Develop a screening-level, risk-based, decision-making methodology to prioritize the portfolio of DCR-Office of Dam Safety's eligible high hazard potential dams that are reported to be in poor or unsafe condition for repair or removal in order to mitigate risk and abate public safety threats associated with these dams.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Statewide, Dams	Leads: MEMA/DCR Partner: FEMA	Dam overtopping
Goal(s) Addressed		**Timeframe**
2, 3, 4, and 6		Less than 3 years

ACTION 22b: Dam safety planning improvements

MEMA will work with EEA/Dam Safety to strengthen dam response planning at the state level. There are gaps in the process of dam safety planning including establishing a regular update cycle. When a dam breaks or is breached it is these plans that MEMA and local officials will turn to understand the safety response, notification procedures, and other response-focused elements. This planning helps protect the infrastructure and populations downstream from dams. This is a stand-alone action as it is for emergency response rather than maintenance plans.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Statewide, Dams	Leads: MEMA Partners: DCR/Office of Dam Safety, EEA	Dam overtopping
Goal(s) Addressed		**Timeframe**
1, 3, and 6		Less than 3 years

<table>
<tr><td colspan="4">ACTION 22c: Implement climate resiliency measures for the New Charles River and Amelia Earhart dams</td></tr>
<tr><td rowspan="4">Design and construct flood resilience projects at Amelia Earhart Dam and associated lands, including Draw Seven Park. Complete Long-term Resiliency Study led by USACE for New Charles River Dam (anticipated completion: 2025).</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Regional</td><td>Lead: DCR
Partners: Charles River Watershed Association, MVP Program</td><td>Dam overtopping</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 3, 4, and 6</td><td>Greater than 5 years</td></tr>
<tr><td colspan="4">ACTION 22d: Municipal and other dam removals year 1: feeding the project pipeline for strong ecological value and climate resilience benefit</td></tr>
<tr><td rowspan="4">Complete feasibility studies and develop preliminary designs for up to five high-priority dam removal projects, prioritizing high- and significant-hazard dams. This early-stage work will increase the Commonwealth's ability to support dam removal projects.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Dams</td><td>Lead: DER
Partner: DCR</td><td>Dam overtopping</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">2 and 4</td><td>Less than 3 years</td></tr>
<tr><td colspan="4">High-Consequence Vulnerability: Damage or Loss of Unreinforced Masonry Buildings Due to Earthquakes</td></tr>
<tr><td colspan="4">ACTION 23: Incorporate earthquake risk assessments into project planning</td></tr>
<tr><td rowspan="4">In an asset management system, identify buildings with particular risk from earthquakes, especially masonry bearing-wall buildings and buildings in identified soil liquefaction zones. Utilize these assessments during major renovation projects to identify and address specific high-priority threats to state buildings. Incorporate IEBC Chapter A1 earthquake risk assessments into the early-stages of major renovation projects on unreinforced masonry bearing-wall buildings. Other priority impacts addressed by action: Inability to carry out mission and services due to damage, disruption, or loss of state assets and services; increase in demand for state and municipal government services.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>State assets, Buildings, Liquefaction Zones</td><td>Lead: DCAMM</td><td>Earthquakes</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">3</td><td>Less than 3 years</td></tr>
</table>

High-Consequence Vulnerability: Damage to Infrastructure, Utilities, and Buildings in Liquefaction Zones Due to Earthquakes
No actions have been tagged to this priority impact. Elements of this High-Consequence Vulnerability may be addressed by actions from the following Priority Impacts/High-Consequence Vulnerabilities: • Damage or Loss of Unreinforced Masonry Buildings Due to Earthquakes
High-Consequence Vulnerability: Damage or Loss to Homes and Critical Facilities in the Wildland Urban Interface
No actions have been tagged to this High-Consequence Vulnerability. Elements of this High-Consequence Vulnerability may be addressed by actions from the following Priority Impacts/High-Consequence Vulnerabilities: • Loss of Urban Tree Cover • Forest Health Degradation

Natural Environment Sector

Action Description

Urgent Priority Impact: Freshwater Ecosystem Degradation

Action Topic 1: Ecological restoration partnerships and projects to evaluate and improve water quality

Description: This action topic addresses the freshwater ecosystem degradation priority impact and is related to hazards including groundwater flooding, inland flooding, drought, and invasive species. The action topic focuses on evaluating opportunities for capacity building and assessments to evaluate ecological restoration projects and their potential to improve water quality, resilience, and ecological habitat.

Partners: DER, DFG, MassWildlife, USGS, UMass-Amherst, NECASC, and other New England States

Other priority impacts addressed by action topic: Shifting distribution of native and invasive species; loss of biodiversity, habitats, and native species due to climate change impacts.

ACTION 1a: Increase regional capacity building to help communities plan and implement climate resilient ecological restoration projects

Increase DER's regional capacity building efforts by partnering with 3-5 new regional partners through the Regional Restoration Partnerships Program. The new regional partners will receive technical and funding assistance from DER to plan, design, and implement aquatic ecosystem restoration projects that increase climate resilience for human and natural communities.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Statewide, Regional, Restoration	Leads: DER/ DFG	All hazards
Goal(s) Addressed		**Timeframe**
1, 2, 4, and 6		Less than 3 years

ACTION 1b: Understand groundwater flow and associated water quality benefits of cranberry bog restoration projects

Support hydrologic and geochemical studies to better understand how effective cranberry bog restoration projects are at improving water quality, specifically looking at nitrogen. Restoration of former agricultural cranberry bogs alters groundwater flow and patterns of ground/surface water exchanges, but the nature and extent of altered flow patterns is likely site specific and potential reductions in nitrogen export are not well understood and difficult to characterize in the field. Increased frequency of high intensity rainfall, increased stormwater runoff and pollutants, and prolonged droughts lead to changes in hydrology within restored cranberry bog systems and an increased water quality impact to freshwater ecosystems. Understanding how effectively cranberry bogs "treat" water under various hydrological conditions will

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Regional, Restoration, Water Quality	Leads: DER/DFG	Groundwater flooding, inland flooding, drought
Goal(s) Addressed		**Timeframe**
2 and 4		3 – 5 years

Natural Environment Sector

Action Description			
help advance scientific understanding of how cranberry bog restoration can mitigate the water quality impacts of climate change.			
ACTION 1c: Aquatic biodiversity conservation: fresh water mussels			
Freshwater mussels provide critical ecosystem services and yet are some of the most threatened animals in the state. Six of the 12 species found in Massachusetts are listed under the state's Endangered Species Act. They are critical to protecting water quality in freshwater systems. Each mussel can filter up to 15 gallons of water per day. As climate change continues to stress freshwater systems through increases in pollutant concentrations and algal blooms, freshwater mussels provide a nature-based solution to protect water quality and reverse freshwater ecosystem degradation. This project would seek to understand how changing environmental conditions are affecting freshwater mussel occupancy and resilience to develop effective conservation strategies.	**Scale**	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	Statewide Eastern Inland Region Central Region, Conservation	Lead: MassWildlife Partners: USGS, UMass-Amherst, NECASC, biologists from New England states	Flooding, invasive species, coastal flooding, inland flooding
	Goal(s) Addressed		**Timeframe**
	1, 2, 3, 4, and 6		Less than 3 years
ACTION 2: Lake level management recommendations to abate cyanobacteria blooms			
MassWildlife has been working with partners (e.g., USGS, UMass-Amherst) to model how lake levels and climate change are likely to affect cyanobacteria blooms. However, little on-the-ground data has been collected to drive the models. This action would seek to collect empirical data in lakes throughout the state to validate and populate models. MassWildlife will coordinate with DCR and DPU when shared goals exist.	**Scale**	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	Statewide, Lakes, Water Quality	Lead: MassWildlife Partners: DCR, DPU, USGS, UMass-Amherst, etc.	Flooding, drought, extreme temperatures
	Goal(s) Addressed		**Timeframe**
	1, 2, 3, 4, and 6		Less than 3 years
ACTION 3: Integrate DCR's Stormwater Best Management Practices (BMPs) into DCR's Design Review Process			
In October 2022, DCR created its Stormwater Design Handbook as a supplement to MassDEP's Stormwater Handbook. Formalizing incorporating these BMPs into DCR's Design Review Process will ensure that every single DCR project considers and manages stormwater in a way that responds to the anticipated increased precipitation	**Scale**	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	Statewide, Stormwater Utilities, Water Quality	Lead: DCR	Other severe weather

Natural Environment Sector

Action Description		
from climate change that poses a threat to freshwater ecosystems under DCR's stewardship.	**Goal(s) Addressed**	**Timeframe**
	1, 3, and 6	3 – 5 years

Urgent Priority Impact: Coastal Wetland Degradation

Action Topic 4: Improve coastal wetland mapping, resilience planning, and restoration efforts

Description: This action aims to address the Coastal Wetland Degradation priority impact and will help to address coastal flooding hazards and improve habitats, among other benefits. The action topic focuses on developing tools and utilizing geospatial datasets to identify opportunities to prioritize resilient efforts for coastal wetland and salt marsh restoration project to improve habitat, accommodate marsh migration, manage stormwater, and mitigate impacts from sea level rise. These efforts will be shared with CZM in consideration of their salt marsh migration land acquisition strategy.

Partners: DER, DCR, MassDEP, CZM, and MassWildlife

Other priority impacts addressed by action topic: Damage to coastal buildings and ports; damage to coastal state and municipal buildings and land; damage, disruption, or loss of coastal infrastructure such as seaports, airports, and maritime industries; and all priority impacts in the Natural Environment sector.

ACTION 4a: Develop a GIS mapping tool for climate coastal and inland wetlands to identify resource area vulnerability corridors

Design, develop, and maintain a mapping tool of coastal and inland floodplains and other wetland resource areas that identifies current and future "climate vulnerability corridors". The mapping tool will include data layers for risks (such as storm damage, sea levels affecting marshes, and others), land use (such as infrastructure), and cadaster information (such as ownership, EJ populations, wetlands restrictions, and conservation easements). The mapping tool will help identify opportunities and prioritize resilience efforts at a regional /watershed scale—moving beyond a project-by-project approach. The tool's GIS and modeling components will be integrated into relevant state mapping platforms and may require a field component for development and periodic updates. MassDEP will coordinate with CZM and DCR to ensure the tool meets the overall needs of the collective agencies.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Statewide, Wetlands	Lead: MassDEP Partner: CZM	Inland flooding, other severe weather, coastal erosion, coastal flooding

Goal(s) Addressed	Timeframe
All	Less than 3 years

<table>
<tr><td colspan="4">ACTION 4b: Identify and prioritize tidal restoration projects using the DER tidal crossing geodatabase</td></tr>
<tr><td rowspan="3">In 2020, DER developed a coast-wide geodatabase containing data on tidal crossings in Massachusetts. Through GIS analysis and field assessments DER will use the tidal crossing geodatabase to identify and prioritize new salt marsh restoration projects that consider multiple criteria including climate resilience, marsh migration potential, and future impacts of sea level rise.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Coastwide, Utilities, Restoration</td><td>Leads: DER/ DFG
Partner: CZM</td><td>Coastal flooding</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">2 and 4</td><td>Less than 3 years</td></tr>
<tr><td colspan="4">ACTION 4c: Conduct coastal wetland modeling and restoration assessments for DCR’s coastal wetlands to support planning and restoration efforts</td></tr>
<tr><td rowspan="3">Assessments documenting and analyzing hydrology, existing conditions, watershed functions, and existing stormwater capacity will be paired with future projections for stormwater and sea level rise. These assessments will help identify mitigation and restoration actions, such as naturalizing the stream, managing stormwater, and improving hydrology of saltmarshes. In 2023, DCR will begin assessments in Belle Isle Marsh Reservation and Town Line & Linden Brook. DCR's coastal wetlands assessment results will be shared with CZM for consideration and integration into their salt marsh migration land acquisition strategy.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Regional, Utilities, Restoration</td><td>Lead: DCR
Partner: CZM</td><td>Coastal flooding, other severe weather</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">2, 3, 4, 5 and 6</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">ACTION 4d: Advance salt marsh conservation and restoration</td></tr>
<tr><td rowspan="3">Advance the conservation and restoration of salt marshes, coordinating closely with partners (EEA, MassDEP, DER) and stakeholders, through the following activities: (1) Facilitation of Land Acquisition for Marsh Migration - CZM will utilize existing tools and data (SLAMM) to prioritize undeveloped areas that are modeled to be suitable for future salt marsh migration and pursue federal funding opportunities to support acquisition of priority parcels; (2) Advance understanding of beneficial reuse of sediments to restore and maintain salt marsh habitat - CZM will convene an expert stakeholder group to explore the science and practice of beneficial reuse of dredged sediments for salt marsh restoration. Opportunities for beneficial reuse that are environmentally sound, economically feasible, and permittable in Massachusetts will be the focus; (3) Implement new grant program to support monitoring and adaptive management of applied salt marsh restoration techniques - CZM will build capacity for salt marsh restoration through a targeted grant program to specifically support monitoring and adaptive management of novel</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Coastwide, Salt Marshes</td><td>Lead: CZM
Partners: EEA, MassDEP, DER, DCR (WBNERR)</td><td>Coastal flooding, inland flooding, coastal erosion</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">All</td><td>3 – 5 years</td></tr>
</table>

<table>
<tr><td>restoration strategies to improve understanding of these techniques, ensure scientific rigor, and improve the ability to evaluate success.</td><td></td><td></td><td></td></tr>
<tr><td colspan="4">ACTION 4e: Great Marsh ecosystem recovery project</td></tr>
<tr><td rowspan="3">Project partners have begun restoration of some of the Great Marsh Ecosystem. However, only a fraction of the ecosystem has been restored. This action will continue monitoring and restoration efforts to reestablish marsh elevations and tidal connections to the system.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Regional, Restoration</td><td>Lead: MassWildlife
Partners: Trustees, NPS, Mass Audubon, and municipalities</td><td>Coastal flooding, coastal erosion</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 2, 3, 4, and 6</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">ACTION 4f: Develop updated wetlands restoration guidance and regulations to improve climate resilience</td></tr>
<tr><td rowspan="3">Develop updated inland and coastal wetlands protection and restoration guidance and/or regulations that improve climate resilience at project, local, and regional /watershed scales. Establish permitting pathways, policies, or guidance to encourage (1) protection / restoration of coastal wetland resource areas including education on new coastal floodplain standards, removal of tidal flow restrictions to restore full extent of salt marshes, restoration of salt marsh ecosystem functionality, migration of salt marshes, dunes, and other coastal resource areas, and address other related challenges; and (2) protection and restoration of inland floodplains, including better alignment with FEMA requirements, consideration of future precipitation data for stormwater and floodplain boundaries, and other strategies. MassDEP will coordinate with CZM and DCR in this effort.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Coastwide, restoration</td><td>Lead: MassDEP
Partners: CZM, DER, DCR, Conservation Commissions, other state and federal agencies, non-profits, private property owners, consultants, developers</td><td>Coastal erosion, coastal flooding and storm surge, groundwater rise, huriane/tropical cyclone, inland flooding, invasive species, landslide, other severe weather</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">All</td><td>3 – 5 years</td></tr>
</table>

ACTION 4g: Support adaptation of roads in salt marshes

Roads exist coast-wide in salt marshes to provide access to homes, businesses, and recreational areas. These roads have impacted coastal resources, restricted tidal flow, and altered hydrology. Sea level rise and coastal storms will flood many of these roads at increasing frequency and depths in the future. There is a need to characterize the problem to support management efforts. CZM will conduct a GIS analysis to identify roads through salt marshes, length, ownership, purpose, ACEC jurisdiction, elevation, vulnerability, and other relevant factors. This information will be summarized in a fact sheet. The fact sheet will also describe impacts of traditional methods to elevate roads in salt marshes.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Coastwide North and South Shores Region Cape, Islands, and South Coast Region, Transportation Infrastructure	Lead: CZM Partners: MassDEP, MassDOT	Coastal flooding, inland flooding, coastal erosion
Goal(s) Addressed		**Timeframe**
2, 3, and 4		Less than 3 years

Urgent Priority Impact: Marine Ecosystem Degradation

Action Topic 5: Evaluate the impacts of ocean acidification

Description: This action is meant to address the Marine Ecosystem Degradation priority impact and includes providing technical support and expanding monitoring networks to gather data and evaluate long term trends in temperature, dissolved oxygen, and ocean acidification.
Partners: CZM, DMF, DAR, SAP, and local municipalities
Other priority impacts addressed by action topic: Decrease in marine fisheries and aquaculture productivity and all priority impacts under the Natural Environment sector.

ACTION 5a: Support new program to initiate coastwide monitoring of ocean acidification, water temperature, and dissolved oxygen

Develop and implement a coastwide monitoring network to observe long term trends in water temperature, dissolved oxygen, and ocean acidification.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Coastwide	Lead: CZM Partner: DMF	Coastal flooding
Goal(s) Addressed		**Timeframe**
2		Less than 3 years

<table>
<tr><td colspan="4">ACTION 5b: Support ocean acidification monitoring efforts</td></tr>
<tr><td rowspan="3">Advance the development of an ocean acidification monitoring network through collaborations with local shellfish departments and shellfish aquaculturists.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Coastwide</td><td>Lead: DMF
Partners: DAR, SAP, municipalities</td><td>Coastal flooding</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">All</td><td>5+ years</td></tr>
<tr><td colspan="4">ACTION 5c: Ocean bottom temperature database</td></tr>
<tr><td rowspan="3">Advance the utility of the DMF Bottom temperature database in addressing ocean warming.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Coastwide</td><td>Lead: DMF
Partners: EEA IT, DFG IT</td><td>Coastal flooding</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">All</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">ACTION 6: Integrate climate change and decarbonization considerations into oil spill preparedness and response activities under Massachusetts Oil Spill Prevention & Response Act (MOSPRA)</td></tr>
<tr><td rowspan="3">MassDEP and its contracted consultant have met with climate experts and other stakeholders to identify and prioritize impacts of climate trends, projections, and policies and programs for oil spill risk, prevention, and response. The final report, anticipated in December 2023, will include findings and recommendations. Recommendations may affect the deployment of resources from funds collected through MOSPRA to the highest risk areas or activities. Recommendations may also include updating geographic response strategies for vulnerable coastal areas and may address response practices and preparation actions that require other modifications as a result of sea-level rise and other climate impacts.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Coastwide, Maritime Industry</td><td>Lead: MassDEP
Partners: USCG, EPA, municipalities</td><td>Coastal Flooding, Sea Level Rise</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">All</td><td>3 – 5 years</td></tr>
</table>

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<tr><th colspan="4">Urgent Priority Impact: Forest Health Degradation</th></tr>
<tr><td colspan="4">ACTION 7: Enhance the Continuous Forest Inventory program by integrating collection and analysis of forest soils data, as well as increase the application of CFI data to promote data-driven, adaptive, and strategic forest planning</td></tr>
<tr><td rowspan="3">In the next five years, expand and increase funding of the Continuous Forest Inventory (CFI) program to include sampling forest soils for physical and chemical properties to better understand the effects of climate change and forest management strategies on soil properties, health, and carbon dynamics. The new soil data collected by DCR’s CFI program will also inform the implementation of the Commonwealth’s Healthy Soils Action Plan and Resilient Lands Initiative. The CFI program is a strategic, systematic sample of forests under DCR’s stewardship. The program started in the late 1950s and provides over 6 decades of data, including information on the status and trends of DCR’s forest land and enables projections of future scenarios to evaluate tradeoffs. It also provides data on resiliency and adaptive capacity; forest health; and growth, yield, and mortality of attributes including carbon. CFI data play a critical role in understanding the resiliency of our forests to stressors and disturbances at a broad scale; and will be used in/with a variety of decision support tools to prioritize strategic action to reduce vulnerabilities.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Forests</td><td>Lead: DCR</td><td>Wildfire, drought, invasive species</td></tr>
<tr><td colspan="2">Goal(s) Addressed
2, 4, 5, and 6</td><td>Timeframe
5+ years</td></tr>
<tr><td colspan="4">ACTION 8: Increase public outreach and education around forest health impacts and DCR’s Forest Health program</td></tr>
<tr><td rowspan="3">Over the next five years, the Forest Health program will expand their public outreach capabilities, increase the number of citizens reached through direct messaging, and streamline public reports of forest threat issues. To achieve these goals, there is a need to increase GIS support for the Forest Health program to respond to the increased need for interpretive materials for public education and integrating public reports into field staff digital mapping tools. DCR’s Forest Health Program monitors and manages forests within DCR’s state forests, parks, and reservations for forest health issues, including non-native pathogens and insects. Early detection and swift mitigation action of forest disturbance events, including invasives pest, pathogens, and invasive plants is the best way to limit a shift in range of invasive species and prevent them from becoming established in the landscape to the detriment of native species. For instance, this program’s identification of Beech Leaf Disease and early detection efforts and swift treatment of Southern Pine Beetle earlier in 2023, successfully prevented invasive species from expanding into the state.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Forests</td><td>Lead: DCR
Partners: MDAR, MassWildlife</td><td>Invasive species, drought, coastal flooding, inland flooding, extreme heat, drought, erosion, landslides</td></tr>
<tr><td colspan="2">Goal(s) Addressed
1 and 2</td><td>Timeframe
3 – 5 years</td></tr>
</table>

<table>
<tr><td colspan="4">ACTION 9: Implementation of regional conservation plans for turtle SGCN (Species of Greatest Conservation Need)</td></tr>
<tr><td rowspan="3">Restoring turtle species in Massachusetts is important for improving forest health. Terrestrial turtles are prolific seed dispersers for many plants, including trees, and fungi, because they are long-lived, widespread, and travel between habitats. Their eggs are also an important food source for other species, such as snakes and small mammals. Unfortunately, six of the ten native terrestrial and aquatic species are listed under the Massachusetts Endangered Species Act. The factors threatening the persistence of turtles are complex and include disease, illegal collections, and habitat degradation. Climate change is expected to amplify many of the factors already adversely impacting turtles. Furthermore, standardized assessments have not been completed and there is scarce information on which to base status evaluations and effective conservation measures. This action will hire seasonal temporary herpetologists to collect data in the state as well as organize biologists within the region to complete status assessments.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Forests, Endangered Species</td><td>Lead: MassWildlife
Partners: northeastern state biologists</td><td>Invasive species, coastal flooding, inland flooding, extreme heat, drought, erosion, landslides</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 2, 3, 4, and 6</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">ACTION 10: Restore forest ecosystem health to bolster climate change resiliency</td></tr>
<tr><td rowspan="3">MassWildlife will continue to coordinate forest health projects with sister agencies such as DCR and MassDEP. However, MassWildlife projects may be developed and prioritized with different goals and methods and at different locations to meet the agency’s mission.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Forests</td><td>Lead: MassWildlife
Partners: DCR, USGS, NIACS</td><td>Wildfire, invasive species, coastal flooding, inland flooding, extreme heat, drought, erosion, landslides</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">All</td><td>Less than 3 years</td></tr>
<tr><td colspan="4">Priority Impact: Shifting Distribution of Native and Invasive Species</td></tr>
<tr><td colspan="4">Action Topic 11: Developing an approach for detecting and responding to invasive species management</td></tr>
<tr><td colspan="4">Description: This action topic addresses the Shifting Distribution of Native and Invasive Species priority impact and overlaps with various priority impacts in the Natural Environment sector in addition to those listed below. The action topic addresses hazards associated with invasive species in addition to aspects of the coastal and inland flooding, extreme heat, drought, and landslide hazards. Although the actions presented below separately pertain to invasive plants, marine species, and forestry, these actions together present a framework for conducting assessments to detect and evaluate impacts from invasive species and creating partnerships to develop and implement effective strategies for invasive species management.</td></tr>
</table>

Partners: CZM, MassWildlife, and DCR,

Other priority impacts addressed by action theme: Decrease in agricultural productivity; reduction in food safety and security; in addition to all priority impacts under the Natural Environment sector.

ACTION 11a: Assessment and management plan for invasive plants

Invasive species are the biggest threat to ecosystems in the state, after habitat destruction and degradation. Their impacts are getting increasingly worse as a result of climate change. Habitats important for carbon sequestration (forests, salt marshes), clean water, and protection from inland flooding are all threatened by the pervasive and largely uncontrolled impacts from invasive species. Management and eradication of invasive species takes early detection, years of treatments, and continued funding which most agencies don't have due to limitations on staff capacity and budget allocations. Making this a statewide action led by EEA will provide much needed coordination and leadership. Organizations like the Northeast Climate Adaptation Center can provide a lot of guidance with this action.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Statewide, Ecosystems	Lead: MassWildlife	Invasive species, coastal flooding, inland flooding, extreme heat, drought, coastal erosion, landslides

Goal(s) Addressed	Timeframe
1, 2, 3, 4, and 6	3 – 5 years

ACTION 11b: Conduct Rapid Assessment Survey for marine species

Conduct a Rapid Assessment Survey focusing on the Gulf of Maine and Buzzards Bay regions. Roughly every five years since 2000, CZM has helped coordinate teams of scientific experts to periodically conduct a rapid assessment of marine species, including invasive animals and plants that have been introduced by human activity and have the capacity to harm the environment, economy, and public health. The last survey was conducted in 2018.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Coastwide, Regional	Lead: CZM Partners: DCR, DMF	Invasive species, coastal flooding, inland flooding, extreme heat, drought, coastal erosion, landslides

Goal(s) Addressed	Timeframe
2	Less than 3 years

ACTION 11c: Develop an Invasive Species Emergency Response Plan for invasive pest species, including federally regulated species, that pose a significant risk to forest resources by 2025

DCR's Bureau of Forestry will develop a detailed response plan for newly introduced invasive species, as well as those pests of regulatory concern with high risk of introduction. The plan will outline emergency response operations to respond to emerging pests, including the eradication or mitigation actions to be taken, long term goals, and key programs and positions involved.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Statewide, Forests	Lead: DCR Partners: MDAR, MassWildlife, Federal agencies	Invasive species, coastal flooding, inland flooding, extreme heat, drought, coastal erosion, landslides
Goal(s) Addressed		**Timeframe**
2, 4, and 5		3 – 5 years

Priority Impact: Coastal Erosion

Action Topic 12: Evaluate impacts from coastal erosion and align restoration projects accordingly

Description: This action topic addresses the Coastal Erosion priority impact in addition to aspects of all priority impacts in the Natural Environment sector in addition to those listed below. The action topic primarily addresses the coastal erosion and coastal flooding and storm surge hazards. The action topic focuses on updating mapping and incorporating new data to evaluate rates of coastal erosion to best inform decision makers and identifying projects for restoration and to reduce coastal erosion, such as the restoration of Ram Island Wildlife Sanctuary.

Partners: CZM and MassWildlife, DCR, MassDEP, EEA, and others (including USGS and The Trustees of Reservations)

Other priority impacts addressed by action topic: Damage to coastal buildings and ports; damage to coastal state and municipal buildings and land; damage, disruption, or loss of coastal infrastructure such as seaports, airports, and maritime industries; and all priority impacts in the Natural Environment sector.

ACTION 12a: Update the Shoreline Change Project and erosion hot spots

Delineate a new mean high-water shoreline for the MA coast (post 2018) and update rates of change. Add new data to the MA Coastal Erosion Viewer. Also, use the erosion rates and other data (e.g., coastal bank erosion hazards and MyCoast reports) to update the erosion hot spots identified in the 2015 Report of the Coastal Erosion Commission.

Scale	Lead(s) and Partner(s)	Hazard(s) Addressed
Coastwide, Erosion Hot Spots	Lead: CZM Partner: USGS	Coastal erosion, coastal flooding, storm surge
Goal(s) Addressed		**Timeframe**
2, 3, and 4		3 – 5 years

<table>
<tr><td colspan="4">ACTION 12b: Update coastal bank erosion hazard mapping and integrate with the MA Coastal Erosion Viewer</td></tr>
<tr><td rowspan="4">Coastal bank erosion and vulnerability are not reflected in existing coastal hazards maps for Massachusetts such as shoreline change maps. CZM will update a pilot 2016 coastal bank erosion hazard mapping product for the Massachusetts coastline. The update will include analysis using 2018 LIDAR data and more recent elevation data, if it becomes available, to look at areas of the coast experiencing high, moderate, and low magnitudes of coastal bank erosion, and have the potential to affect existing and future land uses. This coastal bank erosion hazard mapping product will be integrated into the MA Coastal Erosion Viewer. CZM will conduct outreach on the final product to coastal municipalities and organizations.</td><td>Scale</td><td>Lead(s) and Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Coastwide</td><td>Lead: CZM
Partner: MassDEP</td><td>Coastal erosion, coastal flooding, storm surge</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">2, 3, and 4</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">ACTION 12c: Coastal erosion adaptation project for endangered birds: restoration of Ram Island Wildlife Sanctuary</td></tr>
<tr><td rowspan="4">This project would stabilize and restore Ram Island for the benefit of rare terns and saltmarsh habitat. The island in Buzzard’s Bay is a state-owned wildlife sanctuary that supports 20% of the N. American population of the federally endangered Roseate Tern as well as MA's second-largest Common Tern (MA-listed: Special Concern) colonies. Maximum elevation of 3-acre island is <9 feet above Mean Low Water. It is rapidly eroding and threatened by climate change, including sea-level rise. An alternatives analysis to explore approaches to protecting the island was completed in January of 2023. Preferred approaches include saltmarsh creation and restoration, intertidal cobble berms, coastal dune enhancement, and offshore boulderfields. The next steps are completing detailed design and engineering plans ($200K) and permitting ($300K). Construction costs are likely to run at least $6M and additional sources of funding are being explored.</td><td>Scale</td><td>Lead(s) and Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Regional, Restoration</td><td>Lead: MassWildlife
Partners: Trustees, DCR, MassDEP, EEA, CZM</td><td>Coastal erosion, coastal flooding, storm surge</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 2, 3, 4, and 6</td><td>5+ years</td></tr>
</table>

Priority Impact: Soil Erosion

ACTION 13: Update Erosion and Sediment Control Guidelines and other policies to minimize erosion from work in Wetlands Resource Areas

Update the Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas (1997, reprinted in 2003), and develop a policy to reinforce that controls during construction are required when alterations occur in wetland resource areas and promote implementation of controls outside of wetland resource areas—to dovetail with MS4 requirements.

Other priority impacts addressed by action: Decrease in agricultural productivity; reduction in food safety and security; coastal erosion; freshwater ecosystem degradation; forest health degradation; marine ecosystem degradation; and reduction in clean water supply.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Statewide, Wetland Resource Areas	Lead: MassDEP	Coastal erosion, inland flooding, landslide
Goal(s) Addressed		**Timeframe**
1, 2, 3 and 6		3 – 5 years

High-Consequence Vulnerability: Loss of Biodiversity, Habitats, and Native Species due to Climate Change Impacts

Action Topic 14: Conducting culvert removal and replacement projects to improve habitat connectivity and water quality

Description: The action topic focuses on the Loss of Biodiversity, Habitats, and Native Species due to Climate Change Impacts high-consequence vulnerability in addition to other priority impacts in the Natural Environment sector, as indicated below. Together, the actions focus on identifying and prioritizing culvert replacement projects to improve water quality, habitat, assist ecologically sensitive species, and improve public health and safety. The actions focus on creating habitat connectivity for freshwater and coastal species and environments and restoring habitats.

Partners: DER, DFG, MassWildlife, DCR, USFWS, and Conservation Commission

Other priority impacts addressed by action topic: Damage to tourist attractions and recreation amenities and all priority impacts under the Natural Environment sector.

ACTION 14a: Develop culvert replacement project pipeline to advance high priority ecologically sensitive restoration projects

Advance strategies to help communities and partnering agencies identify and prioritize ecologically sensitive culvert replacement projects. This effort provides early phase planning services to prepare high value ecological projects for future implementation assistance. DER will build on criteria developed to score projects for its Culvert Replacement Municipal Assistance Grant Program with a particular focus on high value ecological projects and municipalities/regions that have historically had less culvert projects in partnership with DER. DER will work with landowners of potential sites which may include private landowners, municipalities and land-holding agencies such as DCR, MassWildlife and MassDOT.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Statewide, Regional, Local, Restoration	Lead: DER	Flooding, dam overtopping
Goal(s) Addressed		**Timeframe**
2 and 4		Less than 3 years

<table>
<tr><td colspan="4">ACTION 14b: Transitional crossings year 1: testing standards for evaluation, feasibility and design of culverts and bridges that will experience the impacts of sea level rise in the next 50 to 75 years</td></tr>
<tr><td rowspan="3">Apply the draft Phase 1 climate resilience guidance developed for stream crossings in coastal and near-coastal environments, document the site assessment processes, obtain site-specific model data, develop preliminary designs for up to three high-priority “transitional” culvert sites, and to use these case studies and feedback from a Technical Advisory Committee to finalize technical guidance for stream crossings in transition.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Coastwide, Transportation Infrastructure, Stormwater Utilities, Restoration</td><td>Leads: DER/DFG</td><td>Coastal flooding, sea level rise</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">2 and 4</td><td>Less than 3 years</td></tr>
<tr><td colspan="4">ACTION 14c: Restore water quality and habitat connectivity in coastal streams</td></tr>
<tr><td rowspan="3">This action will seek to assess culverts in tributaries to Buzzards Bay, complete upgrades or replacements of culverts in Fresh Brook (Wellfleet, MA) and Red Brook, as well as complete restoration of the Upper Coonamesset River.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Regional, Restoration</td><td>Lead: MassWildlife Partners: DER, DCR, USFWS, Conservation Commission</td><td>Coastal flooding, other severe weather</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 2, 3, 4 and 6</td><td>Less than 3 years</td></tr>
<tr><td colspan="4">ACTION 14d: Priority dam assessments and dam removals</td></tr>
<tr><td rowspan="3">MassWildlife has identified several projects important for restoring habitats for cool-water and warm-water fisheries. These include the removal of Salmon Brook Dam (partially funded) and Riley Grist Dam (Mill River). Although much emphasis is placed on cold-water fishes, the Commonwealth's aquatic biodiversity also includes cool-water and warm-water species. The action will also complete assessments of MassWildlife-owned dams statewide.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Asset, Dams</td><td>Lead: MassWildlife</td><td>Coastal flooding, dam overtopping</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 2, 3, 4 and 6</td><td>Less than 3 years</td></tr>
</table>

<table>
<tr><td colspan="4">ACTION 15: Monitor and restore climate refugia aquatic ecosystems</td></tr>
<tr><td rowspan="2">Climate change refugia are habitats naturally more resilient to climate change as they change at a much slower pace than the habitats around them. They are important as anchors to restoration efforts because individuals will recolonize restored areas from these habitats. This action will collect streamflow and temperature data necessary to evaluate impacts to climate change refugia (e.g., at headwater ponds and streams flowing into coldwater habitats). Three projects have also been identified as important to protect climate refugia, including restoration projects in the Hoosic River, Hamant Brook and Upper Quashnet River.

Other priority impacts addressed by action: This action addresses all priority impacts within the Natural Environment sector and is closely related to the shifting distribution of native and invasive species priority impact.</td><td>Scale</td><td>Lead(s) and Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Regional, Restoration</td><td>Lead: MassWildlife
Partners: DCR, USGS, Conservation Commission</td><td>Drought, inland flooding, invasive species, other severe weather</td></tr>
<tr><td></td><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td></td><td colspan="2">1, 2, 3, 4, and 6</td><td>Less than 3 years</td></tr>
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Governance

Governance Sector			
Action Description			
Urgent Priority Impact: Reduction in State and Municipal Revenues			
ACTION 1: Program Administration by States (PAS)			
MEMA will seek Federal Emergency Management Agency (FEMA) PAS designation which will allow MEMA/State to review and approve Local Hazard Mitigation Plans at the State level. This will greatly expedite the review process. MEMA will need additional resources to establish and maintain the program. **Other priority impacts addressed by action:** Loss of life or injury due to high vulnerability dams, hurricanes, wildfires, extreme flooding, or extreme temperatures; damage to inland buildings; damage to coastal buildings and ports; in addition to all priority impacts listed under the Governance sector.	**Scale**	**Lead(s) and Partner(s)**	**Hazard(s) Addressed**
	Statewide, Local Support	Lead: MEMA Partner: FEMA	All hazards
	Goal(s) Addressed		**Timeframe**
	1, 4, and 6		Less than 3 years
ACTION 2: Integrate climate resilience considerations into the FEMA Public Assistance Program			
The Climate Resilience Design Standards Tool will be integrated into FEMA HMA programs starting in FY23. MEMA will then work to Integrate the Tool into FEMA's PA Recovery Program. **Other priority impacts addressed by action:** This action has the potential to address elements of all priority impacts.	**Scale**	**Lead(s) and Partner(s)**	**Hazard(s) Addressed**
	Statewide, Local	Lead: MEMA Partner: municipalities	All hazards
	Goal(s) Addressed		**Timeframe**
	3, 4, and 6		Less than 3 years
ACTION 3: Redesign, configure and implement a strategic capital planning and capital project delivery			
Redesign the existing capital planning process and invest in technology to support improved planning and project delivery. This critical redesign will increase transparency and incorporate metrics for decision making including climate impacts. **Other priority impacts addressed by action:** This action has the potential to address elements of all priority impacts.	**Scale**	**Lead(s) and Partner(s)**	**Hazard(s) Addressed**
	Statewide, capital planning, state assets	Lead: DCR	All hazards
	Goal(s) Addressed		**Timeframe**
	2, 3, 4, 5 and 6		Less than 3 years

<table>
<tr><td colspan="4">ACTION 4: Explore the feasibility of creating a competitive state and local IT Climate Resilience and/or Awareness Program</td></tr>
<tr><td rowspan="4">Explore the feasibility of creating a new competitive State and Local IT Climate Resilience and/or Awareness Program and explore the possibility of adding IT climate resilience as either a Community Compact IT Best Practice or an eligibility area for the Community Compact IT Grant. Based on the funding/program source, EOTSS may provide technical guidance to municipalities regarding the climate impacts on local IT infrastructure.
Other priority impacts addressed by action: Reduced ability to work.</td><td>Scale</td><td>Lead(s) and Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, IT infrastructure</td><td>Lead: EOTSS</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1 and 3</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">Urgent Priority Impact: Increase in Costs of Responding to Climate Migration</td></tr>
<tr><td colspan="4">ACTION 5: Conduct a climate migration assessment</td></tr>
<tr><td rowspan="4">Based on Massachusetts’s lower relative climate risks compared to other parts of the country and world it is likely that the Commonwealth may experience in-migration due to climate change. Conduct an assessment that include the following analysis: (1) Likely sources of in-migration from other states within the USA and outside of the country; (2) Likely settlement sites within Massachusetts based on housing availability and job centers, as well as support services.; (3) Effects of in-migration on natural environment, utilities, schools, and other community resource needs; (4) Effects of in-migration on affordability of housing, and potential displacement of environmental justice and other priority populations; (5) Effects of in-migration on Massachusetts industries, sectors, and jobs. Opportunities to grow economy, new workers, and innovation for growing industries such as climate, technology, and healthcare; and (6) develop two to three likely climate migration scenarios and the adaptation pathways to prepare for each scenario.
Other priority impacts addressed by action: Reduction in the availability of affordably priced housing; emergency service response delays and evacuation disruptions; damage to cultural resources; and all priority impacts listed in Governance sector.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide</td><td>Lead: EEA
Partners: OCIR, MEMA, EOED, HHS</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">2, 3, and 4</td><td>Less than 3 years</td></tr>
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Urgent Priority Impact: Increase in Demand for State and Municipal Government Services

Action Topic 6: Develop a strategy to identify resilience funding needs and leverage federal funding to support adaptation projects

Description: This action topic aims to address the Increase in Demand for State and Municipal Government Services priority impact and has the potential to address elements of all priority impacts, as many proposed actions and adaptation projects identified lack of funding as a barrier to project implementation. Together, the actions focus on collaboratively identifying funding needs for resilience projects and obtaining federal funding sources to support CIP Investments, including adaptation projects.

Partners: A&F EO and DCAMM, MEMA, EEA, OCIR, Gov Office Director of Federal Funds and Infrastructure, and EOED/HLC

Priority impacts addressed by action topic: Providing additional funding to statewide resilience, adaptation, and mitigation projects has the potential to address elements of all priority impacts.

ACTION 6a: Standardize approach to identifying resiliency needs for state capital planning purposes

Work with agency experts to develop a standard approach for easily identifying the resiliency need(s) a proposed Capital Investment Plan (CIP) investment is helping to address and the anticipated resiliency outcomes associated with the investment.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Statewide, State Agencies	Lead: A&F Partners: DCAMM, MEMA, EEA, OCIR	All hazards
Goal(s) Addressed		**Timeframe**
1, 3, 4, and 5		Less than 3 years

ACTION 6b: Standardize approach to aggressively leveraging federal resources

Develop a coordination strategy to effectively pursue federal funding opportunities related to climate and resiliency, focusing on new opportunities, such as those stemming from BIL/IIJA and IRA.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Statewide	Lead: A&F Partners: Director of Federal Funds and Infrastructure, EEA, MassDOT, EOED/HLC, OCIR	All hazards
Goal(s) Addressed		**Timeframe**
1, 3, 4, and 5		Less than 3 years

<table>
<tr><td colspan="4">ACTION 6c: Increase access to state resilience funding</td></tr>
<tr><td rowspan="4">Develop a one-stop grant clearinghouse that streamlines climate/environment grant application process for applicants and ensures efficiency in the distribution of funding to local projects. In coordination with MEMA, update and maintain the ResilientMass website (resilient.mass.gov, formerly "Resilient MA Climate Change Clearinghouse for the Commonwealth") based on stakeholder feedback; build out new pages and resources related to example projects, funding sources, metrics, and topic-specific toolkits; and revise and expand data and GIS maps and tools to better serve stakeholders.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Local</td><td>Lead: EEA
Partner: MEMA</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">All goals</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">ACTION 7: Divert solid waste by increasing local capacity and infrastructure to reduce emissions and vulnerability and promote increase resiliency</td></tr>
<tr><td rowspan="4">Solid waste disposal capacity is becoming increasingly limited in Massachusetts and throughout the Northeast US. As a result, more than 1/3 of Massachusetts’ trash—about 2 million tons per year—is sent to landfills in other states for disposal. This waste is moved primarily by rail; even a brief rail outage could cause severe disruptions to solid waste collection and disposal. MassDEP would support the development of local infrastructure that advances the Commonwealth's Solid Waste Master Plan waste reduction goals, including: (1) increasing composting and anaerobic digestion facilities; (2) installing more in-state outlets for construction waste materials; (3) developing small-scale publicly-owned materials recovery facilities; (4) improving systems to better sort recyclables and organics from mixed wastes; and (5) encouraging facilities to collect and divert household hazardous wastes from the solid waste stream. MEMA is currently updating the Disaster Debris Plan.
Other priority impacts addressed by action: Heath effects from degraded air quality; emergency service response delays and evacuation disruptions; health effects of extreme storms and power outages; damage to rails and loss of rail/transit service; and increase in demand for state and municipal government services.</td><td>Scale</td><td>Lead(s) and Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Solid Waste Disposal</td><td>Lead: MassDEP
Partner: MEMA</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">3 and 6</td><td>3 – 5 years</td></tr>
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<tr><td colspan="4">Priority Impact: Damage to Coastal State and Municipal Buildings and Land</td></tr>
<tr><td colspan="4">ACTION 8: Update Chapter 91 regulations to improve resiliency of public trust tidelands and waterways</td></tr>
<tr><td rowspan="3">Develop and promulgate updated chapter 91 regulations to ensure potential impacts of sea level rise are considered in the project review and licensing process. Initiate technical development and stakeholder consultation for policy and/or regulatory revisions to address broader climate resilience issues to protect public trust interests in tidelands and waterways, such as implications of sea level rise for ground floor facilities of public accommodation. MassDEP will consider collaborating with other state agencies on resilient codes, floodplain management improvements, and other regulations and policies for a package of building code, zoning, and regulations designed to reduce risks from hazards and climate change.

Other priority impacts addressed by action: Damage, disruption, or loss of coastal infrastructure such as seaports, airports, and maritime industries and Inability to carry out mission and services due to damage, disruption, or loss of state assets and services.</td><td>Scale</td><td>Lead(s) and Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Coastwide, Public Trust</td><td>Lead: MassDEP
Partners: CZM, waterfront institutions, non-profit organizations, developers, others</td><td>Coastal erosion, coastal flooding, storm surge</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 2, 3, 4, and 6</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">Priority Impact: Increase in Need for State and Municipal Policy Review and Adaptation Coordination</td></tr>
<tr><td colspan="4">ACTION 9: Division restructuring and expansion</td></tr>
<tr><td rowspan="3">Implement a division restructuring and expansion plan with the following goals: expand and improve DER's ecological restoration work; strengthen DER's internal capacity; expand external capacity; and learn and share knowledge about restoration outcomes and best practices. The expansion plan includes specific actions related to hazard mitigation and climate adaptation including: promoting ecological restoration as an integral part of the Commonwealth's climate adaptation programs participating in emerging policy, program, and funding initiatives on the issue of climate adaptation and hazard mitigation; and improving and documenting our understanding of how restoration practices relate to climate adaptation benefits. Completing the DER restructuring and expansion plan will result in an increased capacity to directly implement aquatic ecosystem restoration projects and to increase the capacity of municipalities, regional organizations, and sister agencies to plan and implement these types of projects. Restoration projects (e.g., dam removals, culvert replacements, riparian and flood zone restoration, tidal restoration, and cranberry bog restoration) increase the resilience and ecosystem health of freshwater and coastal rivers and wetlands, and reduce risks to people, buildings, and transportation infrastructure.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Agency Internal Capacity</td><td>Leads: DER/DFG</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 2, and 4</td><td>Less than 3 years</td></tr>
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<tr><td colspan="2">Other priority impacts addressed by action: All priority impacts under the Natural Environment sector and other cross-government actions.</td><td></td><td></td></tr>
<tr><td colspan="4">Priority Impact: Damage to Inland State and Municipal Buildings and Land</td></tr>
<tr><td colspan="4">ACTION 10: Incorporate hazard and climate change vulnerability into capital planning, master planning, and facilities management functions</td></tr>
<tr><td colspan="2" rowspan="4">Incorporate climate change vulnerability, resilience, and adaptation standards into capital planning and at the outset of projects with client agencies. Complete the RMAT's Climate Resilience Design Standards Tool and DCAMM climate resilience assessments during project planning. Refer to these assessments during project design and master planning exercises to identify planning horizons and specific high-priority threats.

Continue to revise and update the existing DCAMM resilience assessment process as appropriate utilizing RMAT-supported climate data sets, and integrate climate change and natural hazard vulnerability information into an asset management system (CAMIS).
Other priority impacts addressed by action: This action has the potential to address elements of all priority impacts.</td><td>Scale</td><td>Lead(s) and Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, state assets</td><td>Lead: DCAMM</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">3 and 4</td><td>5+ years</td></tr>
<tr><td colspan="4">High-Consequence Vulnerability: Inability to Carry Out Mission and Services Due to Damage, Disruption, or Loss of State Assets and Services</td></tr>
<tr><td colspan="4">ACTION 11: Massachusetts Continuity of Government Plan</td></tr>
<tr><td colspan="2" rowspan="4">In coordination with the Governor's Office and EOPSS, MEMA is leading the development of the whole of Government Continuity of Government (COG) plan. This plan will provide direction to the Executive, Legislative, and Judicial Branches of Government in the event governmental services are heavily impacted by an emergency including natural disasters and those that are exacerbated by climate change. The COG will provide all Branches of Massachusetts Government the steps and processes needed to maintain critical services during and after an emergency in order to maintain minimum essential functions.
Other priority impacts addressed by action: Reduction in state and municipal revenues; reduced ability to work.</td><td>Scale</td><td>Lead(s) and Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, State Non-Physical Functions/Services</td><td>Lead: MEMA
Partners: Governor’s Office, Cabinet Secretaries, EOPSS</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1 and 3</td><td>Less than 3 years</td></tr>
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<tr><td colspan="4">ACTION 12: Amend the Massachusetts Contingency Plan to require consideration of climate change impacts as reasonably foreseeable site conditions during site cleanup and remedy selection</td></tr>
<tr><td rowspan="4">MassDEP is incorporating the evaluation and mitigation of potential climate change vulnerabilities at waste sites into the Massachusetts Contingency Plan, the regulations that govern the assessment and cleanup of oil and hazardous material disposal sites in the Commonwealth. Proposed amendments have been published for comment and finalization of the changes is expected to happen in 2023. The new rule will require consideration of reasonably foreseeable site conditions including potential impacts from climate change in evaluating a site and selecting resilient remedies.
Other priority impacts addressed by action: Emergency service response delays and evacuation disruptions; health effects from degraded air quality; increase in mental health stressors; reduction in clean water supply; freshwater ecosystem degradation; marine ecosystem degradation; forest health degradation; and increase in need for state and municipal policy review and adaptation coordination.</td><td>Scale</td><td>Lead(s) and Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Environmental Justice</td><td>Lead: MassDEP</td><td>Groundwater rise, coastal flooding, storm surge, coastal erosion, other severe weather</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 2, 3, 4, and 6</td><td>Less than 3 years</td></tr>
<tr><td colspan="4">ACTION 13: Study the feasibility of establishing FEMA's Safeguarding Tomorrow Revolving Loan Fund Program</td></tr>
<tr><td rowspan="4">MEMA will review other state agency revolving loan funds to identify which, if any, revolving loan funds can be partnered with to support the STORM Act requirements. MEMA will also identify best practices from other states which have successfully implemented the STORM Act to replicate those processes where possible within existing MA structures.
Other priority impacts addressed by action: Damage, disruption, or loss of coastal infrastructure such as seaports, airports, and maritime industries; in addition to all priority impacts listed under the Governance sector.</td><td>Scale</td><td>Lead(s) and Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide</td><td>Lead: MEMA</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1, 4, and 6</td><td>Less than 3 years</td></tr>
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<tr><td colspan="4">ACTION 14: Utilizing EOTSS videography team to professionalize climate coordination training videos and other digital products</td></tr>
<tr><td rowspan="4">Utilizing EOTSS digital services, including strategy, digital, data and videography experts, to work with content creators and subject matter experts across agencies to create professional-level content. The EOTSS videography team will produce professional-level training videos and other digital awareness products that can significantly enhance the quality and impact of these materials. The video team will support development of production plans that align with the goals and objectives of each campaign and bring technical expertise to ensure high quality of work. They will apply editing techniques to polish the final product that effectively communicates important messages to the intended audiences.</td><td>Scale</td><td>Lead(s) and Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Education and Outreach</td><td>Lead: EOTSS</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">1</td><td>Less than 3 years</td></tr>
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Economy

Economy Sector			
Action Description			
Urgent Priority Impact: Reduced Ability to Work			
ACTION 1: LWD Climate Change Impact Risk Assessment			
Assess the risk to Labor and Workforce Development (LWD) operations and facilities posed by climate change. Prioritize risks and develop mitigation strategies. Estimate costs of capital mitigation measures. **Other priority impacts addressed by action:** Health and cognitive effects from extreme heat; increase in vector borne diseases incidence and bacterial infections; reduction in state and municipal revenues; increase in demand for state and municipal government services; damage to coastal state and municipal buildings and land; damage to inland state and municipal buildings and land; inability to carry out mission and services due to damage, disruption, or loss of state assets and services.	**Scale**	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	Statewide, Workforce	Lead: Dept. of Labor Standards Partner: EEA	All hazards
	Goal(s) Addressed		**Timeframe**
	1, 3, and 6		Less than 3 years
ACTION 2: Enhance the mobility of the state workforce through the continued deployment (and refresh) of devices to implement COOP plans impacted by climate			
Deploying laptops can help the state and employees by enabling remote work during extreme weather events, reducing energy consumption, and generating less heat when compared to legacy desktop systems, facilitating paperless work, and supporting sustainable procurement practices. By using laptops, the state can reduce our carbon footprint, support environmental sustainability, and improve the overall climate resilience. **Other priority impacts addressed by action:** Health and cognitive effects from extreme heat; increase in vector borne diseases incidence and bacterial infections; reduction in state and municipal revenues; and inability to carry out mission and services due to damage, disruption, or loss of state assets and services.	**Scale**	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	Statewide, State Agency Internal Capacity	Lead: EOTSS	Extreme temperatures, hurricane, tropical cyclone, winter storms, nor'easters, tornado, tsunami, other severe weather
	Goal(s) Addressed		**Timeframe**
	3		3 – 5 years
ACTION 3: Continue to identify and to migrate business applications and systems to the cloud			
Migrate the MA21 mainframe-based system into the cloud for the resiliency of a key One Health Integrated Eligibility system. **Other priority impacts addressed by action:** Health and cognitive effects from extreme heat; increase in vector borne diseases incidence and bacterial infections;	**Scale**	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	Statewide	Lead: EOTSS	Extreme temperatures, hurricane, tropical cyclone, winter storms,

Economy Sector			
Action Description			
reduction in state and municipal revenues; and inability to carry out mission and services due to damage, disruption, or loss of state assets and services.			nor'easters, tornado, tsunami, other severe weather
	Goal(s) Addressed		**Timeframe**
	3		3 – 5 years
Urgent Priority Impact: Decrease in Marine Fisheries and Aquaculture Productivity			
ACTION 4: Enhance environmental monitoring capabilities for HAB's and shellfish borne illness			
Improve monitoring capabilities for HAB's and shellfish borne diseases. **Other priority impacts addressed by action:** Marine ecosystem degradation; freshwater ecosystem degradation; coastal wetland degradation.	**Scale**	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	Coastwide	Lead: DMF Partners: DAR, SAP, municipalities	Extreme temperatures, coastal erosion, landslide, other severe weather, inland flooding, coastal flooding, storm surge
	Goal(s) Addressed		**Timeframe**
	All		5+ years
ACTION 5: Increase fishing vessel tracking program support			
Support for research and implementation of vessel tracking for monitoring and assessing shifts in fishing effort. **Other priority impacts addressed by action:** Marine ecosystem degradation; freshwater ecosystem degradation; coastal wetland degradation.	**Scale**	**Lead(s) & Partner(s)**	**Hazard(s) Addressed**
	Coastwide	Leads: DMF Partners: EEAIT, DFG, Massachusetts Lobstermen's Association	other severe weather, coastal flooding, storm surge
	Goal(s) Addressed		**Timeframe**
	2, 3, and 6		3 – 5 years

<table>
<tr><th colspan="4">Economy Sector</th></tr>
<tr><th colspan="4">Action Description</th></tr>
<tr><td colspan="4">ACTION 6: Increase training and workforce diversification</td></tr>
<tr><td rowspan="3">Support training and work force diversification programs for fishers and farmers.
Other priority impacts addressed by action: Marine ecosystem degradation; freshwater ecosystem degradation; coastal wetland degradation; decrease in agricultural productivity.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Coastwide</td><td>Lead: DMF
Partners: Massachusetts Lobstermen’s Association; Urban Harbors Institute; Gloucester Fishermen’s Wives Association</td><td>Coastal erosion, other severe weather, coastal flooding, storm surge</td></tr>
<tr><td>Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">3 and 6</td><td>5+ years</td></tr>
<tr><td colspan="4">Action 7: Increase Program Support</td></tr>
<tr><td rowspan="3">Enhance support for existing programs such as BIG / CVA. Provide support to industry through grant opportunities for shore-based seafood processors and dealers for renewable energy and clean energy conservation improvements to their businesses.
Other priority impacts addressed by action: Marine ecosystem degradation; freshwater ecosystem degradation; coastal wetland degradation; decrease in agricultural productivity.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Coastwide</td><td>Lead: DMF</td><td>Coastal erosion, other severe weather, coastal flooding, storm surge</td></tr>
<tr><td>Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">All</td><td>5+ years</td></tr>
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<tr><th colspan="4">Urgent Priority Impact: Reduction in the Availability of Affordably Priced Housing</th></tr>
<tr><td colspan="4">ACTION 8: Incorporate climate resilience into the Commonwealth's sustainable development principles</td></tr>
<tr><td rowspan="3">Incorporate climate resilience into the Commonwealth's sustainable development principles, resulting in further integration of resilience goals into EOED funding programs that support housing production and economic growth, including capital grant programs offered through the Community One Stop for Growth.
Other priority impacts addressed by the action: Economic losses from commercial structure damage and business interruptions; damage to inland buildings; damage to coastal buildings and ports; disproportionate impacts on unhoused populations from extreme temperature or extreme flooding.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Housing and Buildings</td><td>Lead: CPRO</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed
4</td><td>Timeframe
Less than 3 years</td></tr>
<tr><td colspan="4">ACTION 9: Implement resiliency strategy at state-aided public housing</td></tr>
<tr><td rowspan="3">Conduct five to seven feasibility studies annually to identify improvements which will make vulnerable state-aided Public Housing developments more resilient. Create capital projects annually to implement the recommendations of the feasibility studies as funding allows.
Other priority impacts addressed by action: Damage to inland buildings; damage to coastal buildings and ports.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Public Housing</td><td>Lead: HLC
Partners: EEA, MEMA, DPH</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed
2, 3, 4, and 6</td><td>Timeframe
Less than 3 years</td></tr>
<tr><th colspan="4">Priority Impact: Economic Losses from Commercial Structure Damage and Business Interruptions</th></tr>
<tr><td colspan="4">ACTION 10: Investments to take advantage of opportunities presented by climate change</td></tr>
<tr><td rowspan="3">This Action will (1) Provide workforce training assistance and funding to help workers gain skills, reskill, and upskill in an evolving workplace and labor market in the pursuit of climate ready goals; (2) Collaborate with the Massachusetts Clean Energy Center (MassCEC) to leverage opportunities to blend and braid state-funded workforce initiatives through EOLWD and MassCEC. Combined funding will augment recruitment, wrap-around support services, and technical and on-the-job training experience to build a talent pipeline for the Commonwealth's clean energy industry; (3) Increase coordination with labor unions to assist in climate-critical training and to retrain workers transitioning from other sectors and/or fossil fuel-based roles; and (4) Increase integration across industry, academia, and workforce programming through the</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, work force development</td><td>Lead: LWD
Partners: EEA, EOED, MassCEC, Commonwealth Corporation, Labor Unions</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed
1, 5, and 6</td><td>Timeframe
5+ years</td></tr>
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<tr><td>Workforce Skills Cabinet, which has established clean energy among statewide priority industries.
Other priority impacts addressed by action: Loss of energy production and resources; reduction in state and municipal revenues; reduced ability to work.</td><td></td><td></td></tr>
<tr><td colspan="3">Priority Impact: Damage to Tourist Attractions and Recreation Amenities</td></tr>
<tr><td colspan="3">ACTION 11: Incorporate climate resilience criteria into capital grants for tourism assets</td></tr>
<tr><td rowspan="3">Incorporate climate resilience criteria into capital grant programs that support the construction, restoration, or renovation of tourism assets, such as the Massachusetts Destination Development Capital Grant Program. Utilize the Commonwealth's Climate Resilience and Design Standards Tool to apply these criteria to grant evaluations.
Other priority impacts addressed by action: Damage to cultural resources; decrease in agricultural productivity.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Tourism Resources</td><td>Lead: MOTT
Partners: DCR, CZM, MHC</td><td>All hazards</td></tr>
<tr><td>Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">2 and 4</td><td>Less than 3 years</td></tr>
<tr><td colspan="3">Priority Impacts: Decrease in Agricultural Productivity</td></tr>
<tr><td colspan="3">Action Topic 12: Establishing grant programs to support farmers and agricultural productivity</td></tr>
<tr><td colspan="3">Description: This action topic addresses the Decrease in Agricultural Productivity; Reduction in Food Safety and Security; and Soil Erosion priority impacts due to the inter-related nature of soil health, agricultural sustainability, and food production. This group of actions also address additional priority impacts, as highlighted below. Together, these actions aim to implement grant funding programs to support sustainable approaches to soil management, agriculture, and provide various ecosystem services. The grants will also assist farmers will evaluating their vulnerability to climate change and implementing practices to increase resilience. Similarly, MassDEP’s proposed grant program can assist farmers with incorporate energy efficient and clean energy conservation into food production activities.
Partners: MDAR, MassDEP, and DFG
Other priority impacts addressed by action topic: Increase in mental health stressors; increase in need for state and municipal policy review and adaptation coordination; reduction in clean water supply; freshwater ecosystem degradation; damage to tourist attractions and recreation amenities; and economic losses from commercial structure damage and business interruptions.</td></tr>
<tr><td colspan="3">ACTION 12a: Climate Smart Ag Program, sustainable soil management and grant programs</td></tr>
<tr><td rowspan="3">MDAR's Climate Smart Ag Program helps farmers transition to sustainable approaches to soil management such as reduced or no-till planting; the Agricultural Soil Health program that funds AFT to provide technical assistance to farmers around soil health through the Coordinated Soil Health Program. The Farm Viability Programs provide farmers with technical assistance, business planning and funding to ensure that the farms remain productive and viable. Climate Smart Ag grants and</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Agriculture</td><td>Lead: MDAR</td><td>All hazards</td></tr>
<tr><td>Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">6</td><td>Less than 3 years</td></tr>
</table>

FSIG grants assist farmers with climate resiliency and drought mitigation projects thus creating sustainable agriculture production.

ACTION 12b: Grants for private Agriculture Preservation Restrictions

This program will build on the existing Agricultural Preservation Restriction (APR) program as recommended in the Farmland Action plan. The expanded program could support inclusion of riparian buffers on farms, affordable dwellings for farmers, and climate friendly best practices. These grants will be designed to support resilience-focused APR projects that the existing APR program does not cover, while maintaining consistency with and complementing the APR program.

The APR program is not legislatively authorized to fund private entity acquisition of APRs. Establish a grant program for acquisition and stewardship of APRs by private entities. This will aid in significantly increasing the pace of farmland conservation and the associated public benefits and protections of food security and agricultural production, water supply, soil erosion, freshwater ecosystems, biodiversity and habitat, avoidance of damages to tourist attractions. An increase in the number of APRs will increase capacity of the agricultural system to withstand the effects of climate change.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Statewide, Agriculture	Lead: MDAR	All hazards
Goal(s) Addressed		**Timeframe**
All		Less than 3 years

ACTION 12c: Farm Climate Resiliency Program

Program grants will provide free "climate audits" for agricultural operations that will assess the risks to their operations from climate change and recommend practices to reduce those risks. Practices may range from opportunities in energy efficiency and resource conservation to climate friendly practices addressing crop management, soil management, pest and disease management, water conservation, and wildlife habitat. Phase 2 grants will provide free business planning to address how the identified opportunities can realistically be implemented. Phase 3 grants will provide funding to implement items recommended via the business planning covering costs of adoption and implementation. The grants will continue to invest and protect state assets (APRs) as well as the broader agricultural system (other farms). These funds can be leveraged with federal dollars providing a strong incentive for farmers to utilize the program. While there are existing and emerging Agricultural Best Management Practices (BMPs) to address climate change, a major barrier to implementation is the cost associated risk to farmers. Such practices often

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Statewide, Agriculture	Lead: MDAR	All hazards
Goal(s) Addressed		**Timeframe**
All		Less than 3 years

involve use of additional equipment, letting less productive land go fallow, and come with legitimate fears of risk of reduction in crop production. Another major barrier is the time it takes for farmers to learn and understand the practices, assess how they may be incorporated into their operation, and then figuring out how to implement it.

ACTION 12d: Grant opportunities for food/agriculture sectors to improve energy efficiency, adopt renewable energy, and reduce GHG emissions (CERP)

Increase access to reliable energy for food-producing and food-distribution entities through the Clean Energy Results Program's Gap Energy Grant. The grant supports installation of reliable energy-efficient equipment and access to renewable energy generation project benefits. DEP can work with its sister agencies MDAR and MassWildlife to reach more food producing entities so that they can incorporate energy efficient and clean energy conservation measures into their businesses. The existing program includes criteria encompassing energy resilience and climate resilience and adaptation efforts.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Statewide, Agriculture	Leads: MassDEP Partners: MDAR, DFG	All hazards
Goal(s) Addressed		**Timeframe**
5 and 6		Less than 3 years

Action Topic 13: Mapping and tool development to support agricultural decision-making and land management

Description: This action topic addresses the Decrease in Agricultural Productivity; Reduction in Food Safety and Security; and Soil Erosions priority impacts due to the inter-related nature of soil health, agricultural sustainability, and food production. This group of actions also address additional priority impacts, as highlighted below. Together, these actions aim to develop maps and tools to assist with identifying vulnerabilities and their locations and making land use management decisions to protect natural resources. Specifically, the actions include mapping existing floodplains that intersect with agricultural land to identify hotspots with a high probability of soil erosion and freshwater ecosystem degradation. The actions also include developing tools to evaluate agricultural vulnerability based on climate change projections and a method for prioritizing agricultural lands for protection.

Partners: MDAR, DCR, DFG, MEMA, EEA, and federal partners

Other priority impacts addressed by action topic: Coastal wetland degradation; freshwater system degradation; marine ecosystem degradation; shifting distribution of native and invasive species; loss of biodiversity, habitats, and native species due to climate change impacts.

<table>
<tr><td colspan="4">ACTION 13a: Improve mapping to enhance resilience and emergency preparedness of agricultural land</td></tr>
<tr><td rowspan="4">Utilize and build off hydrologic data and modeling to design, develop, and maintain a mapping tool of “climate vulnerability corridors” for agriculture. The model will identify existing and projected coastal and inland river floodplains that intersect with agricultural land. This will enable users to observe existing hotspots for high probability soil erosion and freshwater ecosystem degradation as well as predict future areas of concern based on projected changes to precipitation and flooding due to climate change. Once hotspots are identified, further climate planning and mitigation actions can be pursued (planning around projected floodplains and risk of erosion, implementing riverbank restoration/buffers etc.). The mapping tool will include not only flooding/inundation, storm damage, sea levels affecting saltwater intrusion, and other risk data layers but also sufficient cadaster data (ownership, APR restrictions, conservation easements, etc.) to identify opportunities and prioritize resilience efforts at a regional/watershed scale (move beyond project-by-project approach). The tool’s GIS and modeling components will be integrated into relevant state mapping platforms and may require a field component for development and periodic updates. MDAR GIS team to coordinate with other agencies engaged in similar work.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Agriculture</td><td>Leads: MDAR, Partners: DCR, DFG, federal partners</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">All</td><td>3 – 5 years</td></tr>
<tr><td colspan="4">ACTION 13b: Model future challenges for specific agricultural commodities</td></tr>
<tr><td rowspan="4">Predicting specific climate related challenges to specific agricultural sectors and commodities and linking that with a projected timeline will enable producers and service providers to best navigate and facilitate required shifts in agriculture due to climate change. Having this information will help farmers make informed business decisions and assist service providers in identifying future needs and rolling out programs early enough to allow adoption and implementation in a timely manner that minimizes climate impacts.</td><td>Scale</td><td>Lead(s) & Partner(s)</td><td>Hazard(s) Addressed</td></tr>
<tr><td>Statewide, Agriculture</td><td>Lead: MDAR Partners: EEA, MEMA</td><td>All hazards</td></tr>
<tr><td colspan="2">Goal(s) Addressed</td><td>Timeframe</td></tr>
<tr><td colspan="2">All</td><td>3 – 5 years</td></tr>
</table>

ACTION 13c: Farmland prioritization tool

Develop and maintain a farmland prioritization tool similar to BioMap. Agriculture is the only natural resource in the Commonwealth that does not have a prioritization tool. The Farmland Action Plan recommends development of such a tool. MDAR will consult with agricultural and natural resource experts, review existing prioritization tools and develop, maintain, and disseminate a tool for prioritizing agricultural land for protection. It will incorporate climate risk and resiliency considerations and compliment prioritization schemes of other natural resources. The tool will be scaled at state, county, and municipal level for use by a broad range of partners and compatibility and consistency with goals at various scales. Once completed the tool can be adopted by MDAR and other entities such as municipalities, non-profits and land trusts into their planning efforts around farmland protection. Farmland protection enhances our food security by protecting valuable soils from development. Farmland provides critical green infrastructure, sequestering carbon through conservation practices and regenerative agriculture practices which include cover crops, crop rotations, reduced tillage, various livestock grazing strategies, and more.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Statewide, Agriculture	Lead: MDAR Partner: EEA	All hazards
Goal(s) Addressed		**Timeframe**
All		3 – 5 years

High-Consequence Vulnerability: Damage, Disruption, or Loss of Coastal Infrastructure Such as Seaports, Airports, and Maritime Industries

ACTION 14: Incorporate climate resilience criteria into Seaport Economic Council (SEC) capital grants

Incorporate climate resilience criteria into Seaport Economic Council (SEC) capital grants to promote local adaptation projects that reduce climate risks for ports, harbors, and maritime assets in Massachusetts. Utilize the Commonwealth's Climate Resilience and Design Standards Tool to apply these criteria to grant evaluations.

Other priority impacts addressed by action: Decrease in marine fisheries and aquaculture productivity; damage to coastal buildings and ports; coastal wetland degradation; marine ecosystem degradation; coastal erosion.

Scale	Lead(s) & Partner(s)	Hazard(s) Addressed
Coastwide	Lead: EOED-SEC	Coastal erosion, coastal flooding and storm surge, other severe weather
Goal(s) Addressed		**Timeframe**
2, 4, and 6		Less than 3 years

7.1.8 2023 Plan Implementation and Maintenance

The 2023 MA SHMCAP is an adaptable, action-based document with the primary purpose of identifying the most consequential risks and taking actions to reduce those risks. The efficacy of the 2023 MA SHMCAP depends on active implementation of actions across state agencies and in partnership with local, regional, and community organizations. Through routine maintenance, the plan will be reviewed, revised, and updated as actions are completed, science and data are updated, and engagement with other partners warrants changes. The following subsections highlight the roles, responsibilities, timeline, dates, and process for maintaining and implementing the 2023 MA SHMCAP, as well as outlining the engagement and involvement of partners and interested parties at all scales.

7.1.8.1 Roles and Responsibilities

While all Massachusetts state agencies have a role in hazard mitigation planning, two executive offices have the strategic and policy responsibility for the SHMCAP: the Executive Office of Public Safety and Security (EOPSS) and the Executive Office of Energy and Environmental Affairs (EEA). The Massachusetts Emergency Management Agency (MEMA), in partnership with EOPSS and EEA, is responsible for the following:

- Making the current version of the SHMCAP accessible to state, Tribal, regional, local, and community organizations and the public in all formats needed, including the online version at the Resilient MA website.
- Provide opportunities for state agencies and Tribal, local, regional, community, and other interested parties to engage and provide comments and input on the plan during updates, reviews, and as actions are implemented.
- Provide support for interagency mitigation, preparedness, response, and recovery actions before and after disaster events, including the review and recommendation of projects for the Hazard Mitigation Grant Program.
- Update the SHMCAP every five years, establish the update schedule, and ensure compliance with federal requirements.

The RMAT, led by Climate Change Coordinators, was created by Executive Order 569, *Establishing an Integrated Climate Change Strategy for the Commonwealth.* This Executive Order has been carried out by Governor Healey and plays a significant role in designing and implementing the actions in the 2023 MA SHMCAP. One of the RMAT's key roles and responsibilities is monitoring and tracking SHMCAP implementation progress, as well as providing recommendations and support for plan updates and supporting collaborations and partnerships across the Commonwealth with local municipalities, regional organizations, private sector and industry, community members and groups, Tribal representatives, and others. The RMAT, through leadership and support from EOPSS and EEA, will also carry out the following activities to ensure the plan is maintained and implemented:

- Develop and implement cross-government and state agency actions.
- Participate in quarterly meetings to track progress, identify opportunities, and respond to challenges. Determine need for revisions or additional resources to support SHMCAP implementation.
- Provide state agency information to the SHMCAP Action Tracker at least annually and attend annual SHMCAP reviews. Identify any needed changes based on new information and data, changed state or federal policies, or new opportunities.
- Participate in post-disaster reviews of the SHMCAP to determine needed changes and to highlight actions that are applicable to post-disaster recovery.
- Participate in scheduled five-year plan reviews and updates.
- Ensure robust engagement throughout all phases of the SHMCAP, including plan updates, plan reviews, and especially action implementation. Coordinate with municipalities, regional and community organizations, Tribal representatives, and others to coordinate and collaborate on hazard mitigation and climate adaptation research, planning, and implementation.
- Incorporate the SHMCAP into state agency plans and programs and use it to inform updates to codes, regulations, policies, and guidance.

7.1.8.2 Plan Implementation

The RMAT provides an important forum for capacity building and collaboration to support action implementation. As a team, the RMAT is well-positioned to advance the actions in the strategy, identify and address challenges, and ensure that risks are reduced equitably across the Commonwealth. The implementation of the actions developed as part of the 2023 MA SHMCAP Strategy is critical to building resilience throughout the Commonwealth in a way that addresses the most consequential risks. The 2023 Strategy was designed to provide a clear path for state agencies to make plan implementation easier, with actions grouped together under action topics to identify collaborative opportunities between state agencies and partners. Organizing state agency actions by priority impacts and vulnerabilities provides agencies with an understanding of any disproportionate impacts and of which lifelines, critical assets, and geographic hotspots may be at the greatest risk.

System for Monitoring Plan Implementation

Performance metrics are important, as they help the Commonwealth evaluate the progress and success of action implementation, identify barriers to implementation, and inform decision-making about action development. For the 2023 MA SHMCAP, the Commonwealth will measure implementation progress through performance metrics developed with the RMAT.

As with the 2018 MA SHMCAP, the RMAT will primarily use the SHMCAP Action Tracker to track progress on climate adaptation and hazard mitigation actions and performance metrics. The Action Tracker will also provide a way to track larger action topics that

multiple agencies are contributing to with individual actions and how those collaborations are increasing resilience on priority impacts and vulnerabilities. The Action Tracker will give the RMAT with an easy-to-use tool to track progress, communicate issues, and collaborate to meet the goals and objectives of the 2023 MA SHMCAP.

The state agencies identified as leading actions will be required to update the Action Tracker at least annually as part of the annual implementation process but will be encouraged to do so prior to the quarterly RMAT meetings. The information provided in the Action Tracker will be used to track progress, identify barriers to implementation, assess completion timelines, and support reporting procedures to inform RMAT meetings.

The Action Tracker presents the following fields to track progress:

- Status of the action (e.g., initiated, in progress, percent completed, complete, deferred, delayed, or request for cancellation).
- Description of challenges, resources needed, reason for delays in implementation.
- Requests for deferral or cancellation, as well as progress made, and any other relevant details of action implementation.

Plan Integration, Partner Engagement, and Coordination

The 2023 MA SHMCAP is the Commonwealth's primary climate adaptation and hazard mitigation planning document; in combination with the MA Climate Assessment, it serves as the risk assessment for natural hazards and climate change in Massachusetts. In addition to its primary purpose of action identification, prioritization, and implementation, the 2023 MA SHMCAP serves as a resource for state, regional, local, Tribal, and community organizations and agencies to use when designing their own plans; assessing risks; and understanding near, mid-, and long-term conditions due to climate change.

The MA Climate Assessment and the 2023 MA SHMCAP integrate data and information from a number of documents and studies, which can be reviewed in each 2023 MA SHMCAP chapter. Some specific plans and programs that are directly integrated with the SHMCAP include:

- Commonwealth of Massachusetts Five-Year Capital Investment Plan, fiscal year 2023–2028
- The Office of Coastal Zone Management's StormSmart Coasts Program and Coastal Resilience Grants
- The Massachusetts *Clean Energy and Climate Plan for 2050*
- The Municipal Vulnerability Preparedness (MVP) program
- The Department of Conservation and Recreation's Flood Hazard Management Program

The Resilient MA website is the home for the MA Climate Assessment and the 2023 MA SHMCAP and includes a range of information, tools, and data such as the SHMCAP Action Tracker, a resource clearinghouse, a maps and data center, and the Massachusetts Climate Resilience Design Standards Tool. The website is used as a hub for collaboration and includes the Massachusetts MVP program and its planning and action grants. The website is designed to support and catalyze local, regional, community, Tribal, and state agency action on resilience and serves as a portal to provide the information and data needed to advance planning and implementation at all scales, including the development of local hazard mitigation plans and local climate action/adaptation plans.

At a federal level, Massachusetts coordinates and participates with FEMA and other federal agencies on hazard mitigation and climate adaptation efforts and programs. This includes participation and accreditation in the Emergency Management Accreditation Program, which ensures that the Commonwealth is in compliance with national standards for risk assessment and reduction, as well as other emergency and disaster management programs. Additionally, Massachusetts will continue to partner and integrate with other federal programs and plans, including the National Climate Assessment, the 2022–2026 FEMA Strategic Plan, the National Mitigation Framework, and the Natural Disaster Recovery Framework.

7.1.8.3 Plan Maintenance

Just as the 2023 MA SHMCAP was developed in partnership with broad participation from state, local, regional, community, and federal agencies, the ongoing maintenance of the plan will be conducted in the same way. To ensure the coordinated implementation of the 2023 MA SHMCAP and support state agencies as they advance individual and cross-government actions, the plan is actively managed and maintained throughout the five-year planning horizon. This maintenance includes procedures for review and minor revisions and updates over the course of the plan's five-year duration, and the comprehensive update and adoption that occurs every five years or less. Quarterly RMAT meetings will provide a venue for the maintenance of the plan over the next five years, allowing for revisions to agency or cross-government actions at minimum annually or as needed. Additionally, the plan can be modified based on new data and information, policy changes at the state or federal level, or needs that arise during plan implementation—or in the event of a disaster.

Schedule for Plan Maintenance

The requirements to ensure adequate maintenance and timely implementation and update of the SHMCAP include an annual review, post-disaster review after each disaster, and a five-year plan review and update. In addition to this standard schedule, the RMAT's quarterly meetings provide additional opportunities to increase engagement and collaboration; consider new funding sources; and discuss updated climate data, tools, and resources.

7.1.8.3.1 Annual Plan Review

The objective of the annual review is for the Commonwealth to evaluate progress on the state agency actions, the cross-government actions, and the overall 2023 MA SHMCAP Strategy. The annual review is an opportunity to evaluate progress on addressing the priority impacts and vulnerabilities and the action topics for the actions to be coordinated among state agencies. It will take place each August and will be coordinated by EEA and MEMA with participation from the RMAT. The annual plan review will include the following:

- Make updates to the SHMCAP Action Tracker (from state agency leads) for each state agency action and cross-government action, in coordination with action partners where appropriate.
- Assess progress for cross-government actions, state agency actions, and action topics overall; determine trends and identify any emerging issues.
- Determine the opportunities and challenges, including barriers to implementation and approaches to overcoming them—funding, capacity, permitting, technical, community support, or other.
- Evaluate changes to federal or state policies, laws, regulations, guidance, or funding opportunities that result in the need to revise the 2023 MA SHMCAP.
- Prepare a document summarizing the annual review process—progress on the SHMCAP state agency actions and cross-government actions, additional capabilities or capacities developed, new research or data, federal and state funding provided for state and local hazard mitigation and climate adaptation efforts, and any needs to revise the SHMCAP to ensure that it can be effectively implemented.

If necessary, the RMAT can amend the 2023 MA SHMCAP to respond to changes in conditions since its adoption. Minor revisions can be made to actions to increase effectiveness or likelihood of implementation without an amendment process. For changes that are not urgent, documentation of changes to be considered in the next five-year update is another option to use over amending the existing plan. If it is determined that the best option is to amend the plan, annexes can be used to document the changes.

7.1.8.3.2 Post-Disaster Plan Review

If a Presidentially Declared Disaster happens in the Commonwealth, the RMAT will convene to conduct a post-disaster plan review and determine if the disaster has resulted in needs or opportunities that could be addressed by the current actions in the SHMCAP or by revised or new actions. Post-disaster reviews allow the RMAT to identify opportunities to leverage or focus resources to address the needs that have emerged due to the disaster, as well as to better understand the impacts resulting from the disaster including climate influences on duration, intensity, and areas affected. The RMAT should also determine whether the post-disaster plan review will replace the regularly scheduled annual review for the year.

7.1.8.3.3 Five-Year Plan Review and Update

At least once every five years, the SHMCAP will undergo a comprehensive review, update, and adoption process in accordance with federal regulations. The comprehensive, five-year review is managed by EEA and MEMA with close coordination and support from the RMAT. MEMA manages the administrative details of the update process, including coordination with FEMA and submitting the plan to FEMA to ensure approval process is done within the allotted timeframe and that the plan is consistent with FEMA's latest requirements and guidance. The minimum requirements for a five-year update include:

- Assess changes in development in the Commonwealth that may have increased or decreased risk exposure to populations, lifelines, and critical assets.
- Assess progress on hazard mitigation and climate adaptation actions and efforts that may have reduced risks.
- Quantify and qualify the changes to the Commonwealth's hazard and climate risks, based on actions taken to reduce risks, new information and data, new climate projections based on an updated National Climate Assessment or other sources, new modeling, or new information based on recent hazard events in the region. Evaluate whether changes to actions are needed based on new information from recently completed vulnerability assessments at the state agency, local, or regional scale or based on other recently completed studies that change the understanding of the risks.
- Conduct a risk and vulnerability assessment to evaluate changes and the need for modifications to the Strategy to address new or modified risks.
- Assess changes in state and federal priorities since the last SHMCAP update.
- Investigate information and data developed since the last SHMCAP update based on new research; recent hazard events; or other experiences at the state, local, or regional scales. This includes any plans that were in progress but not completed in time to be incorporated into last SHMCAP update.

In addition to the above requirements, the RMAT will use the following questions to guide future five-year updates:

- Are the plan's goals still representative of the Commonwealth's priorities? How well were the goals integrated into action implementation?
- What meaningful progress has been made on addressing priority impacts and vulnerabilities? On completing the state agency actions and cross-government actions?
- Did completed actions result in resilience benefits and risk reduction? In what way? For which assets, geographies, populations?
- Did completed actions address disproportionate effects on environmental justice and other priority populations?

- As actions have been implemented, have adaptation gaps identified by the MA Climate Assessment been reduced? Which gaps?
- For actions that were not completed, what were the barriers and challenges that impeded progress on those actions?
    - Should these actions be included in the next SHMCAP?
    - Should incomplete actions be revised to increase likelihood of completion?
    - Are more resources needed to complete actions?
- Are actions that are still in progress going to be completed or become ongoing capabilities?
- Which actions were most effective in addressing priority impacts and vulnerabilities? In what ways have they been effective?
- How have state agency capabilities and capacities changed since the last update? Do these changes present new opportunities for the update?
- Overall, how many actions were completed?
    - How many actions are still in progress?
    - How many were not initiated?
    - Given this overall view, did the state agencies have the capacities and capabilities needed to complete the 2023 MA SHMCAP Strategy? What was missing? How can those issues be addressed in the next update?
- What changes have been made to federal and state laws, regulations, guidance, or funding opportunities since the last update? How should the plan be revised to respond to those changes?
- Has knowledge of the hazards and climate change effects changed due to new data, information, modeling, or hazard events?
- Has exposure from current and future hazards and climate impacts changed due to the location or method of development?
    - Have new codes and regulations reduced risks?
    - Has new development increased exposure?
- Have there been any revisions or amendments to the 2023 MA SHMCAP? What were those amendments? Did they improve the plan?
- Did the approach to the maintenance of the 2023 MA SHMCAP effectively implement the plan, strengthen collaboration and partnerships, and provide support and resources to increase progress on actions and include broad engagement in plan implementation?

Annual Consultation with FEMA

On an annual basis, FEMA will meet with Massachusetts representatives, including MEMA and EEA, to coordinate on the maintenance and implementation of the SHMCAP and any needed updates to the plan. FEMA's State Mitigation Program provides support to states that includes reviewing activities, plans, and programs to assist in the effective implementation of mitigation and adaptation planning and implementation. The meetings are coordinated with FEMA and scheduled to inform the annual review of the SHMCAP. FEMA will provide a State Mitigation Program Consultation summary that describes the Commonwealth's program's strengths, opportunities for improving capabilities, and challenges in advancing mitigation.

2023–2028 Plan Maintenance Schedule

The implementation and maintenance approach described above will be carried out based on the general schedule presented in Table 7-2. The 60-month time span will help to ensure that the 2028 MA SHMCAP can be prepared, adopted, and published within the five-year required timeframe.

Table 7-2. Schedule for Plan Maintenance (2023–2028)

Task	Responsibility	Month/Year
Final SHMCAP published	MEMA and EEA	September 2023
Quarterly RMAT meetings	RMAT	October 2023 January 2024 April 2024 July 2024
Annual implementation updated (using the Action Tracker)	All lead state agencies	May 2024
Annual plan review	RMAT	August 2024
Summary of progress	EEA	September 2024
Annual consultation with FEMA	MEMA, EEA, and FEMA	Fourth quarter 2024
Quarterly RMAT meetings	RMAT	October 2024 January 2025 April 2025 July 2025
Annual implementation updated (using the Action Tracker)	All lead state agencies	May 2025
Annual plan review	RMAT	August 2025
Summary of progress	EEA	September 2025
Annual consultation with FEMA	MEMA, EEA, and FEMA	Fourth quarter 2025

Task	Responsibility	Month/Year
Quarterly RMAT meetings	RMAT	October 2025 January 2026 April 2026 July 2026
Annual implementation updated (using the Action Tracker)	All lead state agencies	May 2026
Annual plan review	RMAT	August 2026
Summary of progress	EEA	September 2026
Annual consultation with FEMA	MEMA, EEA, and FEMA	Fourth quarter 2026
Quarterly RMAT meetings	RMAT	October 2026 January 2027 April 2027 July 2027
Annual implementation updated (using the Action Tracker)	All lead state agencies	May 2027
Five-year plan review and update	RMAT	September 2026–2028
Summary of progress	EEA	September 2027
Annual consultation with FEMA	MEMA, EEA, and FEMA	Fourth quarter 2027
Quarterly RMAT meetings	RMAT	October 2027 January 2028 April 2028 July 2028
Final SHMCAP update (2028) published	RMAT	September 2028

7.1.8.4 Ongoing Engagement and Coordination

While it is critical to have robust and active engagement during the five-year review and update of the SHMCAP, collaboration among state agencies and strong engagement with municipalities, regional organizations, community groups, and Tribal representatives remains necessary during the implementation and maintenance of the plan. During the five-year update process, engagement opportunities include the ability to review and provide input on draft actions, plan goals, and risk assessment findings. During plan implementation, the collaboration and engagement opportunities broaden to participation in project and program development, input on the SHMCAP's effectiveness in addressing local needs, and tangible partnerships to advance action.

Other opportunities to engage and increase participation during the implementation and maintenance of the 2023 MA SHMCAP could include:

- Invite participation from municipalities, regional organizations, community groups, federal agencies, and Tribes to an RMAT meeting after the 2023 MA SHMCAP is finalized, possibly in an open house forum. The meeting/forum would provide a SHMCAP update, identify opportunities to participate and partner on project implementation, discuss needs and support, and hear perspectives on how SHMCAP implementation could benefit these partners and participants. It could be an annual event, held in the spring before the annual review in August (to inform that review) or in the early fall after the annual review (to set direction for the next year).
- Upon approval of the 2023 MA SHMCAP, share MA Climate Assessment and 2023 MA SHMCAP documents broadly with partners; highlight actions, funding opportunities, technical assistance, and opportunities to stay engaged.
- Provide a way for participants and partners to stay informed and engaged in the process through access to the updated Action Tracker, notices on action implementation, and an opportunity to leave comments and input at the Resilient MA website.
- Provide updates on SHMCAP action implementation to state, municipal, regional, and community organizations and Tribal representatives. When actions are geographically focused, hold an early open house to learn how the project will reduce community risk and increase resilience.
- Identify business and industry organizations to provide SHMCAP updates to and identify how the actions in the plan are increasing economic resilience and reducing risks to their industries.

To effectively implement the 2023 MA SHMCAP and build capacity and capability at all scales, engagement should be ongoing across multiple opportunities and venues to better understand the plan and its purpose. Over the next five years, EEA and MEMA will find ways to engage, partner, and collaborate while highlighting the ways that the MA Climate Assessment and the 2023 MA SHMCAP are increasing Massachusetts resilience. This ongoing engagement will build a strong foundation for the next five-year update in 2028.

7.1.9 Summary and Status of Actions from the 2018 SHMCAP

The RMAT, through the 2018 MA SHMCAP planning and implementation processes, identified 108 priority actions to increase resilience and address the Commonwealth's risks and vulnerabilities related to hazards and projected climate change impacts. However, due to consolidation and refinement of actions, 107 total actions were carried forward. Therefore, the number of 2018 actions and their status are evaluated based on a total count of 107 actions. According to information provided by RMAT during the 2018 MA

SHMCAP implementation and the 2023 updates, key highlights of progress on actions and action status include the following:

- 29 out 107 (~27%) actions were completed by state agencies and partners.
- 53 out of 107 (~50%) actions were identified as in progress, meaning that the actions are currently being implemented.
- 6 out of 107 (~6%) actions were in development and were being prepared for implementation.
- 8 out of 107 (~8%) actions were identified as needing modification or were deferred (due to COVID response efforts and associated priority shifting/staffing shortages), meaning that the project scope has been slightly changed or the action has been postponed.
- 7 out of 107 (~7%) actions had not started.
- 4 out of 107 (~4%) actions were deleted because they were no longer applicable or plausible.
- 68 out of 107 (~64%) actions presented in the 2018 SHMCAP were reviewed and revised to be more relevant and effective and were carried over to the 2023 SHMCAP.

Additional information about the action development process between the 2018 and 2023 SHMCAP is provided in Chapter 2 (Planning Process) and Chapter 4 (State Capability and Adaptive Capacity Analysis). Lastly, the 2023 Action Development Worksheet, including the status and additional information on the 2018 SHMCAP actions, and information on funding source and status are presented in Appendix 7.A.