CITY OF WALTHAM
HAZARD MITIGATION PLAN and MUNICIPAL VULNERABILITY PREPAREDNESS PLAN 2019

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EXECUTIVE SUMMARY

Hazard Mitigation planning is a proactive process used to systematically identify policies, actions and tools that can be used to reduce the dangers to life and property from natural hazard events. Amongst the communities of Middlesex County, hazard mitigation planning tends to focus on flooding, the most likely natural hazard to impact these communities. The Federal Disaster Mitigation Act of 2000 requires all municipalities to adopt a local multi-hazard mitigation plan (HMP) and update their plan every five years in order to be eligible for FEMA funding for hazard mitigation grants.

The Massachusetts Executive Office of Energy and Environmental Affairs' Municipal Vulnerability Preparedness (MVP) grant program helps communities plan and take action towards becoming more resilient to the impacts of climate change. The program provides MVP Planning Grants to assist municipalities in preparing for the impacts of climate change through participation in a community climate vulnerability workshop and development of a climate change action plan and MVP Action Grants to fund the implementation of priority climate change adaptation actions.

This plan provides for both a hazard mitigation planning approach, as well as incorporating MVP provisions for the City that are related to increasing resiliency associated with climate change impacts. This provides the City with a holistic assessment and implementation plan for both hazard mitigation and climate change resiliency.

Planning Process

Planning for the Hazard Mitigation Plan and Municipal Vulnerability Preparedness Plan (HMP-MVP Plan) was led by Waltham's Municipal Vulnerability Preparedness/Hazard Mitigation Core Committee ("Core Committee"). This Core Committee was composed of staff from a number of different City Departments. The Core Committee met on January 31, 2019, February 20, 2019, March 27, 2019, and April 17, 2019, and a Municipal Vulnerability Preparedness Workshop was held on February 14, 2019. During these meetings the group planned for the Workshop, reviewed public comments, discussed where the impacts of natural hazards most affect the City, the goals for addressing these impacts, developed the mitigation plan, and transitioned to implementation of the plan's mitigation strategies

The City's Core Committee held two public meetings, on February 27, 2019 and March 14, 2019. Additionally, the draft plan was posted on the City's website for public review. Key City stakeholders and neighboring communities were notified of the public meetings and invited to submit comments.

Risk Assessment

The Waltham HMP-MVP Plan assesses the potential impacts to the City from a variety of natural disasters including flooding, high winds, winter storms, brush fire, geologic hazards, extreme temperatures, and drought. These are shown in the map series located in Appendix B.

Waltham's Core Committee identified 150 Critical Facilities. These are also shown in the map series and listed in Table 2-6, identifying which facilities are located within the mapped hazard zones.

Hazard Mitigation Goals

The Waltham Core Committee reviewed and discussed the set of goals for the City. The committee endorsed a total of nine goals. Many of these were similar to those included in the draft 2013 plan, with

the addition of a new goal addressing climate change. The following list of goals were endorsed by the Core Committee for the Waltham HMP-MVP Plan 2019:

1. Prevent and reduce the loss of life, injury, public health impacts and property damages resulting from all major natural hazards.

2. Identify and seek funding for measures to mitigate or eliminate each known significant flood hazard area.

3. Integrate hazard mitigation planning as an integral factor in all relevant municipal departments, committees and boards.

4. Prevent and/or reduce the damage to public infrastructure resulting from natural hazards.

5. Encourage the business community, major institutions and non-profits to work with the City to develop, review and implement the hazard mitigation plan.

6. Work with surrounding communities, state, regional and federal agencies to ensure regional cooperation and solutions for hazards affecting multiple communities.

7. Ensure that future development meets federal, state and local standards for preventing and reducing the impacts of natural hazards.

8. Take maximum advantage of resources from FEMA and MEMA to educate City staff and the public about hazard mitigation.

9. Consider the impacts of climate change and incorporate climate sustainability, mitigation, and resiliency into hazard mitigation and other City plans and policies.

Hazard Mitigation Strategy

The Core Committee identified and discussed a number of mitigation measures that would serve to reduce the City's vulnerability to natural hazard events. Overall, the hazard mitigation strategy recognizes that mitigating hazards for Waltham will be an ongoing process as our understanding of natural hazards and the steps that can be taken to mitigate their damages change over time. Climate change and a variety of other factors impact the City's vulnerability. In the future local officials will need to work together across municipal lines, and with state and federal agencies, to understand and address these changes. The hazard mitigation strategy will be incorporated into the City's other related plans and policies. This will ensure that all areas of planning and development within the City will recognize and incorporate hazard mitigation measures.

Plan Development Process

In 2013, the City drafted a Hazard Mitigation Plan that was never finalized or officially adopted. Nevertheless, it provides a starting point with respect to considering hazards, vulnerabilities, and mitigation strategies that were under consideration at that time.

Moving forward into the next five-year plan implementation period there will be many more opportunities to incorporate hazard mitigation into the City's decision-making processes.

Though not formally done in the 2013 Draft Plan, the City will document actions taken, challenges met, and mitigation actions successfully adopted within this iteration of the HMP-MVP Plan. This will serve as part of the ongoing plan maintenance to be conducted by the Core Committee, as described in Section 8 Plan Adoption and Maintenance.

1.0 INTRODUCTION

This section provides general background information related to the Hazard Mitigation Plan and Municipal Vulnerability Preparedness Plan (HMP-MVP Plan).

1.1 Planning Requirements under the Federal Disaster Mitigation Act

The purpose of the Federal Disaster Mitigation Act ("the Act"), passed in 2000, is "to reduce the loss of life and property, human suffering, economic disruption, and disaster assistance costs resulting from natural disasters." Section 322 of the Act specifically addresses mitigation planning and requires state and local governments to prepare multi-hazard mitigation plans as a precondition for receiving FEMA mitigation project grants.

Federal hazard mitigation planning and grant programs are administered by the Federal Emergency Management Agency (FEMA) in collaboration with the states. These programs are administered in Massachusetts by the Massachusetts Emergency Management Agency (MEMA) in partnership with the Massachusetts Department of Conservation and Recreation (DCR).

1.2 What is a Hazard Mitigation Plan and Municipal Vulnerability Preparedness?

Hazard mitigation is sustained action(s) taken to reduce or eliminate the long-term risk to human life and property from hazards. Waltham has a responsibility to protect the health, safety, and welfare of its citizens through proactive mitigation policies and actions that help reduce risk and create a safer, more disaster-resilient City. Hazard mitigation is critically important for:

- Protecting public safety and preventing loss of life and injury.
- Reducing harm to existing and future development.
- Preventing damage to a community's unique economic, cultural, and environmental assets.
- Minimizing operational downtime and accelerating recovery of government and business after disasters.
- Reducing the costs of disaster response and recovery and the exposure to risk for first responders.
- Helping accomplish other community objectives, such as leveraging capital improvements, infrastructure protection, open space preservation, and economic resiliency.

Hazard mitigation planning uses a stepped process that includes an assessment of hazards, vulnerabilities and risks and the development of the policies, tools and actions to mitigate those risks. This is accomplished through the participation of a wide range of stakeholders and the public, resulting in a plan for the community that will outline practical approaches to reduce long-term risks from natural hazards and disasters. Hazard mitigation is most effective when it is based on a comprehensive, long-term plan that is developed before a disaster occurs.

According to the FEMA, the purpose of mitigation planning is to identify local policies and actions that can be implemented over the long-term to reduce risk and future losses from hazards. These mitigation policies and actions are identified based on an assessment of hazards, vulnerabilities, and risks. It is important to ensure that stakeholders and the public are an integral part of the planning process. Benefits of mitigation planning include:

- Identifying actions for risk reduction that are agreed upon by stakeholders and the public.
- Focusing resources on the greatest risks and vulnerabilities.
- Building partnerships by involving citizens, organizations, and businesses.
- Increasing education and awareness of threats and hazards, as well as their risks.
- Communicating priorities to State and Federal officials.
- Aligning risk reduction with other community objectives.

In 2017, the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) initiated the Commonwealth's Municipal Vulnerability Preparedness (MVP) grant program to help communities plan and take action towards becoming more resilient to the impacts of climate change. The program provides Planning Grants to assist municipalities in preparing for the impacts of climate change through participation in a community climate vulnerability workshop and development of a climate change action plan. Communities that complete the planning grant program receive a designation of "Certified MVP Community". This designation provides the community with an increased standing in other state grant programs, as well as eligibility for MVP Action Grants. MVP Action Grants fund the implementation of priority climate change adaptation actions that have been described in the municipality's MVP plan. The City of Waltham received an MVP Planning Grant to simultaneously prepare an MVP plan and an HMP. Many of the required steps of the MVP process also satisfy requirements for updating an HMP. As a result, the City prepared this joint HMP-MVP Plan in accordance with FEMA guidelines for hazard mitigation planning (Title 44 Code of Regulations (CFR) 201.6) and with the Massachusetts Executive Office of Energy & Environmental Affairs' (EEA) requirements to follow the Community Resilience Building (CRB) Workshop Guidance, developed by The Nature Conservancy. This enabled Waltham to consider the impacts of climate change in its hazard mitigation planning, following the lead established by the Commonwealth when it adopted the first-ever Massachusetts State Hazard Mitigation and Climate Adaptation Plan (2018).

1.3 Previous Federal/State Disasters

To understand the importance of hazard mitigation, it is useful to know the types and frequencies of disasters that occur in Massachusetts. Since 1991, there have been 22 storms in Massachusetts that resulted in Federal or State Disaster Declarations. Sixteen of those disaster declarations occurred in Middlesex county, of which the City of Waltham is included. Many of these storms caused severe flooding. These disasters and the related assistance from FEMA are described in Table 1-1.

Table 1-1. Previous Federal/State Disaster Declarations

Disaster Name (Date of Event)	Disaster Number	Type of Assistance	Areas Under Declaration
Hurricane Bob August 19, 1991	DR-914	FEMA Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
Severe Coastal Storm October 30-November 2, 1991	DR-920	FEMA Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
Winter Coastal Storm December 11-13, 1992	DR-975	FEMA Hazard Mitigation Grant Program	Counties of Barnstable, Dukes, Essex, Plymouth, Suffolk
Blizzard January 7-13, 1996	DR-1090	No funding reported	All 14 Massachusetts Counties
Severe Storms/Flooding October 20-25, 1996	DR-1142	FEMA Hazard Mitigation Grant Program	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
Heavy Rain and Flooding June 13-July 6, 1998	DR-1224	FEMA Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
Severe Storms & Flooding March 5-April 16, 2001	DR-1364	FEMA Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
Flooding April 1-30, 2004	DR-1512	FEMA Individual & Households Program; FEMA Hazard Mitigation Grant Program	Essex, Middlesex, Norfolk, Suffolk, Worcester
Severe Storms and Flooding October 7-16, 2005	DR-1614	FEMA Public Assistance; FEMA Individual & Households Program; FEMA Hazard Mitigation Grant Program	All 14 Massachusetts Counties
Severe Storms and Flooding May 12-23, 2006	DR-1642	FEMA Public Assistance; FEMA Individual & Households Program; FEMA Hazard Mitigation Grant Program	Middlesex, Essex, Suffolk
Severe Storms and Inland and Coastal Flooding April 15-25, 2007	DR-1701	FEMA Public Assistance; FEMA	Berkshire, Franklin, Hampshire, Hampden, Essex, Plymouth, Barnstable, Dukes

Table 1-1. Previous Federal/State Disaster Declarations

Disaster Name (Date of Event)	Disaster Number	Type of Assistance	Areas Under Declaration
		Hazard Mitigation Grant Program	
Severe Winter Storm and Flooding December 11-18, 2008	DR-1813	FEMA Public Assistance; FEMA Hazard Mitigation Grant Program	All 14 Massachusetts Counties
Severe Storm and Flooding March 12-April 26, 2010	DR-1895	FEMA Public Assistance; FEMA Individual & Households Program; FEMA Hazard Mitigation Grant Program	Bristol, Essex, Middlesex, Suffolk, Norfolk, Plymouth, Worcester
Severe Winter Storm and Snowstorm January 11-12, 2011	DR-1959	FEMA Public Assistance; FEMA Hazard Mitigation Grant Program	Berkshire, Essex, Hampden, Hampshire, Middlesex, Norfolk, Suffolk
Severe Storms and Tornadoes June 1, 2011	DR-1994	FEMA Public Assistance; FEMA Individual & Households Program; FEMA Hazard Mitigation Grant Program	Hampden, Sturbridge, Southbridge, Worcester
Tropical Storm Irene August 27-29, 2011	DR-4028	FEMA Public Assistance; FEMA Individual & Households Program; FEMA Hazard Mitigation Grant Program	Barnstable, Berkshire, Bristol, Dukes, Franklin, Hampden, Hampshire, Norfolk, Plymouth
Severe Storm and Snowstorm October 29-30, 2011	DR-4051	FEMA Public Assistance; FEMA Public Assistance Snow Removal; FEMA Hazard Mitigation Grant Program	Berkshire, Franklin, Hampden, Hampshire, Middlesex, Worcester
Hurricane Sandy October 27-November 8, 2012	DR-4097	FEMA Public Assistance; FEMA Hazard Mitigation Grant Program	Barnstable, Bristol, Dukes, Nantucket, Plymouth, Suffolk

Table 1-1. Previous Federal/State Disaster Declarations

Disaster Name (Date of Event)	Disaster Number	Type of Assistance	Areas Under Declaration
Severe Winter Storm, Snowstorm, and Flooding February 8-9, 2013	DR-4110	FEMA Public Assistance; FEMA Hazard Mitigation Grant Program	All 14 Massachusetts Counties
Severe Winter Storm, Snowstorm, and Flooding January 26-28, 2015	DR-4214	FEMA Public Assistance; FEMA Hazard Mitigation Grant Program	Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, Worcester
Severe Winter Storm and Flooding March 2-3, 2018	DR-4372	FEMA Public Assistance; FEMA Hazard Mitigation Grant Program	Essex, Suffolk, Norfolk, Bristol, Plymouth, Barnstable, Nantucket
Severe Winter Storm and Snowstorm March 13-14, 2018	DR-4379	FEMA Public Assistance; FEMA Hazard Mitigation Grant Program	Essex, Middlesex, Norfolk, Suffolk, Worcester

Source: MEMA 2019; FEMA 2018b; EEA and EOPSS 2018, 6-24 and Appendix B

1.4 National Flood Insurance Program Community Rating

Waltham participates in the National Flood Insurance Program (NFIP) (FEMA, 2018f). The NFIP is a Federal program administered by FEMA enabling property owners in participating communities to purchase insurance as a protection against flood losses in exchange for State and community floodplain management regulations that reduce future flood damages. NFIP offers flood insurance to communities that comply with the minimum standards for floodplain management.

NFIP uses a Community Rating System (CRS) to award communities that go beyond the minimum standards with lower flood insurance premiums for property owners. The incentives are awarded upon a credit system for various activities. Points are awarded to communities that prepare, adopt, implement, and update a comprehensive flood hazard mitigation plan using a Standard planning process. Waltham is not currently eligible to participate in the Community Rating System (CRS) Program.

2.0 COMMUNITY PROFILE, LAND USE AND DEVELOPMENT TRENDS

2.1 Community Profile

Known as "The Watch City," Waltham is located in Middlesex County in Eastern Massachusetts. The City is bordered by Lexington to the north, Belmont and Watertown to the east, Lincoln and Weston to the west, and Newton to the south. Waltham is situated on the Charles River, 9 miles west of Boston and 33 miles east of Worcester. Waltham has a total area of 12.73 square miles (U.S. Census Bureau 2010).

Principal roadways that run through Waltham include State Route 128 (Interstate 95), State Route 20, State Route 117, and State Route 60. Waltham is also serviced by the MBTA Commuter Rail and MBTA bus service. Waltham is home to Bentley College and Brandeis University. Waltham was incorporated as a town in 1738 and incorporated as a City in 1884. It is governed by a mayor and a 15-member City Council elected every two years. For more information, please visit the City's website at www.city.waltham.ma.us.

The Charles River cuts a path through the southern section of Waltham and was used throughout history for transport, industry and as a water source. Today, the Charles River has been replaced by Route 128 as the main economic driving force within the City. Waltham has established itself as a strong presence in the office market for the Route 128 belt. The City is home to several corporate world headquarters of major corporations and the list continues to grow. Likely the most enticing zoning incentive afforded is the Research Laboratory use by right in the Limited Commercial Zoning District, which is designated as the area in and around Route 128. Waltham offers open space amenities with excellent views of Boston and Metro West, combined with easy access to all areas of New England. Because of those amenities, property investment is "white hot" in Waltham, only to be rivaled by Cambridge and Boston. Noteworthy recent tenants in Waltham include Boston Dynamics, ElevateBio, Zoom Info, and Cambridge Savings Bank. In this area, vacancy rates have decreased by more than 10% and the average rent has increased by more than $28 per square foot (Robert and Maloney, 2018).

Waltham has a diverse housing stock, with dense multi-family housing in the southern section of the City and larger lot single-family housing in the northern section. The City also boasts large park and open space amenities such as Prospect Hill Park and the Robert Treat Paine Estate. With an aggressive revitalization program, Waltham is witnessing the rebirth of its historic downtown and is providing better public access to its greatest natural resource, the Charles River.

There are about 54,865 jobs in Waltham (ACS 2013-2017). Waltham hosts a full array of business opportunities ranging from a developed City center to larger industrial and commercial businesses located along the Route 128 corridor. The City is home to about 6,221 businesses related to information technology, communications, education, consulting, manufacturing, and other industries (City of Waltham 2015, 13).

City of Waltham. Image credit: Waltham Local First.

According to the 2013-2017 American Community Survey (ACS), nearly 63,000 people live in Waltham (Table 2-1). The City has a fairly high percentage of residents that are over age 65 (13.2%). Of the City's 25,518 housing units, about one third were built before 1940.

Table 2-1. Waltham Demographics

Population = 62,832

- 5.0% are under age 5
- 14.0% are under age 18
- 13.2% are over age 65
- 9.7% have a disability
- 12.0% speak English "less than very well"
- 0.1% of households have no vehicle

Number of Housing Units = 25,518

- 93.0% of housing units are occupied
- 48.5% are renter-occupied housing units

Total Employment = 54,865

- 3.4% of residents are unemployed
- Waltham's largest employing industries (representing 27.4% of area jobs) include educational services, and health care and social assistance.

Sources: United States Census Bureau, 2013-2017 American Community Survey

There are a number of characteristics unique to Waltham that should be considered when planning for current and future hazards. One special consideration is the City's vulnerable populations, which include, but are not limited to:

- The daytime population. Waltham's population reportedly doubles during the day because Waltham is a center for employment. People are traveling to Waltham from other locations in the surrounding area to work there during the day.
- The undocumented population. The census does not reflect Waltham's undocumented population, which is considerable. Undocumented residents may have limited access to resources and emergency services before, during, and after an extreme event.
- The homeless population
- Hospitalized patients
- The student population, which includes students at Brandeis University and Bentley University

Similarly, Waltham's Environmental Justice (EJ) populations must be considered when planning for an extreme event. EJ populations constitute a considerable portion of Waltham's residents. Six census tracts have an income of 65% or below the statewide median income and the largest con-centration of foreign-born citizens lacking English language proficiency. The 2015 Waltham Open Space and Recreation Plan shows open spaces overlaid with EJ populations. As can be seen in Figure 2-1, minority and minority and income EJ populations are fairly equally distributed throughout the City. However, the area adjacent to the Charles River floodplain is almost entirely inhabited by EJ populations (minority and minority and income).

2.2 Existing Land Use

The most recent land use statistics available from the state are from aerial photography done in 2005. Change has certainly occurred in Waltham since then, but this data still provides the most detailed description of land use available. Table 2-2 shows the acreage and percentage of land use within 24 categories. Table 2-2 (Map 2 of the Hazard Maps) depicts the land use categories in Waltham. If the five residential categories are aggregated, residential uses make up 35.93% of the area of the City (3,164.6 acres). Commercial and industrial combined make up 15.51% of the City, or 1,366.2 acres. Recreation comprises another 2.12%, or 186.6 acres, and several categories of open space combined (forest, forested wetlands, wetlands, crop land, pasture urban public, urban open, open land, and water) make up 34.35% of the City, or 3,026 acres.

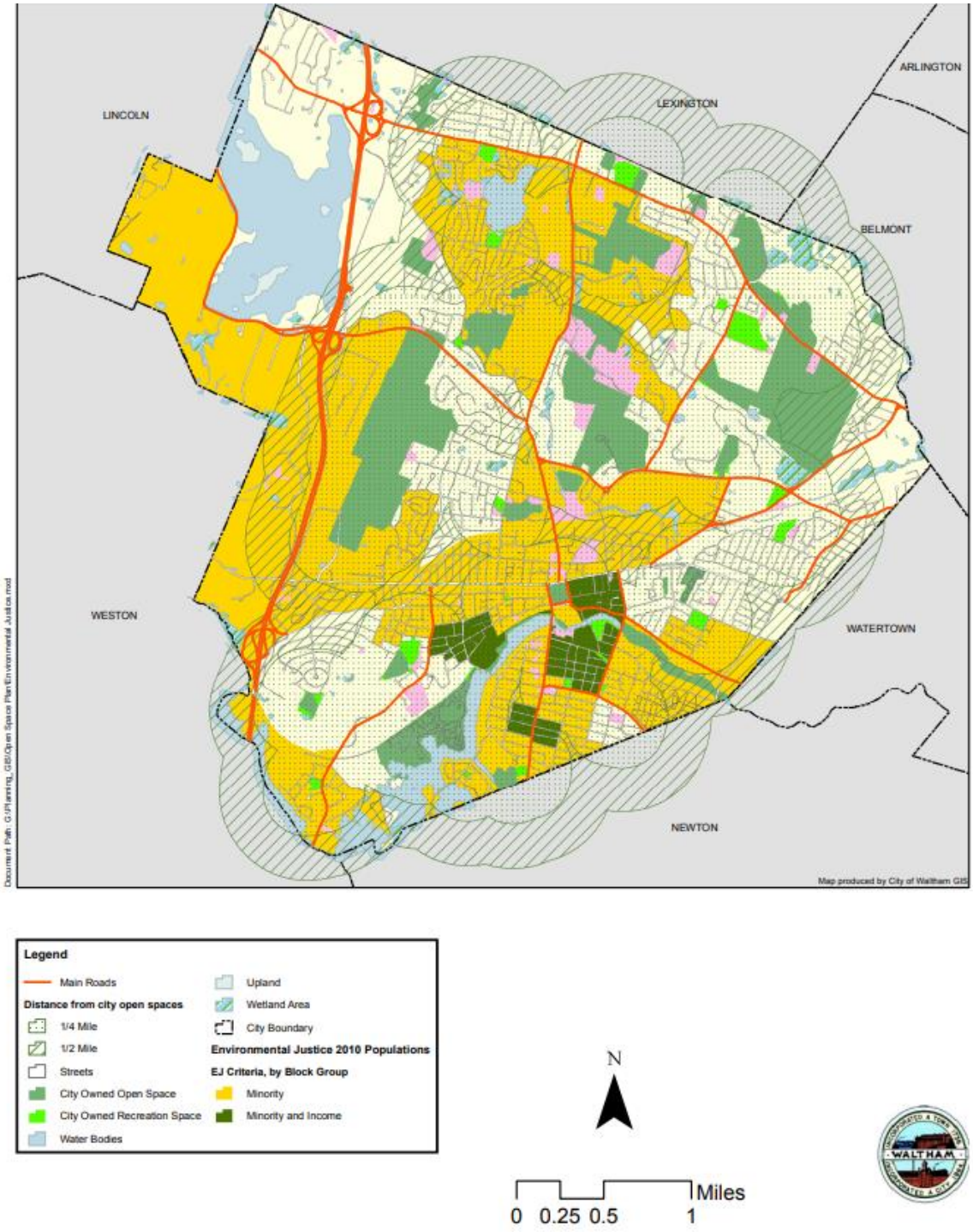

Figure 2-1. Environmental Justice Populations (2010, by block group, 2015 Open Space Plan)

Table 2-2. Land Use in Waltham and Amount of Land Use in Flood Hazard Areas

Land Use Category	Total Acres in City	% of Total Acreage	Acres not in Flood Zone	Acres in Zone A	Acres in Zone AE	Acres in Zone X	Total Acres in Hazard	% of Land Use Category in Hazard	% of City Area in Hazard
Cemetery	109.53	1.24	106.10	0.00	2.90	0.60	3.50	3.20%	0.04%
Commercial	805.41	9.14	762.10	3.72	29.36	10.24	43.31	5.38%	0.49%
Cropland	45.50	0.52	40.51	0.00	4.50	0.50	5.00	10.98%	0.06%
Forest	1924.63	21.85	1743.98	94.74	76.41	9.50	180.65	9.39%	2.05%
Forested Wetland	160.06	1.82	108.73	11.64	39.13	0.56	51.33	32.07%	0.58%
High Density Residential	1646.06	18.69	1594.02	1.55	40.80	9.69	52.04	3.16%	0.59%
Industrial	560.87	6.37	517.55	0.00	35.65	7.67	43.32	7.72%	0.49%
Junkyard	6.38	0.07	6.40	0.00	0.00	0.00	0.00	0.00%	0.00%
Low Density Residential	41.10	0.47	40.92	0.01	0.10	0.08	0.19	0.46%	0.00%
Medium Density Residential	544.42	6.18	537.25	0.59	5.38	1.19	7.17	1.32%	0.08%
Mining	9.57	0.11	9.57	0.00	0.00	0.00	0.00	0.00%	0.00%
Multi-Family Residential	921.23	10.46	896.87	0.00	20.70	3.67	24.37	2.64%	0.28%
Non-Forested Wetland	156.96	1.78	66.30	4.83	84.53	1.30	90.66	57.76%	1.03%
Open Land	20.56	0.23	20.31	0.04	0.18	0.03	0.25	1.23%	0.00%
Participation Recreation	184.99	2.10	148.46	0.02	31.56	4.95	36.54	19.75%	0.41%
Pasture	32.89	0.37	32.35	0.00	0.21	0.33	0.54	1.65%	0.01%
Powerline/Utility	28.75	0.33	28.73	0.02	0.00	0.00	0.02	0.09%	0.00%
Spectator Recreation	1.57	0.02	1.57	0.00	0.00	0.00	0.00	0.00%	0.00%
Transitional	8.79	0.10	8.79	0.00	0.00	0.00	0.00	0.00%	0.00%
Transportation	175.80	2.00	163.10	4.59	7.68	0.43	12.70	7.23%	0.14%
Urban Public/Institutional	730.13	8.29	723.34	0.00	2.62	4.17	6.78	0.93%	0.08%
Very Low Density Residential	13.26	0.15	13.25	0.00	0.00	0.00	0.00	0.04%	0.00%
Waste Disposal	4.18	0.05	4.14	0.00	0.04	0.00	0.04	0.89%	0.00%
Water	676.50	7.68	19.68	401.88	254.44	0.51	656.82	97.09%	7.46%
Totals	8809.15	100.00	7594.01	523.64	636.19	55.42	1215.24		13.80%

Land use in Waltham is controlled by the City's Zoning Ordinances. Open space and conservation areas are protected from development through *Conservation/Recreation* zoning. State buildings, cemeteries, large parks, and state lands are zoned *Conservation/Recreation*. *Conservation/Recreation* Zoning allows the following land uses: farms, semipublic outdoor recreation facilities, churches, educational uses, and commercial accessory uses, governmental, and active and passive recreation. The City Council of Waltham is in the process of updating its Zoning Ordinances and map to reflect changes in land use patterns. The Riverfront District of Waltham was re-designated in 1990 during a re-zoning process to promote a more condensed business zoning district and provide for mixed use (Open Space Plan).

More information on how the land use statistics were developed and the definitions of the categories can be found at: https://docs.digital.mass.gov/dataset/massgis-data-land-use-2005.

2.3 Economic Elements

Much of the City's economic activity is concentrated along Route 128. Waltham remains a strong force in the office/R&D lab market for the Route 128 Belt. Significant recent tenants in Waltham include Boston Dynamics, ElevateBio, Zoom Info, and Cambridge Savings Bank. In this area, direct vacancy has decreased by more than 10% and the average asking rate has increased by more than $28 per square foot (Robert and Maloney, 2018).

Waltham has a diverse housing stock, with dense multi-family housing in the southern neighborhoods of the City and larger lot single-family housing in the northern neighborhoods. The City also boasts large park and open space facilities such as Prospect Hill Park and Storer Conservation Lands. Waltham is witnessing the rebirth of its historic downtown and is providing better public access to its greatest natural resource, the Charles River.

The economy of Waltham MA employs 35,987 people. This employment is specialized in Professional, Scientific, and Tech Services; Educational Services; and Information, which employs respectively 1.85; 1.57; and 1.56 times more people than what would be expected in a location of this size. The largest industries in Waltham are Educational Services (5,284), Healthcare and Social Assistance (4,874), and Professional, Scientific, Tech Services (4,753) (US Census Bureau as reported on from https://datausa.io/profile/geo/waltham-ma/).

The median household income in Waltham was $82,188 in 2010. This represents a 20.1% increase from $68,392 in 2000, after being adjusted for inflation. Waltham's median household income is 10.8% above the state median income. About 9.8% of families were considered below the poverty line.

2.4 Natural, Cultural, and Historic Resource Areas

Waltham was first settled in 1643 as part of Watertown and was officially incorporated as its own town in 1738 and then as a City in 1884. Waltham is known as the "Watch City", because of its association with the watch industry in the 17th and 18th centuries. For the duration of its life until recently, the economic hub of Waltham was the Charles River. First known for its abundance of bass, salmon and herring making their way to and from the sea for spawning, the River then became associated with the textile mills, as well as an outlet for waste. More recently, the River has been rediscovered as a regional recreational asset. The quality has improved, as well as the diversity of aquatic life and recreational activities. The Department of Conservation and Recreation (DCR) is continuously making improvements

to the Charles River Reservation Land which has been a great asset to the residents and visitors in Waltham.

The Charles River Reservation Land spans across eight communities, including Boston. Waltham's own Open Space and Recreation Plan is closely linked with the surrounding towns, due to the regional system of open space and natural areas that they share. The City owns three parcels of land that are permanently designated as "open space" and are used only for passive recreation: Prospect Hill Park, Storer Conservation, and the Waltham Common.

2.5 Development Trends

Based on the Census data, the population of Waltham grew from 60,628 in 2010 to 62,442 in 2017. This is a 3 % increase (US Census. 2018). According to the Metropolitan Area Planning Council (MAPC), by 2040, Waltham's population is projected to be 67,298 (MAPC, 2019). A build-out analysis was conducted in 2000 by MAPC to forecast the potential impacts of future growth on developable land under current zoning conditions. Since most of Waltham is already developed, new growth was forecasted within five redevelopment areas. With the exception of two sites all of these sites have already been redeveloped. Table 2-3 identifies the most recent developments.

Table 2-3. Summary of Waltham Developments, 2015-2019

Name	Status	Year	Housing Units	Commercial Square Feet	Flood Zone
Currents on the Charles	Completed	2015	200	179,003	A, X
10/20 City Point 470-504	Completed	2016		450,000	No
Redevelopment of 130/180 Third Avenue	Completed	2016		399,000	No
The Merc at Moody and Main	Completed	2018	277	196,000	No
Polaroid Site Phase 1	Completed	2015		280,000	No
Polaroid Site Phase 2	Planning		350	1,825,000	No
20 Cooper Street (originally was built-out and is being reconstructed after fire)	Construction	2017	264		No
Boston Children's Hospital	Construction	2019			No
TOTAL			1,091	3,329,003	

Furthermore, Waltham's 2016 zoning map lists two areas for commercial redevelopment: Hope Avenue Redevelopment 1 and Hope Avenue Redevelopment 2 (Zoning District Map of Waltham, Massachusetts). It is assumed that these areas will undergo development in the future.

The zoning district map furthermore references two commercial overlay districts east of Interstate 95:

- Commercial Revitalization Area - formally called the Riverfront Overlay District Article VIII Section 8.4 on page Z 106; allowed by special permit only
- Limited Commercial Residential (LCR) Area Protection Overlay District - allowed by special permit only

The commercial overlay districts are guided by the intent to redevelop these areas in line with existing surrounding development. With respect to the LCR, development shall be compatible with the surrounding residential neighborhoods (Article VIII, page 406).

Furthermore, as mentioned above, a Riverfront Overlay District has been established. Several objectives have been set for the Riverfront Overlay District adjacent to the Charles River. Among these objectives is to provide for orderly redevelopment of the riverfront area, such as residential and mixed-use developments, including affordable low to moderate income units, along with the development of a continuous riverfront walkway (Waltham's Zoning Ordinance Article VIII – Incentive Zoning, Sec. 8.4)

It is assumed that new construction will adhere to higher regulatory standards than existing developments and will be built with modernized building codes; as such it is generally expected to be less vulnerable to natural hazards. However, natural hazards such as high precipitation or high wind events will become more frequent and/ or more severe due to changing climate conditions (compare risk assessment section). It is advisable, especially in the area adjacent to the Charles River floodplain, that new development be designed for an increased risk of riverine flooding through flood-proofing.

As a method to help quantify the potential of future development that could be exposed to natural hazards the number and location of vacant and potentially developable parcels can be assessed. In total there are only eight parcels in Waltham that fall into this category. For analysis purposes, it is assumed that all eight parcels could potentially be developed as they are zoned for certain types of uses. Table 2-4 identifies the number of these vacant and potentially developable land parcels that are located within the geographically-defined flood risk area, and if developed, potentially exposed to riverine flooding. As can be seen, four out of the eight vacant parcels are within identified hazard risk areas.

In order to characterize any change in the City's vulnerability associated with new developments, a GIS mapping analysis was conducted which overlaid the development sites with the FEMA Flood Insurance Rate Map. The analysis shows that none of the three potential developments are within a flood zone.

With respect to other hazard categories, there is no geographic variation across the City of Waltham. All developments are within the zone of low incidence for landslides and the zone of 48 to 72 inches average annual snowfall. The entire City is in the zone of 100-year wind maximum speed of 110 miles per hour. Overall, Waltham's potential new development does not significantly increase the City's vulnerability to natural hazards.

Table 2-4. Exposure of Vacant Parcels to Flooding

Natural Hazard Risk Areas	Vacant Parcels
Flood	Number Exposed
FEMA Zone A (A, AE, 1-percent-annual-chance of flooding)	2
FEMA Zone X (0.2-percent-annual-chance)	2

2.6 Potential Development

Weston & Sampson consulted with the Core Committee to determine areas that may be developed in the future, based on the City's comprehensive planning efforts and current trends and projects. The City

identified three potential new development sites, which are listed in Table 2-5 and shown on Map 8 in Appendix B.

In order to characterize any change in the City's vulnerability associated with new developments, a GIS mapping analysis was conducted. This analysis overlaid the development sites with the FEMA Flood Insurance Rate Map. The analysis shows that none of the three sites are located in flood zones.

With respect to landslide risk, all of the development sites are located in the area designated as "Low Incidence" for landslides. As mentioned above, other hazards such as wind speed and snowfall rates do not vary across the City. None of the potential development sites coincide with hazard areas identified by the Core Committee. (See hazard maps in Appendix B). Therefore, Waltham's potential future development would not increase the City's overall vulnerability.

Table 2-5. Relationship of Potential Development to Hazard Areas

Map ID	Potential Future Project	Flood Zones
A	Fernald State School	No
B	Hope Avenue Redevelopment 1	No
C	Hope Avenue Redevelopment 2	No

2.7 Critical Facilities & Infrastructure in Hazard Areas

Critical facilities and infrastructure are important for disaster response and evacuation (such as emergency operations centers, fire stations, water pump stations, etc.) and where additional assistance might be needed during an emergency (such as nursing homes, elderly housing, day care centers, etc.). There are 150 critical facilities and infrastructure sites identified in Waltham (Table 2-6).

Explanation of Columns in Table 2-6

- *Column 1: Name:* The second column is the name of the site. If no name appears in this column, this information was not available.
- *Column 2: Type*: The third column indicates what type of site it is.
- *Column 3: FEMA Flood Zone*: The fourth column addresses the risk of flooding. A "No" entry in this column means that the site is not within any of the mapped risk zones on the Flood Insurance Rate Maps (FIRM maps). If there is an entry in this column, it indicates the type of flood zone. as follows:
    - Zone AE (1% annual chance) - Zones AE is the flood insurance rate zone that correspond to the 100-year floodplains that are determined in the FIS by detailed methods. In most instances, BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.
    - Zone X: Areas of 0.2% annual chance of flood.
    - Floodway: The channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

Table 2-6. Critical Facilities

Name	Type	FEMA Flood Zone	Locally-Identified Flood Area
1. Waltham City Hall	City Hall	No	No
2. Arthur Clark Government Center	Municipal	No	No
3. Police Headquarters	Police Station	No	No
4. Fire Headquarters	Fire Station	No	No
5. Fire Station - Moody Street	Fire Station	No	No
6. Public Works	CPW	No	No
7. Emergency Management	EOC	No	No
8. US Post Office	Post Office	No	No
9. US Postal Service Distribution Facility	Post Office	No	No
10. US Post Office	Post Office	No	No
11. US Post Office	Post Office	No	No
12. Fernald School	Hospital	No	No
13. Mass General Hospital	Medical	No	No
14. Leland Home	Nursing Home	No	No
15. Marist Hill Nursing and Rehabilitation	Nursing Home	No	No
16. Meadow Green Nursing Home	Nursing Home	No	No
17. Piety Corner Nursing Home	Nursing Home	No	No
18. Waltham Crossing	Nursing Home	No	No
19. Pine Street Elderly Housing	Elderly Housing	No	No
20. Winchester Crane Housing	Elderly Housing	No	No
21. Beaverbrook Apartments	Elderly Housing	X500	No
22. Francis Cabot Lowell Mill Housing	Elderly Housing	No	No
23. Dale Street Housing	Elderly Housing	X500	No
24. School Street	Elderly Housing	No	No
25. Whalen Apartments	Elderly Housing	No	No
26. Charles Lawless Apartments	Elderly Housing	No	No
27. Lower Pond Street	Elderly Housing	No	No
28. Carey Court	Elderly Housing	No	No
29. Myrtle Street	Elderly Housing	No	No
30. South Street Congregate Elderly	Elderly Housing	No	No
31. Cedar Street	Elderly Housing	No	No
32. Saint Mary Apartments	Elderly Housing	No	No
33. Dorothy Francis Home, Inc.	Elderly Housing	AE	No
34. South Street Group Home	Elderly Housing	No	No
35. Chesterbrook Family Housing	Family Housing	No	No

Table 2-6. Critical Facilities

Name	Type	FEMA Flood Zone	Locally-Identified Flood Area
36. Cambridge Reservoir - Stony Brook Basin	Reservoir	No	No
37. Cambridge Reservoir - Hobbs Brook Basin	Reservoir	A	No
38. Banks Elementary School - closed	School	No	No
39. Bright Elementary School - closed	School	No	No
40. Fitch School – closed	School	No	No
41. Fitzgerald Elementary	School	No	No
42. South Middle – closed	School	No	No
43. MacArthur Elementary School	School	No	No
44. Gann Academy/New Jewish High School	School	No	No
45. Northeast Elementary	School	No	No
46. Our Lady's School	School	No	Bow Pond
47. Stanley School	School	No	No
48. McDevitt Middle School	School	No	No
49. St. Jude's School	School	No	No
50. Waltham High School	School	No	No
51. Whittemore Elementary	School	No	No
52. Arthur Clark Workshop	School	No	No
53. Bentley College	School	No	No
54. Brandeis University	School	No	No
55. Waltham Head Start/Waltham Community	School	No	No
56. Chapel Hill - Chauncy Hall	School	No	No
57. Bartlett School	School	No	No
58. AstraZeneca R&D	Hazardous Materials	No	No
59. Genzyme Corporation	Hazardous Materials	No	No
60. Paraxel	Hazardous Materials	No	No
61. Genome Therapeutics Corporation	Hazardous Materials	No	No
62. Confluent Surgical Inc.	Hazardous Materials	No	No
63. GMP Genetics, Inc.	Hazardous Materials	X500	No

Table 2-6. Critical Facilities

Name	Type	FEMA Flood Zone	Locally-Identified Flood Area
64. GPC Biotech	Hazardous Materials	No	No
65. Interleukin Genetics, Inc.	Hazardous Materials	No	No
66. Beyond Genomics	Hazardous Materials	No	No
67. Praecis	Hazardous Materials	No	No
68. Compound Therapeutics	Hazardous Materials	No	No
69. Synthonix Pharm	Hazardous Materials	No	No
70. Repligen	Hazardous Materials	No	No
71. Altana	Hazardous Materials	No	No
72. Acton Metal Processing Corp,	Hazardous Materials	No	No
73. Light Metal Platers	Hazardous Materials	No	No
74. Plating for Electronics	Hazardous Materials	No	No
75. Verizon Waltham Switching Station	Hazardous Materials	No	No
76. Verizon Waltham Offices	Hazardous Materials	No	No
77. Verizon Wireless Waltham	Hazardous Materials	No	No
78. Eversource (Station 282)	Hazardous Materials	No	No
79. Eversource (Station 33)	Hazardous Materials	No	No
80. Eversource (Waltham Service Center)	Hazardous Materials	No	No
81. Verizon/Waltham Microwave Room	Hazardous Materials	No	No
82. National Tire & Battery	Hazardous Materials	No	No
83. Coca-Cola Bottling Company of NE	Hazardous Materials	No	No
84. SBC Telecom	Hazardous Materials	No	No

Table 2-6. Critical Facilities

Name	Type	FEMA Flood Zone	Locally-Identified Flood Area
85. Costco	Groceries/Supplies	No	No
86. Engine 8 Station	Fire Department	No	No
87. Engine 4 Station	Fire Department	No	No
88. Engine 3 Station	Fire Department	No	No
89. The Carousel School, Inc.	Day Care	No	North of Trapelo Road
90. Children's Place at Prospect Hill	Day Care	No	No
91. Waltham Child Care Center	Day Care	No	No
92. Waltham Day Care Center	Day Care	No	No
93. Waltham Family YMCA Child Care	Day Care	No	No
94. Waltham Fire Department	Fire Station	No	No
95. Waltham City Hall	City Hall	No	No
96. Children's Hospital at Waltham	Hospital	No	No
97. E911 Dispatch Center	Primary Dispatch	No	No
98. Dr. Merola	Medical	No	No
99. Prospect Children's Center	Day Care	No	No
100. Radio Tower	Radio Tower	No	No
101. Telecommunications	Telephone	No	No
102. Telephone Tower	Communication	No	No
103. Communication Tower	Communication	No	No
104. Communication Tower	Communication	No	No
105. Communication	Communication	No	No
106. Communication	Radio Tower	No	No
107. Radio Tower	Communication	No	No
108. Communication	Communication	No	No
109. Communication	Communication	No	No
110. Bridge Over Highway - Trapelo Road	Bridge	No	No
111. Bridge Over Highway - Winter Street	Bridge	No	No
112. Bridge Over Stream	Bridge	No	No
113. Bridge Over Lyman Pond	Bridge	X500	No
114. Rail Bridge over Lyman Pond (abandoned)	Bridge	AE	Linden Street (Route 60)
115. Main Street Bridge - Railroad Tracks	Bridge	X500	No
116. Main Street Bridge -	Bridge	No	No

Table 2-6. Critical Facilities

Name	Type	FEMA Flood Zone	Locally-Identified Flood Area
Rt 95			
117. Newton Street Bridge - Railroad Tracks	Bridge	No	No
118. Jackson Street Bridge - Railroad Tracks	Bridge	No	No
119. Moody Street Bridge - Charles River	Bridge	AE	No
120. Elm Street Bridge - Charles River	Bridge	AE	No
121. Elm Street Rail Bridge - Charles River	Bridge	AE	No
122. Newton Street Bridge - Charles River	Bridge	AE	No
123. Foot Bridge - Charles River	Bridge	AE	No
124. Bridge over Rt 95 - Off Ramp	Bridge	No	No
125. Bridge over Rt 95 - On Ramp	Bridge	No	No
126. Charles River Rail Bridge	Bridge	AE	No
127. Charles River Foot Bridge	Bridge	AE	No
128. Prospect Bridge - Railroad Tracks	Bridge	No	No
129. Prospect Bridge - Charles River	Bridge	AE	No
130. Bridge over Railroad Tracks - Rt 95	Bridge	No	No
131. Bridge over Charles R	Bridge	No	No
132. Dam - Charles River	Dam	AE	No
133. Dam - Charles River	Dam	AE	No
134. Sewer Pump Station	Pumping Station - Sewer	No	No
135. Sewer Pump Station - Bear Hill Valley	Pumping Station - Sewer	A	No
136. Sewer Pump Station - Bear Hill Valley	Pumping Station - Sewer	No	No
137. Sewer Pump Station - Bear Hill Valley	Pumping Station - Sewer	No	No
138. Sewer Pump Station - Spencer Street	Pumping Station - Sewer	No	No
139. Sewer Pump Station - Edgewater Drive	Pumping Station - Sewer	AE	No
140. Sewer Pump Station - Woerd Avenue	Pumping Station - Sewer	AE	West of Moody Street
141. Water Pump Station – Cedarwood	Pumping Station - Water	No	No
142. Stand Pipe	Standpipe	No	No
143. Prospect Hill Water Tanks	Water Tanks	No	No

Table 2-6. Critical Facilities

Name	Type	FEMA Flood Zone	Locally-Identified Flood Area
144. Water Pump Station – Cedarwood	Pumping Station - Water	No	No
145. Water Pump Station – MWRA	Pumping Station - Water	No	No
146. Municipal Building - Wires Department	Municipal Building	No	No
147. William F. Stanley Senior Center	Municipal Building	No	No
148. Cabot Lowell Mill Housing	Elderly Housing	No	No
149. Power Substation – Eversource	Sub	No	No
150. Algonquin Gas - Relay Building	Gas	No	No

3.0 PLANNING PROCESS & PUBLIC PARTICIPATION

This section presents the process that the City undertook to develop the HMP-MVP for both hazard mitigation and climate resiliency, and how stakeholders and members of the general public were engaged throughout the process.

3.1 Planning Process Summary

To prepare for the development of this MVP-HMP Plan, the City of Waltham followed the process described in the Community Resilience Building Workshop Guidebook, which was developed by The Nature Conservancy (TNC, 2019). The Guidebook provides a clear approach on how to organize the public process for mitigating the impacts of, and increasing resilience against, natural hazards and climate change. An important aspect of the natural hazard and climate change impact mitigation planning process is the discussion it promotes among community members about creating a safer, more resilient community. Developing a plan that reflects the City of Waltham's values and priorities is likely to produce greater community support and result in greater success in implementing mitigation strategies that reduce risk.

Community Resilience Building Workshop Guidebook

The Community Resilience Building Workshop Guidebook provides a process for developing resilience action plans. The process has been implemented and successful in over one-hundred communities. The process, outlined below, is rich in information and dialogue and results in actionable plans and strong collaboration.

The Community Resilience Building Workshop Guidebook's central objectives are to:

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

Federal regulation for HMP approval requires that stakeholders and the general public are provided opportunities to be involved during the planning process and in the plan's maintenance and implementation. Community members can therefore provide input that can affect the content and outcomes of the mitigation plan. The planning and outreach strategy used to develop this MVP-HMP Plan had three tiers: 1) the Core Committee, with representation from municipal leadership at the City of Waltham, 2) stakeholders who could be vulnerable to, or provide strength against, natural hazards and/or climate change, and 3) the public, who live and work in the City.

3.2 The Local Multiple Hazard Planning / Municipal Vulnerability Preparedness Core Committee

The City of Waltham, with support from the Planning Department and leadership from the Mayor's Office, convened the Core Committee to act as a steering committee for the development of the HMP-MVP

Plan. The Core Committee met on January 31, 2019, February 20, 2019; March 27, 2019, and April 17, 2019 to plan for the Workshop, review public comments, develop the mitigation plan, and transition to implementation of the plan's mitigation strategies. More information on these meetings is included in Appendix A.

The Core Committee established goals for the plan, provided information on hazards affecting the City, identified critical infrastructure, identified key stakeholders, reviewed the status of existing mitigation measures, and developed proposed mitigation measures for this plan. Members of the Core Committee are listed in Table 3-1.

Table 3-1. Waltham's Core Committee

Catherine Cagle, Project Manager	Planning Department
Steve Casazza	Engineering
Michael Chiasson	Public Works
J. Michael Garvin	Traffic Engineering
Deputy Chief Richard Grant	Fire Department
Tim Kelly	Wires Department
Deputy Chief Andrew Mullin	Fire Department
Lieutenant James Perry	Fire Department
Captain Jeff Rodley	Police Department
Lieutenant Tim Maher	Police Department

The Core Committee developed the invitation list for the Community Resilience Building Workshop at which key stakeholders were invited to help the City identify hazards, vulnerabilities, strengths, and proposed actions to mitigate the impacts of natural hazards and climate change. The Core Committee sought to include municipal leaders as well as politicians, representatives from local nonprofit organizations, local universities, other local jurisdictions, regional organizations, and state government. The Core Committee also suggested or made available reports, maps, and other pertinent information related to natural hazards and climate change impacts in Waltham. These included:

- 2015-2022 Open Space & Recreation Plan (Waltham, 2015)
- Waltham Transportation Master Plan (McMahon, 2017)
- City of Waltham Hazard Mitigation Plan, October 7, 2013, Revised Draft (MAPC, 2013)
- City of Waltham, Zoning Ordinance
- City of Waltham, Stormwater Ordinance
- Massachusetts Climate Change Projections (NECSC, 2018)
- Massachusetts Climate Change Adaptation Report (EEA, 2011)
- Massachusetts State Hazard Mitigation and Climate Change Adaptation (EEA and EOPSS 2018)
- Local Mitigation Plan Review Guide, October 2011 (FEMA, 2011)
- Flood Insurance Rate Maps for Middlesex County, MA, (FEMA, 2010)
- National Center for Environmental Information (NOAA)
- National Water Information System (USGS)
- US Census, 2010 and American Community Survey, 2017

3.3 Stakeholder Involvement: Community Resilience Building Workshop

Stakeholders with subject matter expertise and local knowledge and experience, including public officials, regional organizations, neighboring communities, environmental organizations, and local institutions, were invited to engage in a two-part Community Resilience Building Workshop, held on February 14, 2019. During the first part of the Workshop, Weston & Sampson provided information about natural hazards and climate change and participants identified top hazards; infrastructural, societal and environmental features in the City that are vulnerable to or provide strength against these challenges. During the second part of the Workshop, participants identified and prioritized key actions that would improve the City's resiliency to natural and climate-related hazards. Community representatives who were invited via email by Catherine Cagle, Director of Planning, and those who participated in the process are presented in Table 3-2. Materials from the Workshop are included in Appendix C.

The Building Department is the primary city department responsible for regulating development in the City. Staff members of the Building Department and the Planning Department – along with many other municipal officials - provided input into the plan as participants in the Community Resilience Building Workshop on February 14, 2019. The Metropolitan Area Planning Council, the state-designated regional planning authority for Waltham, participated in the Workshop as did local universities, a museum, and a land trust. Representatives from the Massachusetts Emergency Management Agency, the Massachusetts Department of Conservation and Recreation, the Charles River Watershed Association, and the Massachusetts Water Resources Authority provided their regional perspectives at the Community Resilience Building Workshop. With water supply sources in Waltham, the City of Cambridge Water Department also actively engaged in the Workshop. Leadership from neighboring communities of Belmont, Lexington, Lincoln, Newton, Watertown, and Weston were invited to participate in the Workshop but were unable to attend. Table 3-2 notes the names and positions of those stakeholders who were invited to and those who attended the Workshop. This broad representation of local and regional entities ensures the HMP-MVP Plan aligns with the operational policies and any hazard mitigation strategies at different levels of government and implementation.

Table 3-2. Stakeholders Invited to Attend Waltham's Community Resilience Building Workshop

Attend?	Name	Title	Affiliation
√	Jeannette A. McCarthy	Mayor	Mayor's Office, City of Waltham
√	Stephen A. Casazza, P.E.	City Engineer	Engineering, City of Waltham
√	Michael Chiasson	Director of Public Works	Department of Public Works, City of Waltham
√	Mike Garvin	Traffic Engineer	Traffic Engineering, City of Waltham
√	Michael Delfino	Senior Public Health Inspector	Local Emergency Planning Committee, City of Waltham
	Michelle Feeley	Acting Director of Public Health	Board of Health, City of Waltham
√	Jeff Rodley for Chief Keith MacPherson	Captain	Police Department, City of Waltham
√	Tim Maher for Chief Keith MacPherson	Lieutenant	Police Department, City of Waltham
	Thomas MacInnis	Fire Chief	Fire Department, City of Waltham
√	Catherine Cagle	Planning Director	Planning Office, City of Waltham
√	Jimmy LaCrosse	Planner	Planning Office, City of Waltham

Table 3-2. Stakeholders Invited to Attend Waltham's Community Resilience Building Workshop

Attend?	Name	Title	Affiliation
√	Joe Pedulla	CPO	Purchasing, City of Waltham
√	Louie DiDino	Electrician	Wires Department, City of Waltham
	Dr. Drew M. Echelson Ed.D.	Superintendent of Schools	Public Schools, City of Waltham
	John Peacock	Executive Director	Chamber of Commerce
	Doug Waybright	DWP Board	Downtown Waltham Partnership
√	Martin Pillsbury	Environmental Planning Director	Metropolitan Area Planning Council
√	Nishaila Porter for Emily Norton	Program Associate	Charles River Watershed Association
	Katherine M. Clark	Congresswoman	Commonwealth of Massachusetts
	Thomas M. Stanley	State Representative	Commonwealth of Massachusetts
	Michael J. Barrett	State Senator	Commonwealth of Massachusetts
√	William L. Forte	Inspector of Building/Superintendent of Public Buildings	Building Department
	Diane LeBlanc	Council President	City Council
	Robert Logan	Council Vice President	City Council
	Paul Brasco	Councilor at Large	City Council
	Kathleen McMenimen	Councilor at Large	City Council
	Thomas M. Stanley	Councilor at Large	City Council
	Randall LeBlanc	Councilor at Large	City Council
	Carlos Vidal	Councilor at Large	City Council
	Dan Romard	Ward One Councilor	City Council
	Bill Fowler	Ward Two Councilor	City Council
	George Darcy	Ward Three Alderman	City Council
	John McLaughlin	Ward Four Alderman	City Council
	Joseph P. LaCava	Ward Five Alderman	City Council
	Sharline Nabulime	Ward Six Alderman	City Council
	Kristine A. Mackin	Ward Seven Alderman	City Council
	Cathyann Harris	Ward Eight Alderman	City Council
	Robert Logan	Ward Nine Alderman	City Council
	Paul Biddinger, MD, FACEP	Program Director, CDM	Mass General Hospital Center for Disaster Medicine
	Kathy Beans	Program Coordinator	Newton-Wellesley Hospital Wellness Center
	Lauren Lele	Director, Community Benefits	Newton-Wellesley Hospital
	Alan Peterson	Program Lead, Targeted Brownfields Assessment	U.S. Environmental Protection Agency

Table 3-2. Stakeholders Invited to Attend Waltham's Community Resilience Building Workshop

Attend?	Name	Title	Affiliation
	Katelyn Rainville	Representative	Army Corps of Engineers
	Wayne Lozzi	Environmental Analyst	MA Department of Environmental Protection
	Eric Worrall	Northeast Regional Director	MA Department of Environmental Protection
	Customer Support Representative	Customer Support	MBTA
	Commuter Services Representative	Commuter Services	Keolis
	Priscilla Geigis	Deputy Commissioner for Conservation and Resource Stewardship	MA Department of Conservation and Recreation
	Bill Gode	Director Flood Control Management	MA Department of Conservation and Recreation
	Monica G. Tibbits-Nutt	Executive Director	128 Business Council
√	Sonja Wadman	Executive Director	Waltham Land Trust
√	Robert A. Perry	Executive Director	Charles River Museum of Innovation and Industry
√	Natalie Hayes	Asst. Executive Director of Sustainability	Bentley University
√	Mary Fischer	Manager, Sustainability Programs	Brandeis University Sustainability Department
	Bernard E. Mullin, Jr.	Director of Emergency Management	City of Waltham
√	James Perry	Local Emergency Planning Committee	City of Waltham
	Randy Mullin	Deputy Fire Chief /Local Emergency Planning Committee	Fire Department. City of Waltham
	Paul G. Centofanti	City Auditor	City of Waltham
√	Bill Doyle	Waltham Conservation Commission	City of Waltham
	Marybeth Duffy	Director	Waltham Council on Aging
	Robert J. Waters, Jr.	Housing Supervisor	Waltham Housing Divisions
√	Sarah White	Hazard Mitigation Unit Supervisor	Massachusetts Emergency Management Agency
√	Ed Dowling	Laboratory Manager	Cambridge Water Department
√	David Kaplan	Watershed Manager	Cambridge Water Department

Table 3-2. Stakeholders Invited to Attend Waltham's Community Resilience Building Workshop

Attend?	Name	Title	Affiliation
	Jim Cuddy	Executive Director	Massachusetts Association for Community Action/South Middlesex Opportunity Council
	Lt. Tony Dean	Lieutenant	State Police, Brighton Barracks
√	Hillary Monahan for Stephen Estes-Smargiassi	Senior Projects Coordinator	MA Water Resources Authority
	Patrice Garvin	Town Administrator	Town of Belmont
	Michael J. Driscoll	Town Manager	Town of Watertown
	James J. Malloy	Town Manager	Town of Lexington
	Ruthanne Fuller	Mayor	City of Newton
	Timothy S. Higgins	Town Administrator	Town of Lincoln
	Leon A. Gaumond, Jr.	Town Manager	Town of Weston
√	Lindsey Adams	Environmental Scientist	Weston & Sampson
√	Kathleen Baskin	Senior Project Manager	Weston & Sampson
√	Adria Boynton	Resilience Specialist	Weston & Sampson
√	Deanna Lambert	Engineer	Weston & Sampson
√	Steven Roy	Senior Technical Leader	Weston & Sampson
√	Sam Bade	President	SSV Engineering

√ indicates invitee also attended the Workshop

Discussions of Natural Hazards and Climate Change Impacts

There was extensive discussion about riverine and stormwater flooding during the portion of the workshop that introduced known and potential natural hazards and climate change impacts that currently occur or are predicted to occur in Waltham. Workshop participants expressed concern that poorly designed stormwater management systems can deplete groundwater supplies, drain resource areas and cause localized flooding. Attendees felt that the National Flood Insurance Program's (NFIP) data on Repetitive Loss Properties underrepresent flood damage that occurs in Waltham because the numbers only include properties that qualify for that designation. Attendees indicated that the data shows only a fraction of the losses that they experienced during a 2013 storm.

Regarding impervious surfaces, there was concern that Waltham does not have enough space for retention. There was interest in using existing open space or leaving parcels vacant when buildings are torn down, to serve as areas to increase infiltration, thus reducing risk to public health and safety. There was concern expressed that changing precipitation patterns have increased the 24-hour, 100-year precipitation event. Participants discussed what standards should apply to Waltham so that areas do not flood during large precipitation events and do not drain too quickly during drought. Participants noted that wetlands upstream of Waltham were preserved by the U.S. Army Corps of Engineers' Natural Valley Storage Area Project in the 1960s; this helps Waltham minimize some flooding. Also, flood mitigation is already addressed in Waltham's zoning code.

Identification of Top Hazards

Workshop participants were asked to identify the four top hazards/climate change impacts that Waltham faces. They were: 1) flooding, 2) high winds, 3) winter storms, and 4) extreme temperatures (both heat and cold). There was extensive discussion that lead to the selection of these top hazards.

Discussion of Existing Infrastructure

Workshop participants identified those key infrastructure features in Waltham that are most vulnerable to, or provide protection against, natural hazards and climate change impacts (Table 3-3).

Table 3-3. Infrastructure Features and Natural Hazards/Climate Change in Waltham

Vulnerabilities	Strengths
• Storm drain system • Culverts • Power Grid • Electrical/wires • Transportation • Buildings • Bridges • Moody Street Dam • Water supply • Wastewater services • Communication network • Hospitals	• Fire • Police • City Hall and Government Center • MWRA (water supply, wastewater services) • Communication network • Hospitals • Stormwater Management • Transportation

Discussion of Society and Vulnerable Populations

Workshop participants identified those key societal aspects of Waltham that are most vulnerable to, or provide protection against, natural hazards and climate change impacts (Table 3-4).

Table 3-4. Societal Features and Natural Hazards/Climate Change in Waltham

Vulnerabilities	Strengths
• Elderly/infirmed • Language barriers • Homeless population • Schools/universities & students • Undocumented population • Non-profits providing assistance • Working population	• Schools/universities • Non-profits providing assistance • Halfway houses • Warming centers

Discussion of the Environment

Workshop participants identified those key environmental features in Waltham that are most vulnerable to, or provide protection against, natural hazards and climate change impacts (Table 3-5).

Table 3-5. Environmental Features and Natural Hazards/Climate Change in Waltham

Vulnerabilities	Strengths
• Wetlands/Watersheds • Charles River & Hardy Pond • Open space/Trees • Cambridge Reservoir • Invasive species • Vector-borne diseases • Air quality	• Wetlands • Open space • Fernald • Cambridge Reservoir

Identification of Hazard/Climate Change Mitigation Strategies

Workshop participants focused considerable time and attention to identifying priority actions for addressing natural hazard and climate change impacts. The priority actions were then ranked in the order below. The input from the workshops was integrated throughout the HMP-MVP plan, which is described in Section 3.6 and Table 3-6.

High Priority Actions

- Reduce the impact of riverine and stormwater flooding in roads, floodplains, and adjacent properties.
    - Assess and inventory stream crossings such as culverts and bridges; prioritize/rank these assets based on vulnerability.
    - Replace culverts and storm drainage causing flood hazards and make roadway improvements such as elevating roads, if needed.
    - Upgrade infrastructure to handle flooding, maintain drains, and create upstream storage to reduce flooding in areas such as but not limited to: Linden Street, Second Ave at Winter Street, and the Lanes. Invest in low impact development to reduce flooding.
    - Work locally, and in cooperation with, surrounding communities such as Newton, Lexington, and Belmont to reduce flooding through watershed management, stormwater management, flood mitigation, and roadway improvements in the Charles River and Hardy Pond watersheds and on shared roadways such as Lexington Street and Route 60.
- Restore wetlands and floodplains for flood mitigation and flood storage. As an example, restoring wetlands and floodplains at the Fernald property would reduce flooding risk downstream of Beaver Brook. Wetlands can provide flood protection for culverts.
- Collaborate between City departments and private entities to plan stormwater improvements. Improve development and management strategies to reduce impervious surfaces. Consider ways to encourage installation of green infrastructure to reduce stormwater runoff.

Medium Priority Actions

- Conduct proactive tree pruning to prevent downed lines.
- Consider development of innovative best practices, policies, and ordinances for stormwater management in combination with education and outreach to the community.
- Create or rehabilitate parks and open space, including through conservation restrictions. Create new or rehabilitated parks for cooling and to treat stormwater and integrate more trees into the landscape to help prevent heat island effect.
- Continue offering extreme weather-related centers to protect vulnerable populations.

Additional Priority Actions

- Inventory existing City policies, regulations, and zoning that promote stormwater management, Low Impact Development, green infrastructure and other resilience measures, such as structure elevation and general access improvements to reduce flooding to infrastructure and to residential, commercial and industrial properties.
- Educate and raise awareness about the benefits of green infrastructure. Promote its adoption and look for opportunities to implement best practices from other communities in the area.
- Continue coordinated planning and communication between citizens, business, and government, including through the Local Emergency Planning Committees (LEPC).
- Support and seek opportunities to enhance access and collaboration between universities and the City to help during emergencies. In-house and community coordination should be improved. Emergency management planning should be conducted. Communication through social media should be considered.

3.4 Public Involvement: Listening Sessions

To gather information from the general public and to educate the public on hazard mitigation and climate change, the City hosted two public listening sessions. The Community Resilience Building Workshop process and findings were presented at a listening session open to the general public on February 27, 2019 at Waltham Government Center followed by a public comment period from February 27 to March 8, 2019. The City received no public comments subsequent to the meeting. A second public listening session was held on March 14, 2019, where the draft HMP-MVP Plan was presented. The draft Plan was posted on the City's website and public comments were received between March 14 and March 25, 2019. Both meetings were publicized in accordance with the Massachusetts Public Meeting Law (see public meeting notices in Appendix C) and the second meeting was broadcast on Waltham Local Access Cable Television. More information about the meetings and public comments are available in Appendix 2.

3.5 Continuing Public Participation

Following FEMA approval of the HMP-MVP Plan, the Core Committee, originally convened as the steering committee for establishing the Plan, will transition their work to updating and keeping the Plan current. The Core Committee membership will initially be the same as when they worked on developing the Plan, but members may be added as needed. This ongoing review and evaluation will be accomplished by monitoring implementation, evaluating effectiveness of mitigation strategies, and updating the plan as needed. The Core Committee will provide residents, businesses, and other stakeholders the opportunity to learn about natural hazard mitigation and climate change resilience planning and inform the City's understanding of local hazards. All updates and reviews of the Plan made by the Core Committee will be placed on the City's web site and meetings will be publicly noticed in accordance with city and state open meeting laws. The list of Core Committee membership is presented in Table 3-1.

3.6 Stakeholder Priority Items Cross-Reference

Section 3 of this document describes items that the Core Committee and stakeholders have identified as a priority actions in their community. The rest of the document dives deeper into these priority items and presents mitigation measures developed for these items. Section 6 describes ongoing, existing mitigation measures that the City developed and implemented. There was a draft Hazard Mitigation

Report developed in 2013 which, although it was never submitted and formally adopted by the town, included future mitigation measures. Section 7 includes the mitigation measures that were developed for the 2013 Plan, and then it identifies whether those measures are still relevant and if they will be carried over to the 2019 Hazard Mitigation Plan. Section 8 covers the Hazard Mitigation Goals that the City of Waltham has recommended for the future. Table 3-6 below summarizes how the priority items that were identified by the Core Committee and stakeholder group were integrated into these three sections.

Table 3-6. Waltham Stakeholder Priority Actions and Section Cross-References

Priority Items Identified in Section 3	Section 6 – Existing Mitigation Measures	Section 7 – Status of Existing Measures from 2013 Draft	Section 8 – Hazard Mitigation Strategies
HIGH PRIORITY ACTIONS			
Assess and inventory stream crossings			-Stormwater master plan update/maintenance plan -Assessment/prioritization of critical infrastructure (bridges & culverts)
Replace culverts, storm drainage and make roadway improvements	On-going drainage improvement program	Continuation of replacement of drainage pipes and outdated infrastructure	-Trapelo Rd culvert -Linden St drainage improvements -Beaver Brook cleaning -Fernald stormwater detention -Continued replacement of existing drainage pipes/infrastructure -Detention basins at Prospect Hill
Upgrade infrastructure to handle flooding, maintain drains and create upstream storage		Continuation of replacement of drainage pipes and outdated infrastructure	-Trapelo Rd culvert -Linden St drainage improvements -Beaver Brook cleaning -Fernald stormwater detention -Continued replacement of existing drainage pipes/infrastructure -Detention basins at Prospect Hill
Work locally/cooperate with other communities			Coordination of review of developments on a regional basis for stormwater/Trapelo Rd.
Restore wetlands and floodplains			Fernald Center
Collaborate city departments for stormwater improvements	-Collaboration of City departments review development plans -Review/inspection of new developments		

Table 3-6. Waltham Stakeholder Priority Actions and Section Cross-References

Priority Items Identified in Section 3	Section 6 – Existing Mitigation Measures	Section 7 – Status of Existing Measures from 2013 Draft	Section 8 – Hazard Mitigation Strategies
MEDIUM PRIORITY ACTIONS			
Proactive tree pruning	Tree maintenance by NG and Eversource Energy		Tree trimming and maintenance
Innovative best practices for stormwater/education/outreach	-Floodplain overlay district -Massachusetts Stormwater Regulations -Wetlands Protection Act -Stormwater management ordinance		Update City stormwater ordinance
Parks/OS for stormwater, cooling and offset heat island effect	Open Space and Recreation Plan	Continuation of OS protection and land acquisition	Continuation of Open Space protection and land acquisition
Extreme weather-related centers for vulnerable populations			Spray park common's pool (DCR). City Council has funds for warming center – it is an ongoing budget item.
ADDITIONAL PRIORITY ACTIONS			
Inventory existing policies and regulations that promote stormwater management	Stormwater management ordinance		Update FIRM maps and info/update city ordinance. Display information on City's website.
Educate and raise awareness on flooding, stormwater and green infrastructure	NPDES Phase II		Provide public info on NFIP
Continue coordinated planning amongst citizens, businesses and government	-City Departments review development plans -Review and inspections of new developments		
Support and seek opportunities to collaborate with universities, including during emergencies.	Ongoing, police communicate with each other on an as needed basis.		Strengthen Communication

4.0 RISK ASSESSMENT

Risk assessment in hazard mitigation planning examines the natural hazards that have the potential to impact the City of Waltham and identifies the risk associated with those hazards. This assessment includes a description of the type, location, and extent of natural hazards, along with information on previous occurrences. This information assists in painting a picture of what types of risks exist for the City and the possible likelihood they will occur in the future, based on historic data. This section also includes an analysis of the vulnerability of existing and future buildings, infrastructure, and critical facilities; an estimate of the potential dollar losses to vulnerable structures; and a description of land uses and development trends.

To complete the hazard identification and risk assessment, Weston & Sampson researched and analyzed hazard and land use data, met with municipal staff, conducted an MVP workshop, and completed a vulnerability analysis. The purpose of the vulnerability analysis is to estimate the extent of potential damages from natural hazards of varying types and intensities. A vulnerability assessment and estimation of damages was performed for hurricanes, earthquakes, and flooding through a GIS-based exposure analysis that combined the City's Assessor data records with available hazard data layers used to map and illustrate hazard risk.

4.1 Overview of Hazards and Impacts

The 2013 Massachusetts State Hazard Mitigation Plan (MEMA and DCR, 2013) and the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP) (EEA and EOPSS 2018) examined the natural hazards that have the potential to impact the Commonwealth. These plans summarize the frequency and severity of hazards of greatest concern. The frequency classification ranges from very low to high. Severity classifications are listed as a range from minor severity to catastrophic. Table 4-1 summarizes the frequency and severity of hazard risk in Waltham and the State. These frequency and severity classifications will assist the City in prioritizing mitigation actions for each hazard.

Definitions Used in the Commonwealth of Massachusetts State Hazard Mitigation Plan

Frequency

- **Very low frequency:** events that occur less frequently than once in 100 years (less than 1% per year).
- **Low frequency:** events that occur from once in 50 years to once in 100 years (1% to 2% per year).
- **Medium frequency:** events that occur from once in 5 years to once in 50 years (2% to 20% per year).
- **High frequency**: events that occur more frequently than once in 5 years (Greater than 20% per year).

Severity: extent or magnitude of a hazard, as measured against an established indicator

- **Minor**: Limited and scattered property damage; limited damage to public infrastructure and essential services not interrupted; limited injuries or fatalities.
- **Serious:** Scattered major property damage; some minor infrastructure damage; essential services are briefly interrupted; some injuries and/or fatalities.
- **Extensive:** Widespread major property damage; major public infrastructure damage (up to several days for repairs); essential services are interrupted from several hours to several days; many injuries and/or fatalities.
- **Catastrophic:** Property and public infrastructure destroyed; essential services stopped; numerous injuries and

Table 4-1. Hazard Risk Summary

Hazard	Frequency		Severity	
	Massachusetts	Waltham	Massachusetts	Waltham
Inland Flooding	High (1 flood disaster declaration event every 3 years; 43 floods per year of lesser magnitude)	High	Serious to Catastrophic	Minor to Serious
Dam failures	Very Low	Very Low	Extensive to Catastrophic	Minor to Catastrophic
Coastal Hazards	High (6 events per year over past 10 years)	N/A (Not a coastal community)	Serious to Extensive	N/A (Not a coastal community)
Tsunami	Very Low (1 event every 39 years on East Coast, 0 in MA)	N/A (Not a coastal community)	Extensive to Catastrophic	N/A (Not a coastal community)
Hurricane/Tropical Storm	High (1 storm every other year)	Medium	Serious to Catastrophic	Serious
High Wind (Severe Weather)	High (43.5 events per year)	High	Minor to Extensive	Minor to Extensive
Tornadoes (Severe Weather)	High (1.7 events per year)	Low	Serious to Extensive	Minor
Thunderstorms	High (20 to 30 events per year)	High	Minor to Extensive	Minor to Extensive
Nor'easter	High (1 to 4 events per year)	High	Minor to Extensive	Minor to Extensive
Snow and Blizzard (Severe Winter Weather)	High (1 per year)	High	Minor to Extensive	Minor to Extensive
Ice Storms (Severe Winter Weather)	High (1.5 per year)	High	Minor to Extensive	Minor to Extensive
Earthquake	Very Low (10-15% probability of magnitude 5.0 or greater in New England in 10 years)	Very Low	Minor to Catastrophic	Minor to Extensive
Landslide	Low (once every two years in western MA)	Low	Minor to Extensive	Minor
Brush Fires	High (at least 1 per year)	Medium	Minor to Extensive	Minor to Serious

Table 4-1. Hazard Risk Summary

Hazard	Frequency		Severity	
	Massachusetts	Waltham	Massachusetts	Waltham
Extreme Temperatures	High (1.5 cold weather and 2 hot weather events per year)	High	Minor to Serious	Minor to Serious
Drought	High (8% chance of "Watch" level drought per month [recent droughts in 2016 and 1960s])	High	Minor to Serious	Minor to Serious

Source: Table adapted from the 2018 SHMCAP and 2013 Massachusetts State Hazard Mitigation Plan, with assistance from the City of Waltham

Not all of the hazards included in the 2018 State Hazard Mitigation and Climate Adaptation Plan or the 2013 Massachusetts State Hazard Mitigation Plan apply to the City of Waltham. Given Waltham's inland location, coastal hazards and tsunamis are unlikely to affect the City. Given the type of fires that have occurred in Waltham's history, the City will focus on brush fires rather than wildfires. It is assumed that the entire City of Waltham and its critical facilities are exposed to earthquakes, high wind events, hurricanes, winter storms, temperature extremes and snow and ice, to a similar extent. Flood risk from riverine flooding is elevated in the vicinity of the flood zones. Landslides are more likely in areas with more unstable soils types.

The Core Committee and stakeholders at the CRB Workshop identified flooding, high winds, winter storms, and extreme temperatures as the top four hazards of concern.

Participants identify hazards and vulnerabilities during Waltham's MVP Workshop

4.2 Flood-Related Hazards

Flooding was among the four main hazards identified by participants during Waltham's MVP workshop. Flooding can be caused by various weather events including hurricanes, extreme precipitation, thunderstorms, nor'easters, and winter storms. Flooding can be both riverine (topping the banks of streams, rivers, ponds) and from stormwater that is not properly infiltrated into the ground. While Waltham experiences these events, the impacts of climate change will likely lead to increasingly severe

storms and, therefore, increasingly severe impacts. The impacts of flooding include injury or death, property damage, and traffic disruption. Areas within the FEMA Flood Zones, repetitive loss sites, and local areas identified as flood prone are more vulnerable to the impacts of flooding. The following sub-sections provide more information on historic flooding events, potential flood hazards, a vulnerability assessment, locally identified as areas of flooding, and information on the risk of dam failures.

4.2.1 Regionally Significant Floods

Since the 1950, several significant floods have impacted the Middlesex County area. Major floods events that affected the City of Waltham are presented in the list below.

- August 1954
- March 1968
- January 1979
- April 1987
- October 1991
- September 1996
- October 1996
- June 1998
- March 2001
- April 2004
- October 2005
- May 2006
- April 2007
- March 2010
- October 2012
- February 2013
- March 2014
- January 2015
- January 2018
- September 2018

Flooding on 2nd Ave. from the remnants of Hurricane Florence in September 2018. Photo by Nichole Berlie/WCVB.

NOAA's National Centers for Environmental Information Storm Events Database provides information on previous flood events for Middlesex County, which includes the City of Waltham. Table 4-2 summarizes the 132 flood events that impacted this area between 1998 and 2018. Thirty-three of these events were flash floods. Flash Flood events are considered by the NOAA's National Centers for Environmental Information Storm Events Database as "A life-threatening, rapid rise of water into a normally dry area beginning within minutes to multiple hours of the causative event (e.g., intense rainfall, dam failure, ice jam)." Floods are considered, "Any high flow, overflow, or inundation by water which causes damage. In general, this would mean the inundation of a normally dry area caused by an increased water level in an established watercourse, or ponding of water, that poses a threat to life or property" (NOAA, 2018c) No deaths or injuries were reported, and the property damage totaled $42.04 million dollars (not adjusted for inflation). Incredibly, flooding during March 2010 caused more than 80% of the total property damage reported during this time period.

Table 4-2. Middlesex County Flood Events, 1998 to 2018

Location	Date	Deaths	Injuries	Property Damage ($)
Totals:		0	0	42.041M
WESTERN MIDDLESEX (ZONE)	03/10/1998	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	03/11/1998	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	05/12/1998	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	06/14/1998	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	06/15/1998	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	06/17/1998	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/22/2000	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/23/2000	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/23/2000	0	0	0.00K

Table 4-2. Middlesex County Flood Events, 1998 to 2018

Location	Date	Deaths	Injuries	Property Damage ($)
WESTERN MIDDLESEX (ZONE)	04/23/2000	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	03/22/2001	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	03/22/2001	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	03/22/2001	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	03/23/2001	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	03/23/2001	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	03/31/2001	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/01/2001	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/01/2004	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/01/2004	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/02/2004	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/02/2004	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/02/2004	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/02/2004	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/15/2004	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	03/29/2005	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	10/15/2005	0	0	100.00K
WESTERN MIDDLESEX (ZONE)	10/15/2005	0	0	100.00K
SOUTHEAST MIDDLESEX (ZONE)	10/15/2005	0	0	125.00K
COUNTYWIDE	05/13/2006	0	0	5.000M
COUNTYWIDE	05/13/2006	0	0	0.00K
WAKEFIELD	07/11/2006	0	0	2.00K
CAMBRIDGE	10/28/2006	0	0	5.00K
SAXONVILLE	04/16/2007	0	0	25.00K
FRAMINGHAM	02/13/2008	0	0	0.00K
MEDFORD	05/27/2008	0	0	3.00K
STONEHAM	06/24/2008	0	0	10.00K
WESTLANDS	06/29/2008	0	0	5.00K
EVERETT	08/10/2008	0	0	15.00K
SUDBURY	08/10/2008	0	0	40.00K
NORTH WOBURN	09/06/2008	0	0	15.00K
BILLERICA	12/12/2008	0	0	20.00K
HOLLISTON	03/14/2010	0	0	26.430M
FARM HILL	03/29/2010	0	0	8.810M
FARM HILL	04/01/2010	0	0	0.00K
WEST NEWTON	08/28/2011	0	0	5.00K
RIVER PINES	10/14/2011	0	0	0.00K
NORTH SOMMERVILLE	06/08/2012	0	0	0.00K
BEAVER BROOK	06/23/2012	0	0	0.00K
MELROSE	06/23/2012	0	0	0.00K
TUFTS COLLEGE	06/23/2012	0	0	0.00K

Table 4-2. Middlesex County Flood Events, 1998 to 2018

Location	Date	Deaths	Injuries	Property Damage ($)
MALDEN	06/23/2012	0	0	0.00K
TUFTS COLLEGE	06/23/2012	0	0	15.00K
NEWTON	07/18/2012	0	0	5.00K
NORTH WALTHAM	10/29/2012	0	0	0.00K
RIVER PINES	06/07/2013	0	0	0.00K
LOWELL	07/01/2013	0	0	0.00K
RIVER PINES	07/01/2013	0	0	0.00K
HARWOOD	07/23/2013	0	0	0.00K
FRAMINGHAM	09/01/2013	0	0	10.00K
CHELMSFORD CENTER	03/30/2014	0	0	35.00K
NORTH WALTHAM	03/30/2014	0	0	0.00K
GRANITEVILLE	03/30/2014	0	0	0.00K
CONCORD	07/27/2014	0	0	0.00K
NORTH LEXINGTON	08/31/2014	0	0	0.00K
FELCHVILLE	10/22/2014	0	0	20.00K
NEWTON LOWER FALLS	10/23/2014	0	0	0.00K
BOXBOROUGH	12/09/2014	0	0	0.00K
CLEMATIS BROOK	12/09/2014	0	0	5.00K
NONANTUM	12/09/2014	0	0	0.00K
SOMERVILLE	12/09/2014	0	0	30.00K
CONCORD	05/31/2015	0	0	0.00K
NEWTON CENTER	05/31/2015	0	0	0.00K
FRAMINGHAM	08/04/2015	0	0	0.00K
NATICK	08/15/2015	0	0	50.00K
FRAMINGHAM	08/15/2015	0	0	75.00K
NATICK	09/30/2015	0	0	0.00K
FRAMINGHAM	09/30/2015	0	0	0.00K
SOUTH WILMINGTON	09/30/2015	0	0	0.00K
SILVER HILL	09/30/2015	0	0	0.00K
AUBURNDALE	09/30/2015	0	0	0.00K
BILLERICA	04/06/2017	0	0	0.00K
WEST CONCORD	06/27/2017	0	0	1.00K
(BED)HANSCOM FLD BED	07/12/2017	0	0	1.000M
CHELMSFORD CENTER	07/12/2017	0	0	0.00K
CLEMATIS BROOK	07/12/2017	0	0	0.00K
SILVER HILL	07/12/2017	0	0	0.00K
BEAVER BROOK	07/12/2017	0	0	0.00K
BOSTON NAVAL SHIPYAR	07/12/2017	0	0	0.00K
LAKE STREET	07/12/2017	0	0	0.00K
EAST CHELMSFORD	07/18/2017	0	0	0.00K
WESTLANDS	07/18/2017	0	0	0.00K
EAST EVERETT	07/18/2017	0	0	0.00K

Table 4-2. Middlesex County Flood Events, 1998 to 2018

Location	Date	Deaths	Injuries	Property Damage ($)
STOW	08/02/2017	0	0	5.00K
CHESTNUT HILL	08/02/2017	0	0	0.00K
MELROSE	10/25/2017	0	0	0.00K
NATICK	10/25/2017	0	0	0.00K
EAST CHELMSFORD	10/30/2017	0	0	0.00K
FELCHVILLE	01/12/2018	0	0	0.00K
NORTH WALTHAM	01/13/2018	0	0	0.00K
BELMONT	04/16/2018	0	0	0.00K
BEDFORD SPGS	04/16/2018	0	0	0.00K
HOPKINTON	04/16/2018	0	0	0.00K
FARM HILL	04/16/2018	0	0	0.00K
SILVER HILL	06/25/2018	0	0	0.00K
CONCORD	06/25/2018	0	0	0.00K
BELMONT	06/25/2018	0	0	0.00K
WEST VLG	06/25/2018	0	0	0.00K
MEDFORD	06/25/2018	0	0	0.00K
EAST EVERETT	06/25/2018	0	0	0.00K
BEAVER BROOK	06/25/2018	0	0	0.00K
WEST EVERETT	06/25/2018	0	0	15.00K
MINUTE MAN ARPT	08/08/2018	0	0	0.00K
MAYNARD	08/08/2018	0	0	5.00K
FELCHVILLE	08/08/2018	0	0	30.00K
EAST EVERETT	08/12/2018	0	0	5.00K
CAMBRIDGE	08/12/2018	0	0	15.00K
WELLINGTON	08/12/2018	0	0	5.00K
OAK GROVE	08/12/2018	0	0	0.00K
FARM HILL	08/12/2018	0	0	5.00K
EAST CHELMSFORD	08/17/2018	0	0	0.00K
SOMERVILLE	10/29/2018	0	0	0.00K
FRAMINGHAM	11/03/2018	0	0	0.00K
MALDEN	11/10/2018	0	0	0.00K
Totals:		0	0	42.041M

Source: NOAA 2018a

Waltham firefighters helped one driver out of their car while two others opted to remain in their cars until the water receded. Photo by Peter Lobo.

As Table 4-2 suggests, the most destructive flooding in Middlesex County occurred in March 2010. During the March 14th - March 21st flood, rainfall totals reached 10 inches in eastern Massachusetts. Streets were closed due to flooding in Waltham and there were several lane restrictions on Interstate 95. Approximately 20 residents from apartments on Linden Street were evacuated, along with residents at Gardencrest Apartments and Waverly Oak Road apartments. Water overflowing the Moody Street Dam in Waltham flooded a retirement home and a museum. During the March 29th - March 31st flood, rainfall totals reached eight inches in Massachusetts. The Charles River rose above flood stage, streets were closed in Waltham and surrounding communities due to flooding, and approximately 30 residents from apartments on Linden Street were evacuated (NOAA 2018a).

The U.S. Geological Survey (USGS) manages a streamflow gauging station on the Charles River, 800 feet downstream from the Moody Street Bridge in Waltham. As Figure 4-1 indicates below, the gage height exceeded seven feet on March 16, 2010 and exceeded six (feet on March 31, 2010. (USGS 2019b).

4.2.2 Overview of City-Wide Flooding

The entire City of Waltham is located within the Charles River watershed. There are numerous rivers, streams, and bodies of water throughout the City. The Cambridge Reservoir, which serves as the drinking water source for the City of Cambridge, is located in the northwest portion of the City. The Charles River runs through the southern portion of the City. Kendall Brook, Chester Brook, and Beaver Brook all converge in the eastern portion of the City. Hardy Pond to the north and Square Pond in the central part of the City are other significant bodies of water.

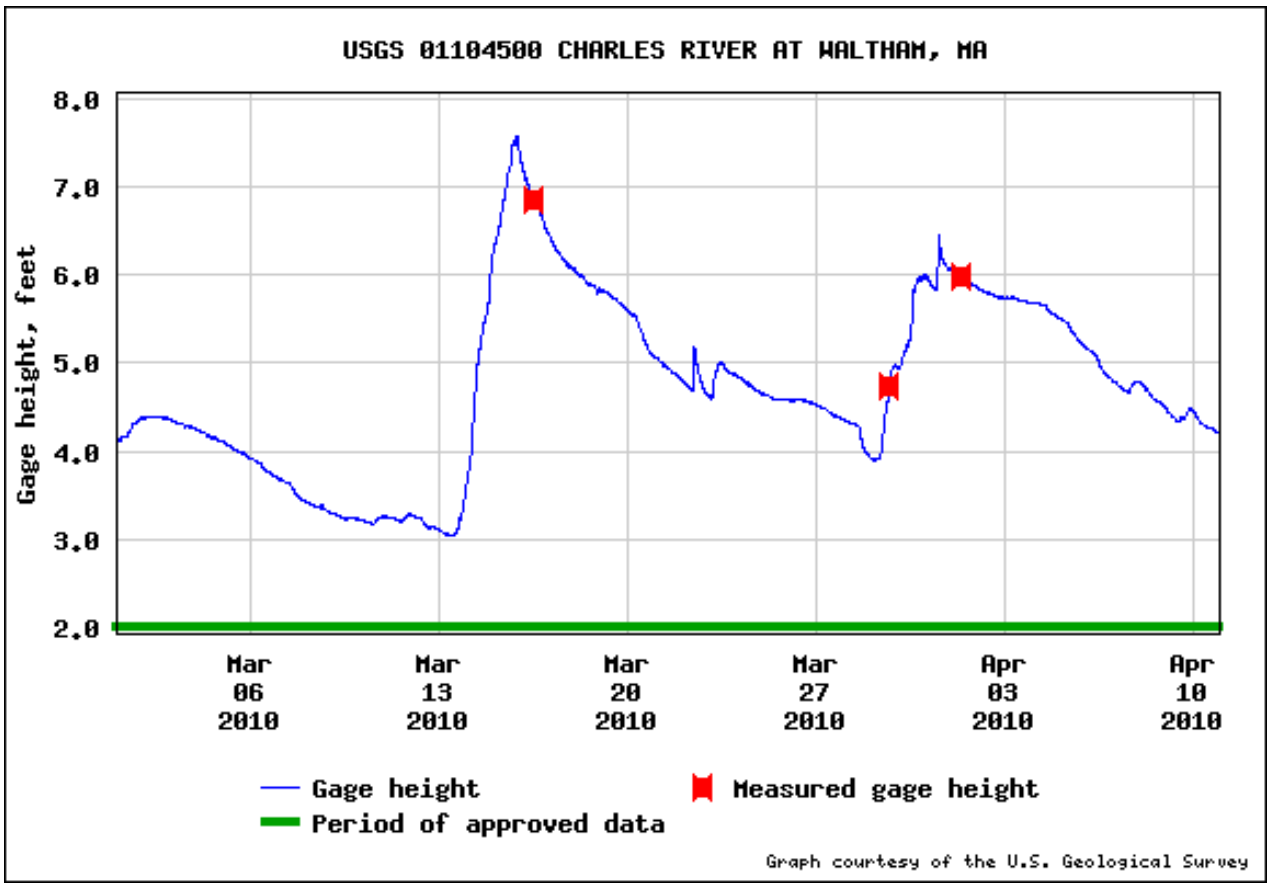

Figure 4-1. USGS Flow Gage Data for Charles River, March 2010

Waltham experiences frequent flooding during heavy rainstorms, not only as a result of its numerous water resources and floodplain, but also because it is very urbanized. Localized flooding will also occur due to undersized or outdated drainage infrastructure. In addition, Waltham is downstream from other communities that drain to its water bodies. As a result, Waltham feels the impacts of increased urbanization and development from other surrounding cities and towns. Waltham's terrain is also very hilly in places with ledge and hard pan soil layers, creating high volumes of runoff and groundwater recharge problems. The Waltham Fire Department will assist in pumping out flooded basements or yards, but it is a cost to the City. The winter and spring thaw can also bring challenges to the City, with clogged catch basins or ice flowing into dams.

Flood hazards are also directly linked to erosion, which can compromise the stability of building foundations. This puts current and future structures and populations located near steep embankments, or along the Charles River, at risk. Erosion can also undercut streambeds and pose a risk to those walking along the banks. Structures or critical facilities located near the streams and lakes in Waltham may be considered at risk from fluvial erosion. This includes structures within the flood overlay district, including the critical facilities of Bleachery and Moody Street Dams.

City officials have identified the need for a long-term plan addressing water, drainage, and sewer systems. In general, years of development and aging stormwater infrastructure have led to present day drainage problems in the City. Not only do conditions in Waltham contribute to flooding, but impacts

from communities such as Arlington, Belmont, and Lexington also affect runoff and overflows in Waltham. More details on specific flooding areas within the City are provided in the site-specific flooding section below.

This analysis of flood hazard areas was informed by the FEMA NFIP Flood Insurance Rate Maps (FIRMs), a GIS vulnerability assessment, information from Waltham City staff, and accounts of past flood events provided by participants during the Waltham MVP Workshop.

4.2.3 Potential Flood Hazards

FEMA-designated flood zones from the NFIP FIRM are included in Map 3 in Appendix B are more vulnerable to flood events. The definitions of these flood zones are provided below. Most of the FEMA floodplain in Waltham borders the Charles River, Kendall Brook, Beaver Brook, Chester Brook, Square Pond, Bow Pond, Hardy Pond, and/or the Cambridge Reservoir/Hobbs Brook Basin.

Flood Insurance Rate Map Zone Definitions

Zone A (1% annual chance): Zone A is the flood insurance rate zone corresponding to the 100-year floodplains that are determined in the Flood Insurance Study (FIS) by approximate methods. Detailed hydraulic analyses are not performed for such areas, therefore, no BFEs (base flood elevations) or depths are shown within this zone. Mandatory flood insurance purchase requirements apply.

Zone AE and A1-A30 (1% annual chance): Zones AE and A1-A30 are the flood insurance rate zones that correspond to the 100-year floodplains that are determined in the FIS by detailed methods. In most instances, BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.

Zone X (0.2% annual chance)**:** Zone X is the flood insurance rate zone that corresponds to the 500-year floodplains that are determined in the Flood Insurance Study (FIS) by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs or depths are shown within this zone.

Source: https://www.fema.gov/flood-zones

4.2.4 GIS Flooding Exposure Analysis

Hazard location and extent of riverine flooding was determined using the current effective FEMA Flood Insurance Rate Map (FIRM) data for Waltham dated 2017. The FIRM is the official map on which FEMA has delineated both the special flood hazard areas and the risk premium zones applicable to the community under the National Flood Insurance Program (NFIP). This includes high risk areas that have a one percent chance of being flooded in any year (often referred to as the "100-year floodplain"), which under the NFIP, is linked to mandatory purchase requirements for federally-backed mortgage loans. It also identifies moderate to low risk areas, defined as the area with a 0.2 percent chance of flooding in any year (often referred to as the "500-year floodplain"). For purposes of this exposure analysis, the following special flood hazard areas as identified in the City of Waltham's current FIRMs were included:

- Flood Zone AE – Regulatory Floodway
- Flood Zone A (AE, AH) – 1% Annual Chance Flood Hazard
- Flood Zone X (shaded) – 0.2% Annual Chance Flood Hazard

The City's existing tax parcel and property value data were used to estimate the number of parcels (developed and undeveloped) and buildings located in identified hazard areas along with their respective assessed values. The parcel data set provides information about the parcel size, land use type, and assessed value among other characteristics. The parcel data was also classified into various land use types based on the Massachusetts Department of Revenue's Property Type Classification Code for Fiscal Year 2019, as described below in Table 4-3 below.

Table 4-3. Waltham's Land Use Classification Based on Massachusetts Land Use Codes

Land Use Categories with Land Use Descriptions	Land Use Code
Commercial - Industrial/Manufacturing/Automotive	
Retail (Automotive)	993
Retail (Carwash)	335
Retail (parking lots)	337
Retail Trade - Hardware	321
Retail Trade (Fuel Service)	333
Retail Trade (gas stations)	334
Retail Trade (other automotive)	338
Retail Trade (parking garages)	336
Storage Warehouse and Distribution (Other)	316
Commercial - Office	
Commercial - Bank	341
Commercial - Medical Office	342
Commercial - Office	340
Commercial - Retail/Entertainment	
Commercial - Entertainment (movie theater)	362
Indoor recreation (gymnasium)	376
Indoor recreation (tennis)	375
Retail Trade - department stores	322
Retail trade - shopping centers/malls	323
Retail trade (restaurants)	326
Retail Trade (supermarket)	324
Retail trade (small retail)	325
Commercial - Unknown	
Unknown	1019
Industrial - Unknown	
Unknown	445
Industrial	
Industrial - Manufacturing and processing (buildings)	400
Industrial - Manufacturing and processing (warehouses)	401
Industrial - Mining (sand)	410
Industrial - Mining (rock)	412
Industrial - Office building	402
Industrial - Research and development	404
Industrial - Utility	
Industrial - Utility	2136
Public Service	
Public Land	1801

Table 4-3. Waltham's Land Use Classification Based on Massachusetts Land Use Codes

Land Use Categories with Land Use Descriptions	Land Use Code
Public land - DCR	920
Public Land - Education	917
Public Land - Health	914
Public Land - Unknown	999
Public Land - Unknown	7244
Public Service (Bus transport)	354
Public Service (Fraternal Organizations)	353
Public Service (Funeral Homes)	355
Residential - Multifamily	
Accessory Land with Improvement	106
Apartment	223
Condominium	102
Multi-home on one parcel	109
Multi-Use (Commercial)	31
Multi-Use (Residential)	13
Three-Family	105
Two-Family	104
Residential - Other	
Other Congregate Housing which includes non-transient shared living arrangements	125
Child Care Facility	140
Commercial - Hotel	300
Commercial - Nursing Home	304
Multi-Use Unknown	297
Rooming and Boarding	121
Residential - Single Family	
Single Family	101
Vacant Land (Developable)	
Vacant Land (Developable)	130
Vacant Land (Potentially Developable)	131
Vacant Land (Developable)	830
Vacant Land (Potentially Developable)	832
Vacant Land (Developable)	390
Vacant Land (Potentially Developable)	391
Vacant Land (Developable)	440
Vacant Land (Potentially Developable)	441
Vacant Land (Undevelopable)	
Vacant Land (Undevelopable)	132
Vacant Land (Undevelopable)	834
Vacant Land (Undevelopable)	392
Vacant Land (Undevelopable)	442

To determine the vulnerability of each parcel and building, a GIS overlay analysis was conducted in which the flood hazard extent zones were overlaid with the parcel data and existing building footprint data.

To calculate the exposure of parcels and buildings to the flood hazards, parcels with buildings, that are located completely or partially, within recognized hazard zones were identified using the ArcGIS overlay analysis (i.e. select by location using the intersect function). The number of parcels and buildings for each land use category was then totaled, along with the value of buildings and real property associated with those parcels. These figures provide a strong indication of current hazard vulnerability, as well as potential future vulnerability as it relates to vacant and potentially developable parcels.

The following types and numbers of critical facilities were identified for the City of Waltham and included in the exposure analysis:

- City Hall
- Police Department
- Fire Department
- Nursing Home
- Sewer Pump Station
- Sewer Wastewater Treatment Plant
- Lift Station
- Schools
- Colleges and Universities
- Low Income Housing
- Hospitals
- Boys and Girls Club / YMCA
- Daycares

Critical facilities were identified and mapped in ArcGIS based on the confirmed physical location/address. Like the vulnerability analysis for parcels and buildings, each was then overlaid with the identified and mappable hazard zones (FEMA Flood Zones). For purposes of this analysis it was assumed that the physical location of a critical facility within a hazard area (completely or partially) meant that it is exposed and potentially vulnerable to that specific hazard. However, it is recognized that more site-specific evaluations may be required to confirm this assumption.

4.2.5 Flood Exposure Tables

The results of the vulnerability assessment conducted for Waltham's existing community assets are summarized on the following pages. These include an exposure table for those natural hazards with geographically-defined risk areas (FIRM zones). Table 4-4 below shows the exposure to buildings in flood zones by parcel type for each of the FEMA zones (Zone A, AE and X). This table shows the buildings that are located within the flood zone, the value of these buildings, and the total property value. Table 4-5 provides a detailed summary of the value of all buildings and their exposure to flood within the FIRM zones. Table 4-5 also shows all property that is located within the flood zone, even if there are no buildings located in the flood zone. The value of the buildings on these parcels is then shown (even if the building is not in the flood zone) along with the total property value.

Table 4-4. Exposure of Buildings in Flood Zones by Parcel Type (FEMA Zone A, AE and X)

Parcel Type Category	Number of Buildings	Building Value	Total Value
Commercial - Industrial/Manufacturing/Automotive	165	$118,323,900	$206,531,700
Commercial - Office	176	$1,269,029,400	$1,668,498,800
Commercial - Retail/Entertainment	138	$166,050,300	$254,140,000
Commercial - Unknown	22	$135,020,000	$135,138,200
Industrial - Unknown	1	$298,800	$298,800
Industrial	141	$313,256,700	$492,218,500
Industrial - Utility	8	$3,919,200	$11,553,300
Public Service	280	$578,298,800	$1,621,334,500
Residential - Multifamily	2953	$1,427,080,900	$2,194,560,600
Residential - Other	50	$318,848,600	$371,862,300
Residential - Single Family	8690	$1,691,162,600	$4,114,523,600
Vacant Land (Developable)	58	$0	$60,281,700
Vacant Land (Undevelopable)	25	$0	$3,904,600
Other*	134	$0	$0
Grand Total	12841	$6,021,289,200	$11,134,846,600

Table 4-5. Summary of the Value of all Building and their Exposure to Flood Within the Firm Zone

	Number of parcels			Value of Buildings			Value of Total Property		
Land Use Category	Total	Total in Hazard	% in Hazard	Total Value	Total Value in Hazard	% Value in Hazard	Total Value	Total Value in Hazard	% Value in Hazard
Commercial - Industrial/Manufacturing/Autor	207	27	13.04%	$118,323,900	$15,077,400	12.74%	$206,531,700	$29,512,000	14.29%
Commercial - Office	177	16	9.04%	$1,269,029,400	$229,056,300	18.05%	$1,668,498,800	$288,707,000	17.30%
Commercial - Retail/Entertainment	138	14	10.14%	$166,050,300	$25,770,200	15.52%	$254,140,000	$41,648,000	16.39%
Commercial - Unknown	22	2	9.09%	$135,020,000	$24,245,800	17.96%	$135,138,200	$24,245,800	17.94%
Industrial	142	26	18.31%	$313,256,700	$105,035,200	33.53%	$492,218,500	$152,903,300	31.06%
Industrial - Unknown	1	1	100.00%	$298,800	$298,800	100.00%	$298,800	$298,800	100.00%
Industrial - Utility	9	0	0.00%	$3,919,200	$3,919,200	100.00%	$11,553,300	$11,553,300	100.00%
Public Service	493	97	19.68%	$578,298,800	$173,214,300	29.95%	$1,621,334,500	$553,157,600	34.12%
Residential - Multifamily	2955	74	2.50%	$1,427,080,900	$253,962,400	17.80%	$2,194,560,600	$363,500,000	16.56%
Residential - Single Family	8698	459	5.28%	$1,691,162,600	$80,178,700	4.74%	$4,114,523,600	$206,220,400	5.01%
Residential - Other	50	4	8.00%	$318,848,600	$4,440,000	1.39%	$371,862,300	$5,743,400	1.54%
Vacant Land (Developable)	190	32	16.84%	$0	$0	0.00%	$60,281,700	$14,067,400	23.34%
Vacant Land (Undevelopable)	148	28	18.92%	$0	$0	0.00%	$3,904,600	$895,400	22.93%
Other	97	9	9.28%	$0	$0	0.00%	$170,900	$0	0.00%
Total	**13327**	**789**	5.92%	**$6,021,289,200**	**$915,198,300**	15.20%	**$11,135,017,500**	**$1,692,452,400**	15.20%

There are 789 developed parcels totaling $6,021,289,200 in property value located in FEMA mapped flood zones. A total of 12,841 buildings are located in the flood zone (Table 4-4). Overall, 15.2% of Waltham's total property is at risk to flooding. Waltham is mostly built out. An analysis of developable vacant parcels has shown that 338 parcels remain undeveloped, with 60 of them, or 17.75 % of the total, located in flood zones. Undeveloped parcels in Waltham can be seen in Table 4-6. Future development within the City of Waltham will mostly focus on redevelopment. Three redevelopment areas are proposed, none of which are in a flood zone.

Table 4-6. Vacant Parcel Analysis

Land Use Category	# of Parcels	Land Value	Other Value	Total Value	Acres
Residential Vacancy					
Developable (130)	*74*	*$20,881,200.00*	*$0.00*	*$20,881,200.00*	*21.45*
AE	2	$463,800.00	$0.00	$463,800.00	0.29
X	4	$1,185,300.00	$0.00	$1,185,300.00	2.66
Not Vulnerable	68	$19,232,100.00	$0.00	$19,232,100.00	18.5
Percentage in flood zone	8.11%			7.90%	0.14
Potentially Developable (131)	*78*	*$7,065,800.00*	*$0.00*	*$7,065,800.00*	*30.11*
A	2	$153,300.00	$0.00	$153,300.00	1.01
AE	8	$496,700.00	$0.00	$496,700.00	1.9
X	7	$877,200.00	$0.00	$877,200.00	6.16
Not Vulnerable	61	$5,538,600.00	$0.00	$5,538,600.00	21.04
Percentage in flood zone	21.79%			21.61%	0.3
Undevelopable (132)	*131*	*$2,573,100.00*	*$0.00*	*$2,573,100.00*	*34.53*
A	1	$14,800.00	$0.00	$14,800.00	0.38
AE	20	$635,900.00	$0.00	$635,900.00	8.6
X	4	$55,100.00	$0.00	$55,100.00	2.01
Not Vulnerable	106	$1,867,300.00	$0.00	$1,867,300.00	23.54
Percentage in flood zone	19.08%				0.32
Total Residential Vacancy					
Acres				$30,520,100.00	283
Acres in Flood Zone				$3,882,100.00	23.02
Total Percentage in flood Zone				12.72%	8.13%
Commercial Vacancy					
Developable (390)	*23*	*$16,419,900.00*	*$13,400.00*	*$16,433,300.00*	*24.25*
AE	2	$2,894,600.00	$11,500.00	$2,906,100.00	4.78
X	4	$7,005,100.00	$0.00	$7,005,100.00	9.31
Not Vulnerable	17	$6,520,200.00	$1,900.00	$6,522,100.00	10.16
Percentage in flood zone	26.09%			60.31%	58.10%
Potentially Developable (391)	*12*	*$4,755,900.00*	*$2,500.00*	*$4,758,400.00*	*13.31*
AE	3	$979,900.00	$0.00	$979,900.00	1.66
Not Vulnerable	9	$3,776,000.00	$2,500.00	$3,778,500.00	11.64

Table 4-6. Vacant Parcel Analysis

Percentage in flood zone	25.00%				12.49%
Undevelopable (392)	*16*	*$1,318,200.00*	*$200.00*	*$1,318,400.00*	*13.61*
AE	3	$189,600.00	$0.00	$189,600.00	1.91
Not Vulnerable	13	$1,128,600.00	$200.00	$1,128,800.00	11.69
Percentage in flood zone	18.75%				14.05%
Total Commercial Vacancy					
Acres				$22,510,100.00	51.17
Acres in Flood Zone				$11,080,700.00	17.67
Total Percentage in flood Zone				49.23%	34.52%
Industrial Vacancy					
Developable (440)	*2*	*$10,905,600.00*	*$3,600.00*	*$10,909,200.00*	*21.37*
(blank)	2	$10,905,600.00	$3,600.00	$10,909,200.00	21.37
Potentially Developable (441)	*1*	*$233,800.00*	*$0.00*	*$233,800.00*	*2.9*
(blank)	1	$233,800.00	$0.00	$233,800.00	2.9
Undevelopable (442)	*1*	*$13,100.00*	*$0.00*	*$13,100.00*	*0.12*
(blank)	1	$13,100.00	$0.00	$13,100.00	0.12
Total Industrial Vacancy					
Acres					24.39
Acres in Flood Zone					0
Total Percentage in flood Zone					0.00%
Total Residential, Commercial and Industrial Vacancies (based on # of parcels)					
Total Vacancy	338	$64,166,600.00	$19,700.00	$64,186,300.00	161.65
Total Vacant Parcels in Flood Zones	60			$14,962,800.00	40.68
Percentage of Vacant Parcels in Flood Zones	17.75%			23.31%	25.17%
Total Residential, Commercial and Industrial Vacancies (based on land area)					
Total Acres in Waltham					8809.17
Percentage Vacancy					1.84%
Percentage Vacancy in Flood Zone					0.46%

As can be seen on the Critical Facilities Map (Figure 3 of the Map Binder) and Table 4-6 below, seven critical facilities are located within a flood zone. These are three sewer pump stations, two low income housing facilities, one daycare and one nursing home. Furthermore, the Waltham Fire Department headquarters and the local police station as well as the Waltham Commuter Rail Station and homeless shelter, are located in close vicinity to an AE flood zone, which has a 1% annual chance of flooding.

Table 4-7. Critical Facilities in Flood Zones

Critical Facilities	Total	In Flood Zone
City Hall	1	0
Police Department	1	0
Fire Department	6	0
Nursing Home	7	1
Sewer Pump Station	10	3
Sewer Wastewater Treatment Plant	1	0
Lift Station	1	0
Schools	17	0
Colleges and Universities	2	0
Low Income Housing	25	2
Hospitals	2	0
Boys and Girls Club / YMCA	2	0
Daycares	16	1

4.2.6 Locally Identified Areas of Flooding

Waltham City staff and MVP Workshop participants helped identify local areas of flooding, which are summarized in Table 4-8 below. These areas may not directly overlap with the FEMA-designated flood zones previously discussed. These locally identified areas of flooding are shown on Map 8 of Appendix B, "Local Hazard Areas".

Table 4-8. Locally Identified Areas of Flooding

Name	Description
Linden Street (Route 60)	This area at Route 60 (Linden Street) near Beaver Brook is low and surrounded by 100- year floodplain. It has been identified by City officials as the worst flooding in the City. Flooding will affect business and property owners on Waverly Oaks Road near the railroad tracks. Both Beaver Brook and Chester Brook meet up at Linden Street, and the floodwaters will back up at a basin at Linden Street.
Hardy Pond	Located in and around the neighborhoods of Hardy Pond and Hardy Pond Road in the northern part of the City, this area is located within or near 100-year floodplain. This area sees flooding and wet basements. These neighborhoods are made up of summer cottages that were converted to year-round residences that were never intended to be permanent.
Bow Pond	Located in the northern part of the City along the Lexington border, this area has seen increased flow to Bow Pond and has experienced flooding as a possible result of the nearby Brookhaven development. Homes and basements in the area are affected very negatively by the flooding.

Table 4-8. Locally Identified Areas of Flooding

Name	Description
North of Trapelo Road	Located north of Trapelo Road and just south of the Lexington border in the northern part of the City, homes in this area will experience basement flooding during heavy rainstorms.
Square Pond	The area in and around Square Pond near Kendall Brook in the center of the City is located near floodplain. There has been overflow from the pond into yards in the area that also has led to sewage backup issues.
Shriver Center/ Shirley Road	Located near the eastern border of the City adjacent to Belmont near Beaver Brook, this area has experienced flooding likely due to flow coming down the abutting steep slope.
Hobbs Road	The vicinity of Hobbs Road is a hilly area in the northeast portion of the City that experiences basement flooding.
Livermore and Bigelow Road	On a tributary to Kendall Brook near 100-year and 500-year floodplain, this area experiences flooding of basements and yards.
Greenwood Lane	Located in the neighborhoods just south of Totten Pond Road, this area experiences basement flooding.
West of Moody Street	This neighborhood west of Moody Street in the southern part of the City is adjacent to the Charles River and its bordering 100-year floodplain. As a result, it experiences basement and yard flooding during heavy rainstorms.
Cedarwood Area	This area in the southwest part of the City just east of Route 128 also experiences basement and yard flooding.

4.2.7 Repetitive Loss Structures

As defined by FEMA and the National Flood Insurance Program (NFIP), a repetitive loss property is any insured property which the NFIP has paid two or more flood claims of $1,000 or more in any given 10-year period since 1978 (FEMA and NFIP 2018a).

There are 15 repetitive loss properties in Waltham but no severe repetitive loss structures (Table 4-99). Of these properties, 10 are single family residences, two are multi-family residences, and three are non-residential structures. These 15 properties have experienced a total of 47 losses as of November 30, 2018. Repetitive loss payments over this period totaled $503,804.70.

Table 4-9. Summary of Repetitive Loss Properties

Repetitive Loss Buildings (Total)	15
Repetitive Loss Buildings (Insured)	4
Repetitive Losses (Total)	47
Repetitive Losses (Insured)	11
Repetitive Loss Payments (Total)	$503,804.70
Building	$267,431.06
Contents	$236,373.64
Repetitive Loss Payments (Insured)	$85,452.46
Building	$81,184.72
Contents	$4,267.74

Source: MA Department of Conservation and Recreation, data as of November 30, 2018

Eleven of the City's repetitive loss buildings are located within the designated Zone A floodplain. The remaining four repetitive loss buildings are located within B, C, or X zones, which are defined by FEMA as areas of moderate or minimal flood hazard.

During Waltham's MVP Workshop in February 2019, participants expressed concern that the data available for repetitive loss structures underrepresents the damage that their community has experienced. Repetitive loss data only includes buildings that qualify for the repetitive loss designation, which workshop attendees felt only included a fraction of the loss that they experienced during previous flood events.

Flooding events in Waltham have been classified as a high frequency event. As defined by the Massachusetts State Hazard Mitigation and Climate Adaptation Plan (EEA and EOPSS 2018), this hazard occurs once in three years (33% chance per year).

4.2.8 Dams and Dam Failure

The Bleachery Dam. Photo by Scott Shurr.

Dam failure is defined as a collapse of an impounding structure resulting in an uncontrolled release of impounded water from a dam (DCR 2017a). Dam failures during flood events are of concern in Massachusetts, given the high density of dams constructed in the 19th century (MEMA and DCR 2013, 298).

Dams can fail due to overtopping caused by floods that exceed the capacity of the dam, deliberate acts of sabotage, structural failure of materials used in dam construction, movement and/or failure of the foundation supporting the dam, settlement and cracking of concrete or embankment dams, piping and internal erosion of soil in embankment dams, and inadequate maintenance and upkeep (MEMA and DCR 2013, 210).

Many dam failures in the United States have been secondary results of other disasters. The prominent causes are earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage (MEMA and DCR 2013, 210).

Although dam failure does not occur frequently in Waltham, it can cause property damage, injuries, and potentially fatalities. These impacts can be at least partially mitigated through advance warning to communities impacted by a dam failure. In addition, the breach may result in erosion on the rivers and stream banks that are inundated.

Climate change may indirectly affect dam breaches for a variety of reasons. Dams are typically designed based on historic water flows and known hydrology. Climate change projections indicate that the frequency, intensity, and amount of precipitation will increase in New England. Increased precipitation may push dams over capacity. Therefore, dams will have to be monitored for safety. There are several mechanisms in place to manage increases in water, such as slowly releasing water. It is advised that these events are monitored as it can add additional stress on the dam infrastructure.

There has not been a dam failure in Waltham, and dam failure is classified as a very low frequency event in the City, a dam failure can present a high level of risk and could result in a catastrophic event with extreme damage and loss of life. As defined by the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (EEA and EOPSS 2018), a very low frequency hazard may occur less frequently than once in 100 years (less than a 1% chance per year).

According to City officials and the Massachusetts Department of Conservation and Recreation's (DCR) Office of Dam Safety, there are nine dams in Waltham. Information related to these dams is summarized in Table 4-10. This summary table includes the hazard classification for each dam, which is defined by DCR as described below:

Table 4-10. Inventory of Dams in Waltham

Dam Name	Impoundment	Dam Owner	Hazard Potential Classification
Stony Brook Reservoir Dam	Stony Brook Reservoir	City of Cambridge, Water Department	High Hazard
Moody Street Dam	Charles River	Massachusetts Department of Conservation and Recreation	High Hazard
Cambridge Reservoir Dam	Cambridge Reservoir	City of Cambridge, Water Department	High Hazard
Bleachery Dam	Charles River	Massachusetts Department of Conservation and Recreation	Low Hazard
Hardy Pond Dam	Hardy Pond	City of Waltham	Small Unregulated Dam
Lyman Pond Dam #1	Lyman Pond	Private Owner N/A	Small Unregulated Dam
Lyman Pond Dam #2	Lyman Pond	Private Owner N/A	Small Unregulated Dam
Chapel Hill School Dam	Chapel Hill Pond	Private Owner N/A	Small Unregulated Dam
Clark's Pond Dam	Clark's Pond	Private Owner N/A	Small Unregulated Dam

Moody Street / Charles River Dam

The Moody Street / Charles River Dam, located at Moody Street on the Charles in the center of the City, is owned and maintained by the Commonwealth of Massachusetts Department of Conservation and Recreation (DCR). This dam is rated by the DCR database as a high-risk hazard and is listed in fair condition. During the heavy rainstorms of March 2010, the dam was significantly stressed as the Charles River rose to historic levels. However, with rocks, jersey barriers and other aids, the state was able to contain the dam.

With the dam intact, the reach of the Charles River upstream of the dam is vulnerable to flooding during high precipitation events (See Map 3 of Appendix B.). Critical facilities including the commuter rail station are considered at risk. It is assumed that City Hall would not be severely impacted from a breach as it is located more than 0.2 miles from the dam, and at a higher elevation.

Bleachery / Charles River Dam
Another dam located along the Charles River owned by the Commonwealth of Massachusetts Department of Conservation and Recreation is further downstream near the border of Watertown. This dam was partially breached by the Charles River Watershed Association and the Commonwealth in 2005.

Stony Brook Dam
This dam is located at the end of Stony Brook at the Waltham/Weston line. This dam is used to control release to the Charles River. A breach of this dam could be a threat to people, residences, and businesses downstream.

Other Dams
Other dams listed in the DCR dam database include:

- *Cambridge Reservoir Dam* – on Hobbs Brook at the Cambridge Reservoir, owned by the City of Cambridge, high hazard risk, in fair condition.
- *Hardy Pond Dam* – at Hardy Pond on a tributary to Chester Brook, owned by the City of Waltham, low hazard risk.
- *Lyman Pond Dams #1 and #2* – on Lyman Pond, privately owned, low hazard risk.
- *Chapel Hill School Dam* – on Chester Brook at Chapel Hill Pond, privately owned, low hazard risk, in fair condition.
- *Clark's Pond Dam* – on Clark's Pond, privately-owned, low hazard risk.

4.3 Wind Related Hazard

High winds can occur during hurricanes, tropical storms, tornadoes, nor'easters, and thunderstorms. The entire planning area is vulnerable to the impacts of high wind. . All current and future buildings including critical facilities and populations are considered to be at vulnerable during high wind events. Wind may down trees and power lines. High wind and storm events cause property damage and hazardous driving conditions. While Waltham's current 100-year wind speed is 110 mph, climate change will likely increase events and severity. Please refer to Map 5 in Appendix B for more information.

Extreme winds can take down trees and branches that cause service disruptions. An identified issue during storms in Waltham is the damage to power and phone wires from overhanging trees that have not been trimmed by the electric utilities (National Grid and Eversource Energy) or the phone or cable companies. The utilities' tree maintenance program should be upgraded in an effort to reduce the risk associated with tree damage to utility lines. High winds and heavy snow loads caused significant power line damage in Waltham during a nor'easter in 2018. Falling trees and branches can also block traffic and emergency routes. This is a regional issue that affects cities and towns beyond Waltham.

During Waltham's MVP Workshop in February 2019, attendees discussed the impact of past storms on power systems and service disruption. In 2016, a storm led to a downed power line which resulted in the loss of power at a wastewater pumping station. The gas for the generator at a pumping station caught on fire and eliminated the backup power. Workers were able to bypass the pumping station and Eversource was able to get the pumps back online. However, backup power to the area impacted was cut off for an estimated four hours.

Waltham does have reliable communications towers that house communications equipment for the Police and several other City departments. City officials stated that their communications systems are not at risk during high wind events. Prospect Hill is the location of a City tower, which does see high wind gusts, but is not considered a safety issue. Bear Hill, the site of AT&T and Sprint towers, also experience high winds but is also not considered a safety issue.

4.3.1 Hurricanes and Tropical Storms

Tropical cyclones (including tropical depressions, tropical storms, and hurricanes) form over the warm waters of the Atlantic, Caribbean, and Gulf of Mexico. A tropical storm is defined as having sustained winds from 39 to 73 mph. If sustained winds exceed 73 mph, it is categorized a hurricane. The Saffir-Simpson scale ranks hurricanes based on sustained wind speeds from Category 1 (74 to 95 mph) to Category 5 (156 mph or more). Category 3, 4, and 5 hurricanes are considered "Major" hurricanes. Wind gusts associated with hurricanes may exceed the sustained winds and cause more severe localized damage (MEMA and DCR 2013, 323).

When hurricanes and tropical storms occur, they will impact the entire planning area. All existing and future buildings including critical facilities and populations are at risk to the hurricane and tropical storm hazard (including critical facilities). Hurricane events have a large spatial extent and would potentially affect all of Waltham's infrastructure and buildings. Impacts include water damage in buildings from building envelope failure, business interruption, loss of communications, and power failure. Flooding is a major concern as slow-moving hurricanes can discharge tremendous amounts of rain on an area.

The official hurricane season runs from June 1 to November 30. However, storms are more likely to occur in New England during August, September, and October (MEMA and DCR 2013, 324).

The region has been impacted by hurricanes throughout its history, starting with the Great Colonial Hurricane of 1635. Between 1851 and 2012, Massachusetts experienced 11 hurricanes and one named tropical storm. This includes six category 1 hurricanes, two category 2 hurricanes, and three category 3 hurricanes (Blake, Landsea, and Gibney 2011, 21). Hurricanes that have occurred in the region since 1938 are listed in Table 4-111:

Table 4-11. Hurricane Records for Eastern Massachusetts, 1938 to 2012

Hurricane Event	Date
Great New England Hurricane*	September 21, 1938
Great Atlantic Hurricane*	September 14-15, 1944
Hurricane Doug	September 11-12, 1950
Hurricane Carol*	August 31, 1954
Hurricane Edna*	September 11, 1954
Hurricane Diane	August 17-19, 1955
Hurricane Donna	September 12, 1960
Hurricane Gloria	September 27, 1985
Hurricane Bob	August 19, 1991
Hurricane Earl	September 4, 2010
Tropical Storm Irene	August 28, 2011
Hurricane Sandy	October 29-30, 2012
Hurricane Florence	September 18, 2018

* Category 3 Source: National Oceanic and Atmospheric Administration (NOAA)

The Saffir/Simpson scale categorizes or rates hurricanes from 1 (minimal) to 5 (catastrophic) based on their intensity. This is used to provide an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on context (MEMA and DCR 2013, 324). More information is included in Table 4-12 below:

Table 4-12. Saffir/Simpson Scale

Scale No. (Category)	Winds (mph)	Potential Damage
1	74 – 95	Minimal: damage is primarily to shrubbery and trees, mobile homes, and some signs. No real damage is done to structures.
2	96 – 110	Moderate: some trees topple, some roof coverings are damaged, and major damage is done to mobile homes.
3	111 – 130	Extensive: large trees topple, some structural damage is done to roofs, mobile homes are destroyed, and structural damage is done to small homes and utility buildings.
4	131 – 155	Extreme: extensive damage is done to roofs, windows, and doors; roof systems on small buildings completely fail; and some curtain walls fail.
5	> 155	Catastrophic: roof damage is considerable and widespread, window and door damage is severe, there are extensive glass failures, and entire buildings could fail.

Source: MEMA and DCR 2013, page 325 (table originally created by NOAA)

Based on an HAZUS Hurricane module, estimated damage in Waltham from Hurricanes was assessed (Draft 2013 HMP). According to the State HMP, the strongest Hurricane that passed through Massachusetts was a Category 3 storm. The HAZUS assessment modeled the impacts from a Hurricane 4 (which is a 500-year storm) passing through the City center. There have been no hurricanes with this force reported; this reflects the worst-case scenario with the greatest damage which can be used for planning purposes. Table 4-13 below lists estimated damage in Waltham for this worst-case scenario.

Table 4-13. Estimated Damages in Waltham from a Probabilistic 100- and 500-Year Hurricane

Estimated Damage	100 Year	500 Year
Building Characteristics		
Estimated total number of buildings	14,150	
Estimated total building replacement value (Yr 2002)	7,740,617,000	
General Building Damage		
# of buildings sustaining minor damage	1,516	4,700
# of buildings sustaining moderate damage	268	2,387
# of buildings sustaining severe damage	9	282
# of buildings destroyed	2	133
Population Needs		
% of hospital beds available on day of event	100%	100%
# of households displaced	111	970
# of people seeking public shelter	26	228
Debris		
Building debris generated	9,914	50,578
Tree debris generated	4,665	17,771
# of truckloads to clear building debris	395	2,037
Value of Damages		
Total property damage	$58,065,890	$467,392,560
Total losses due to business interruption	$9,938,180	$76,261,440

Adapted from Draft 2013 HMP

Hurricanes are a City-wide hazard in Waltham and are considered a medium frequency event. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, this hazard can occur between once in 5 years to once in 50 years (a 2% to 20% chance per year).

4.3.2 Tornados

A tornado is a narrow, violently rotating column of air that extends from the base of a cloud to the ground. Tornadoes are the most violent of all atmospheric storms (EEA and EOPSS 2018, 4-242). According to the 2018 SHMCAP, the following are common factors in tornado formation:

- Very strong winds in the middle and upper levels of the atmosphere
- Clockwise turning of the wind with height
- Increasing wind speed in the lowest 10,000 feet of the atmosphere (i.e. 20 mph at the surface and 50 mph at 7,000 feet)
- Very warm, moist air near the ground, with unusually cooler air aloft
- A forcing mechanism such as a cold front or leftover weather boundary from previous shower or thunderstorm activity

Tornadoes can be spawned by tropical cyclones or the remnants thereof, and weak tornadoes can even form from little more than a rain shower if air is converging and spinning upward. The most common months for tornadoes to occur are June, July, and August. There are exceptions: The Great Barrington, Massachusetts, tornado in 1995 occurred in May; and the Windsor Locks, Connecticut, tornado in 1979. occurred in October (EEA and EOPSS 2018, 4-244).

The Fujita Tornado Scale measures tornado severity through estimated wind speed and damage. The National Weather Service began using the Enhanced Fujita-scale (EF-scale) in 2007, which led to increasingly accurate estimates of tornado severity. Table 4-14 provides more detailed information on the EF Scale.

Table 4-14. Enhanced Fujita Scale

Fujita Scale			Derived		Operational EF Scale	
F Number	Fastest ¼ mile (mph)	3-second gust (mph)	EF Number	3-second gust (mph)	EF Number	3-second gust (mph)
0	40 – 72	45 – 78	0	65 – 85	0	65 – 85
1	73 – 112	79 – 117	1	86 – 109	1	86 – 110
2	113 – 157	118 – 161	2	110 – 137	2	111 – 135
3	158 – 207	162 – 209	3	138 – 167	3	136 – 165
4	208 – 260	210 – 261	4	168 – 199	4	166 – 200
5	261– 318	262 – 317	5	200 – 234	5	Over 200

Source: Massachusetts State Hazard Mitigation Plan 2013, page 416

Massachusetts experiences an average of 1.7 tornadoes per year. The most tornado-prone areas of the state are the central counties. Tornadoes are comparatively rare in eastern Massachusetts, although Middlesex County is considered an at-risk location (EEA and EOPSS 2018, 4-243). The most devastating tornado in Massachusetts in the history of recorded weather occurred in Worcester in 1953, it killed 94 people, injured more than 1,000, and caused more than $52 million in damages (more than $460 million in current dollars). The most recent tornadoes in Massachusetts occurred in 2011 in Springfield, 2014 in Revere, and 2016 in Concord (Morrison 2014; Epstein 2016).

There have been 18 recorded tornados in Middlesex County since 1955. One fatality and six injuries were reported (Lietz 2019). Table 4-15 below provides additional information.

Table 4-15. Tornado Records for Middlesex County

Date	Fujita	Fatalities	Injuries	Width	Length	Damage
10/24/1955	1	0	0	10	0.1	$500-$5000
6/19/1957	1	0	0	17	1	$5K-$50K
6/19/1957	1	0	0	100	0.5	$50-$500
7/11/1958	2	0	0	17	1.5	$50K-$500K
8/25/1958	2	0	0	50	1	$500-$5000
7/3/1961	0	0	0	10	0.5	$5K-$50K
7/18/1963	1	0	0	50	1	$5K-$50K
8/28/1965	2	0	0	10	2	$50K-$500K
7/11/1970	1	0	0	50	0.1	$5K-$50K
10/3/1970	3	1	0	60	35.4	$50K-$500K

Date	Fujita	Fatalities	Injuries	Width	Length	Damage
7/1/1971	1	0	1	10	25.2	$5K-$50K
11/7/1971	1	0	0	10	0.1	$50-$500
7/21/1972	2	0	4	37	7.6	$500K-$5M
9/29/1974	3	0	1	33	0.1	$50K-$500K
7/18/1983	0	0	0	20	0.4	$50-$500K
9/27/1985	1	0	0	40	0.1	$50-$500K
8/7/1986	1	0	0	73	4	$50K-$500K
8/22/2016	1	0	0	400	.85	$10K

Source: Lietz 2019

Although tornadoes are a potential City-wide hazard in Waltham, there have been no recorded tornadoes in the City. If a tornado were to occur in Waltham, damages would depend on the track of the tornado and would be most likely be high due to the prevalence of older construction and the density of development that exist. Structures built before current building codes may be more vulnerable. Evacuation, sheltering, debris clearance, distribution of food and other supplies, search and rescue, and emergency fire and medical services may be required. Critical evacuation and transportation routes may be impassable due to downed trees and debris, and recovery efforts may be complicated by power outages.

Tornado events in Waltham are a very low frequency event. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, this hazard may occur less than once in 100 years (a less-than 1% chance per year). Tornados are difficult to simulate well in climate models because of their small size. However, it is predicted that the frequency of tornados in eastern Massachusetts will rise in the future due to climate change.

4.3.3 Nor'easters

A nor'easter is characterized by large counter-clockwise wind circulation around a low-pressure center that often results in heavy snow, high winds, waves, and rain along the East Coast of North America. The term nor'easter refers to their strong northeasterly winds blowing in from the ocean. These winter weather events are among the season's most ferocious storms, often causing beach erosion, flooding, and structural damage (EEA and EOPSS 2018, 4-225).

Nor'easters generally occur on at least an annual basis, typically in late fall and early winter. Some years bringing up to four nor'easter events. This is currently the most frequently occurring natural hazard in the state. The storm radius is often as much as 100 miles and sustained wind speeds of 20 to 40 mph are common, with short-term gusts of up to 50 to 60 mph. Nor'easters are commonly accompanied by a storm surge equal to or greater than two feet. High surge and winds during a hurricane can last from 6 to 12 hours, while these conditions during a nor'easter can last from 12 hours to three days (EEA and EOPSS 2018, 4-224–4-226). Previous nor'easters events are listed in Table 4-16 below.

Table 4-16. Nor'easter Events for Massachusetts, 1978 to 2015

Nor'easter Event	Date
Blizzard of 1978	February 1978
Severe Coastal Storm ("Perfect Storm")	October 1991
Great Nor'easter of 1992	December 1992
Blizzard, Nor'easter	January 2005
Coastal Storm, Nor'easter	October 2005
Severe Storms, Inland and Coastal Flooding	April 2007
Winter Storm and Nor'easter	January 2011
Severe Storm and Snowstorm	October 2011
Severe Winter Storm, Snowstorm, and Flooding	April 2013
Severe Winter Storm, Snowstorm, and Flooding	April 2015
Severe Winter Storm and Flooding	March 2018
Severe Winter Storm and Snowstorm	March 2018

Some of the historic events described in the "Flood-Related Hazards" section of this report were preceded by nor'easters, including the 1991 "Perfect Storm." The Blizzard of '78 was a notable storm. More recently, winter storms in 2015 and 2018 caused significant snowfall amounts.

The City of Waltham is vulnerable to high winds, snow, and extreme rain during nor'easters. These impacts can lead to property damage, downed trees, power service disruptions, surcharged drainage systems, and localized flooding. These conditions can impact evacuation and transportation routes and complicate emergency response efforts. Due to its inland location, Waltham is not subject to the coastal hazards often associated with nor'easters.

Nor'easters in Waltham are high frequency events. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, this hazard may occur more frequently than once in 5 years (a greater than 20% chance per year).

4.3.4 Severe Thunderstorms

Thunderstorms in Massachusetts are usually accompanied by rainfall; however, during periods of drought, lightning from thunderstorm cells can result in fire ignition. Thunderstorms with little or no rainfall are rare in New England but have occurred (EEA and EOPSS 2018, 4-173).

Thunderstorms are typically less severe than other events discussed in this section. However, thunderstorms can cause local damage and are a City-wide risk in Waltham. Thunderstorms can include lightning, strong winds, heavy rain, hail, and sometimes tornados. Thunderstorms typically last for about 30 minutes and can generate winds of up to 60 mph.

NOAA's National Centers for Environmental Information offers thunderstorm data for Middlesex County, which includes Waltham. Between 2008 and 2018, 278 thunderstorm events caused $3,208,000 in property damages. Three injuries and no deaths were reported. Table 4-17 provides detailed information related to thunderstorms.

Table 4-17. Middlesex County Thunderstorm Events, 2008 to 2018

Location	Date	Magnitude*	Deaths	Injuries	Property Damage
Totals:			0	3	3.208M
LITTLETON	05/27/2008	50 kts. EG	0	0	1.00K
WESTFORD	05/27/2008	50 kts. EG	0	0	8.00K
WEST CHELMSFORD	05/27/2008	50 kts. EG	0	0	0.50K
WEST CONCORD	05/27/2008	50 kts. EG	0	0	1.00K
READING	05/27/2008	50 kts. EG	0	0	1.00K
MARLBOROUGH	06/10/2008	50 kts. EG	0	0	20.00K
SOUTH WILMINGTON	06/10/2008	50 kts. EG	0	0	13.00K
OAK GROVE	06/10/2008	50 kts. EG	0	0	5.00K
ASHBY	06/23/2008	50 kts. EG	0	0	5.00K
FELCHVILLE	06/23/2008	50 kts. EG	0	0	4.00K
SHIRLEY	06/24/2008	50 kts. EG	0	0	5.00K
ACTON	06/24/2008	50 kts. EG	0	0	5.00K
CONCORD	06/24/2008	50 kts. EG	0	1	0.00K
CONCORD	06/24/2008	50 kts. EG	0	0	5.00K
MEDFORD	06/24/2008	50 kts. EG	0	0	1.00K
NORTH SOMMERVILLE	06/24/2008	50 kts. EG	0	0	3.00K
EAST EVERETT	06/24/2008	50 kts. EG	0	0	1.00K
BEAVER BROOK	06/27/2008	50 kts. EG	0	0	5.00K
WATERTOWN	06/27/2008	50 kts. EG	0	0	3.00K
GROTON	06/29/2008	50 kts. EG	0	0	10.00K
WESTFORD	06/29/2008	50 kts. EG	0	0	5.00K
DRACUT	06/29/2008	50 kts. EG	0	0	0.00K
HUDSON	07/01/2008	50 kts. EG	0	0	20.00K
STOW	07/01/2008	55 kts. MG	0	0	0.00K
MAYNARD	07/01/2008	50 kts. EG	0	0	10.00K
BEAVER BROOK	07/01/2008	50 kts. EG	0	0	5.00K
BEDFORD	07/01/2008	50 kts. EG	0	0	5.00K
LAKE STREET	07/02/2008	50 kts. EG	0	0	1.00K
SHERBORN	07/02/2008	50 kts. EG	0	0	1.00K
NORTH SOMMERVILLE	07/02/2008	50 kts. EG	0	0	5.00K
WESTFORD	07/02/2008	50 kts. EG	0	0	5.00K
ACTON	07/03/2008	50 kts. EG	0	0	15.00K
CONCORD	07/03/2008	50 kts. EG	0	0	3.00K
READING	07/03/2008	50 kts. EG	0	0	3.00K
BILLERICA	07/19/2008	50 kts. EG	0	0	6.00K
WILMINGTON	07/19/2008	50 kts. EG	0	0	8.00K
WESTLANDS	07/19/2008	50 kts. EG	0	0	2.00K
BEAVER BROOK	07/20/2008	50 kts. EG	0	0	5.00K
ASHBY	07/27/2008	50 kts. EG	0	0	5.00K
NORTH SOMMERVILLE	08/03/2008	50 kts. EG	0	0	5.00K
MARLBOROUGH	08/07/2008	50 kts. EG	0	0	5.00K
HOPKINTON	08/07/2008	50 kts. EG	0	0	5.00K
WEST CHELMSFORD	09/09/2008	50 kts. EG	0	0	8.00K
NORTH SOMMERVILLE	09/09/2008	50 kts. EG	0	0	4.00K
AYER	05/09/2009	50 kts. EG	0	0	2.00K
FRAMINGHAM	05/24/2009	50 kts. EG	0	0	15.00K

Table 4-17. Middlesex County Thunderstorm Events, 2008 to 2018

Location	Date	Magnitude*	Deaths	Injuries	Property Damage
HOLLISTON	07/07/2009	50 kts. EG	0	0	1.00K
HOPKINTON	07/08/2009	50 kts. EG	0	0	20.00K
WESTFORD	07/26/2009	50 kts. EG	0	0	1.00K
WEST CHELMSFORD	07/26/2009	50 kts. EG	0	0	15.00K
SUDBURY CENTER	07/31/2009	50 kts. EG	0	0	30.00K
ACTON	07/31/2009	50 kts. EG	0	0	15.00K
WAKEFIELD	07/31/2009	50 kts. EG	0	0	10.00K
WOODVILLE	07/31/2009	50 kts. EG	0	0	3.00K
INMAN SQUARE	07/31/2009	50 kts. EG	0	0	15.00K
NORTH SOMMERVILLE	07/31/2009	50 kts. EG	0	0	5.00K
CONCORD	05/04/2010	50 kts. EG	0	0	30.00K
NEWTON	05/04/2010	50 kts. EG	0	0	7.00K
WEDGEMERE	06/01/2010	50 kts. EG	0	0	5.00K
FARM HILL	06/03/2010	50 kts. EG	0	0	20.00K
READING	06/03/2010	50 kts. EG	0	0	1.00K
HOLLISTON	06/05/2010	50 kts. EG	0	0	40.00K
FRAMINGHAM	06/06/2010	50 kts. EG	0	1	25.00K
WESTON	06/06/2010	50 kts. EG	0	0	20.00K
NEWTON CENTER	06/06/2010	50 kts. EG	0	0	3.00K
NATICK	06/06/2010	50 kts. EG	0	0	50.00K
BELMONT	06/06/2010	50 kts. EG	0	0	30.00K
ARLINGTON	06/06/2010	50 kts. EG	0	0	10.00K
WAYLAND	06/06/2010	50 kts. EG	0	0	25.00K
WATERTOWN	06/06/2010	50 kts. EG	0	0	100.00K
OAK GROVE	06/06/2010	50 kts. EG	0	0	1.00K
INMAN SQUARE	06/06/2010	50 kts. EG	0	0	30.00K
LEXINGTON	06/06/2010	50 kts. EG	0	0	1.00K
ASHBY	06/24/2010	50 kts. EG	0	0	10.00K
HOVEY CORNER	06/24/2010	50 kts. EG	0	0	2.00K
ACTON	06/24/2010	50 kts. EG	0	0	2.00K
LITTLETON COMMON	06/24/2010	50 kts. EG	0	0	3.00K
WESTLANDS	06/24/2010	50 kts. EG	0	0	15.00K
COCHITUATE	06/24/2010	50 kts. EG	0	0	30.00K
BEAVER BROOK	06/24/2010	50 kts. EG	0	0	1.00K
OAK GROVE	06/24/2010	50 kts. EG	0	0	15.00K
BURLINGTON	06/24/2010	50 kts. EG	0	0	1.00K
FARM HILL	06/24/2010	50 kts. EG	0	0	15.00K
WILMINGTON	07/12/2010	50 kts. EG	0	0	25.00K
BURLINGTON	07/12/2010	50 kts. EG	0	0	50.00K
HUDSON	07/19/2010	50 kts. EG	0	0	25.00K
ACTON	06/01/2011	50 kts. EG	0	0	5.00K
CONCORD	06/01/2011	50 kts. EG	0	0	3.00K
WAYLAND	06/09/2011	50 kts. EG	0	0	15.00K
WESTLANDS	06/09/2011	50 kts. EG	0	0	15.00K
READING	08/02/2011	50 kts. EG	0	0	1.00K
NEWTON CENTER	08/19/2011	50 kts. EG	0	0	3.00K
NORTH SOMMERVILLE	08/19/2011	50 kts. EG	0	0	5.00K

Table 4-17. Middlesex County Thunderstorm Events, 2008 to 2018

Location	Date	Magnitude*	Deaths	Injuries	Property Damage
CAMBRIDGE	08/19/2011	50 kts. EG	0	0	5.00K
WEST EVERETT	08/19/2011	50 kts. EG	0	0	15.00K
ACTON	08/19/2011	50 kts. EG	0	0	0.00K
WEST CHELMSFORD	08/19/2011	50 kts. EG	0	0	5.00K
INMAN SQUARE	06/08/2012	50 kts. EG	0	0	25.00K
ARLINGTON	06/23/2012	45 kts. EG	0	0	5.00K
NORTH READING	07/04/2012	50 kts. EG	0	0	10.00K
WEST VLG	07/18/2012	50 kts. EG	0	0	15.00K
ARLINGTON	07/18/2012	70 kts. EG	0	0	350.00K
CONCORD	09/07/2012	50 kts. EG	0	0	10.00K
TYNGSBORO	09/08/2012	40 kts. EG	0	0	3.00K
HUDSON	06/17/2013	50 kts. EG	0	0	20.00K
STOW	06/17/2013	50 kts. EG	0	0	25.00K
NEWTON CENTER	06/17/2013	45 kts. EG	0	0	3.00K
SAXONVILLE	06/18/2013	45 kts. EG	0	0	10.00K
ASHBY	06/24/2013	45 kts. EG	0	0	3.00K
TEWKSBURY	07/23/2013	50 kts. EG	0	0	20.00K
NATICK	07/29/2013	50 kts. EG	0	0	5.00K
SHERBORN	07/29/2013	50 kts. EG	0	0	5.00K
KENWOOD	07/03/2014	50 kts. EG	0	0	50.00K
HOLLISTON	07/03/2014	50 kts. EG	0	0	75.00K
BILLERICA	07/07/2014	40 kts. EG	0	0	5.00K
CONCORD	07/07/2014	50 kts. EG	0	0	15.00K
EAST EVERETT	07/07/2014	50 kts. EG	0	0	5.00K
BEDFORD	07/07/2014	87 kts. EG	0	0	100.00K
BURLINGTON	07/07/2014	50 kts. EG	0	0	5.00K
NORTH WOBURN	07/07/2014	50 kts. EG	0	0	5.00K
LEXINGTON	07/07/2014	50 kts. EG	0	0	15.00K
NORTH WOBURN	07/07/2014	50 kts. EG	0	0	25.00K
FARM HILL	07/07/2014	50 kts. EG	0	0	5.00K
WEDGEMERE	07/07/2014	50 kts. EG	0	0	15.00K
MEDFORD	07/07/2014	50 kts. EG	0	0	25.00K
WEST EVERETT	07/07/2014	50 kts. EG	0	0	5.00K
WEST EVERETT	07/07/2014	50 kts. EG	0	0	5.00K
WESTFORD STATION	07/15/2014	50 kts. EG	0	0	25.00K
WILLOWS	07/28/2014	50 kts. EG	0	0	50.00K
WESTLANDS	09/06/2014	50 kts. EG	0	1	10.00K
DRACUT	09/06/2014	50 kts. EG	0	0	5.00K
HOVEY CORNER	09/06/2014	50 kts. EG	0	0	5.00K
DRACUT	09/06/2014	50 kts. EG	0	0	5.00K
WESTFORD	09/06/2014	50 kts. EG	0	0	3.00K
BILLERICA	09/06/2014	50 kts. EG	0	0	10.00K
MEDFORD	09/06/2014	50 kts. EG	0	0	3.00K
READING	09/06/2014	50 kts. EG	0	0	2.00K
WILMINGTON	09/06/2014	50 kts. EG	0	0	15.00K
ARLINGTON	09/06/2014	50 kts. EG	0	0	5.00K
NEWTON CENTER	09/06/2014	50 kts. EG	0	0	1.00K

Table 4-17. Middlesex County Thunderstorm Events, 2008 to 2018

Location	Date	Magnitude*	Deaths	Injuries	Property Damage
NORTH SOMMERVILLE	09/06/2014	50 kts. EG	0	0	10.00K
INMAN SQUARE	09/06/2014	50 kts. EG	0	0	10.00K
BURLINGTON	05/28/2015	45 kts. EG	0	0	5.00K
WAKEFIELD	05/28/2015	50 kts. EG	0	0	2.00K
WAKEFIELD	08/04/2015	40 kts. EG	0	0	5.00K
ACTON	08/04/2015	50 kts. EG	0	0	15.00K
BOXBOROUGH	08/04/2015	50 kts. EG	0	0	10.00K
HARWOOD	08/04/2015	50 kts. EG	0	0	40.00K
CONCORD	08/04/2015	50 kts. EG	0	0	15.00K
WAKEFIELD	08/04/2015	50 kts. EG	0	0	10.00K
MARLBOROUGH	08/04/2015	50 kts. EG	0	0	10.00K
BLEACHERY	08/04/2015	50 kts. EG	0	0	5.00K
NEWTON	08/15/2015	45 kts. EG	0	0	5.00K
NATICK	08/15/2015	45 kts. EG	0	0	5.00K
NATICK	08/15/2015	50 kts. EG	0	0	15.00K
NATICK	08/15/2015	50 kts. EG	0	0	5.00K
NATICK	08/15/2015	50 kts. EG	0	0	5.00K
NATICK	08/15/2015	50 kts. EG	0	0	25.00K
NATICK	08/15/2015	50 kts. EG	0	0	15.00K
NATICK	08/15/2015	50 kts. EG	0	0	5.00K
FRAMINGHAM	08/15/2015	45 kts. EG	0	0	5.00K
WEST CHELMSFORD	02/25/2016	50 kts. EG	0	0	10.00K
SHERBORN	02/25/2016	50 kts. EG	0	0	20.00K
HOPKINTON	02/25/2016	50 kts. EG	0	0	5.00K
CONCORD	02/25/2016	50 kts. EG	0	0	1.00K
SHERBORN	02/25/2016	50 kts. EG	0	0	5.00K
CONCORD	02/25/2016	50 kts. EG	0	0	30.00K
SHERBORN	02/25/2016	50 kts. EG	0	0	5.00K
SHERBORN	02/25/2016	50 kts. EG	0	0	15.00K
CONCORD	02/25/2016	50 kts. EG	0	0	60.00K
BILLERICA	02/25/2016	50 kts. EG	0	0	5.00K
OAK GROVE	02/25/2016	50 kts. EG	0	0	5.00K
CONCORD	02/25/2016	50 kts. EG	0	0	15.00K
BILLERICA	02/25/2016	50 kts. EG	0	0	5.00K
NATICK	02/25/2016	50 kts. EG	0	0	20.00K
SHIRLEY	03/17/2016	45 kts. EG	0	0	5.00K
NORTH CHELMSFORD	03/17/2016	45 kts. EG	0	0	5.00K
SAXONVILLE	07/22/2016	50 kts. EG	0	0	15.00K
NATICK	07/22/2016	50 kts. EG	0	0	5.00K
SAXONVILLE	07/22/2016	50 kts. EG	0	0	25.00K
SAXONVILLE	07/22/2016	50 kts. EG	0	0	15.00K
WEDGEMERE	07/23/2016	50 kts. EG	0	0	55.00K
WEST EVERETT	07/23/2016	50 kts. EG	0	0	15.00K
OAK GROVE	07/23/2016	50 kts. EG	0	0	10.00K
ARLINGTON	07/23/2016	50 kts. EG	0	0	20.00K
MEDFORD	07/23/2016	50 kts. EG	0	0	1.00K
EAST EVERETT	07/23/2016	50 kts. EG	0	0	5.00K

Table 4-17. Middlesex County Thunderstorm Events, 2008 to 2018

Location	Date	Magnitude*	Deaths	Injuries	Property Damage
WESTLANDS	07/23/2016	50 kts. EG	0	0	50.00K
WESTFORD	07/23/2016	50 kts. EG	0	0	10.00K
SHIRLEY	07/23/2016	50 kts. EG	0	0	5.00K
BILLERICA	07/23/2016	50 kts. EG	0	0	5.00K
NORTH READING	07/23/2016	50 kts. EG	0	0	5.00K
WEST CHELMSFORD	07/23/2016	50 kts. EG	0	0	45.00K
WEST TOWNSEND	07/23/2016	50 kts. EG	0	0	5.00K
BILLERICA	07/23/2016	50 kts. EG	0	0	1.00K
GROTON	07/23/2016	50 kts. EG	0	0	10.00K
CONCORD	07/23/2016	50 kts. EG	0	0	25.00K
LITTLETON COMMON	07/23/2016	50 kts. EG	0	0	5.00K
CONCORD	07/23/2016	50 kts. EG	0	0	15.00K
READING	07/23/2016	50 kts. EG	0	0	1.00K
LEXINGTON	07/23/2016	50 kts. EG	0	0	1.00K
BEAVER BROOK	07/23/2016	50 kts. EG	0	0	1.00K
NORTH SOMMERVILLE	07/23/2016	50 kts. EG	0	0	5.00K
MARLBOROUGH	08/22/2016	50 kts. EG	0	0	5.00K
MARLBOROUGH	08/22/2016	50 kts. EG	0	0	30.00K
CONCORD	08/22/2016	50 kts. EG	0	0	5.00K
EAST SUDBURY	08/22/2016	50 kts. EG	0	0	10.00K
NORTH WOBURN	08/22/2016	50 kts. EG	0	0	1.00K
GROTON	09/11/2016	50 kts. EG	0	0	10.00K
TOWNSEND	09/11/2016	50 kts. EG	0	0	20.00K
HOVEY CORNER	09/11/2016	50 kts. EG	0	0	5.00K
GROTON	09/11/2016	50 kts. EG	0	0	10.00K
GROTON	09/11/2016	50 kts. EG	0	0	5.00K
WEST CHELMSFORD	09/11/2016	50 kts. EG	0	0	20.00K
ASHLAND	09/11/2016	50 kts. EG	0	0	5.00K
BEAVER BROOK	09/11/2016	50 kts. EG	0	0	15.00K
NEWTON CENTER	09/11/2016	50 kts. EG	0	0	5.00K
CONCORD	09/11/2016	50 kts. EG	0	0	10.00K
NEWTON CENTER	09/11/2016	50 kts. EG	0	0	5.00K
NORTH SOMMERVILLE	09/11/2016	50 kts. EG	0	0	10.00K
NUTTING LAKE	05/18/2017	50 kts. EG	0	0	1.00K
LOWELL	05/18/2017	50 kts. EG	0	0	1.00K
SOUTH LOWELL	05/18/2017	50 kts. EG	0	0	1.00K
FRESH POND	06/13/2017	52 kts. EG	0	0	5.00K
NORTH SOMMERVILLE	06/13/2017	52 kts. EG	0	0	1.00K
CAMBRIDGE	06/13/2017	55 kts. MG	0	0	1.00K
CAMBRIDGE	06/13/2017	55 kts. MG	0	0	0.00K
MEDFORD	06/13/2017	52 kts. EG	0	0	1.00K
LAKE STREET	06/13/2017	52 kts. EG	0	0	1.00K
FRESH POND	06/13/2017	52 kts. EG	0	0	4.00K
SOMERVILLE	06/13/2017	52 kts. EG	0	0	4.00K
SOMERVILLE	06/13/2017	52 kts. EG	0	0	1.50K
SOMERVILLE	06/13/2017	52 kts. EG	0	0	1.50K
CAMBRIDGE	06/13/2017	52 kts. EG	0	0	5.00K

Table 4-17. Middlesex County Thunderstorm Events, 2008 to 2018

Location	Date	Magnitude*	Deaths	Injuries	Property Damage
MEDFORD	06/13/2017	52 kts. EG	0	0	6.00K
INMAN SQUARE	06/13/2017	52 kts. EG	0	0	1.00K
CAMBRIDGE	06/13/2017	52 kts. EG	0	0	5.00K
FELCHVILLE	06/23/2017	50 kts. EG	0	0	2.50K
NEWTON LOWER FALLS	06/23/2017	50 kts. EG	0	0	1.00K
CENTRAL SQUARE	06/23/2017	50 kts. EG	0	0	1.50K
CENTRAL SQUARE	06/23/2017	50 kts. EG	0	0	6.00K
WEDGEMERE	06/23/2017	50 kts. EG	0	0	1.00K
WALNUT HILL	06/23/2017	50 kts. EG	0	0	4.00K
ARLINGTON HGTS	06/23/2017	50 kts. EG	0	0	1.00K
WEST VLG	06/23/2017	50 kts. EG	0	0	4.50K
SOUTH WILMINGTON	06/23/2017	50 kts. EG	0	0	7.00K
NORTH READING	06/23/2017	50 kts. EG	0	0	1.00K
WEST CONCORD	06/27/2017	50 kts. EG	0	0	1.00K
WABAN	06/27/2017	50 kts. EG	0	0	1.00K
WATERTOWN	07/12/2017	50 kts. EG	0	0	1.00K
NEWTONVILLE	07/12/2017	50 kts. EG	0	0	15.00K
CLEMATIS BROOK	07/12/2017	50 kts. EG	0	0	3.00K
ACTON	08/02/2017	50 kts. EG	0	0	6.00K
MAYNARD	08/02/2017	50 kts. EG	0	0	6.00K
MINUTE MAN ARPT	08/02/2017	50 kts. EG	0	0	1.00K
MINUTE MAN ARPT	08/02/2017	50 kts. EG	0	0	1.00K
CAMBRIDGE	09/06/2017	50 kts. EG	0	0	8.00K
BEAVER BROOK	05/15/2018	40 kts. EG	0	0	12.00K
HOVEY CORNER	06/18/2018	50 kts. EG	0	0	1.50K
WESTFORD	06/18/2018	50 kts. EG	0	0	25.00K
SOUTH CHELMSFORD	06/18/2018	50 kts. EG	0	0	15.00K
SOUTH CHELMSFORD	06/18/2018	50 kts. EG	0	0	6.00K
EAST ACTON	06/18/2018	50 kts. EG	0	0	5.00K
ACTON	06/18/2018	50 kts. EG	0	0	5.00K
BOXBOROUGH	06/18/2018	50 kts. EG	0	0	2.00K
WEST MEDFORD	06/25/2018	43 kts. EG	0	0	10.00K
WEST MEDFORD	06/25/2018	43 kts. EG	0	0	2.00K
BENNETT HALL	07/17/2018	45 kts. EG	0	0	1.00K
BILLERICA	07/17/2018	45 kts. EG	0	0	1.00K
SILVER LAKE	07/17/2018	45 kts. EG	0	0	1.00K
MARLBOROUGH	07/26/2018	50 kts. EG	0	0	5.00K
WEST TOWNSEND	08/07/2018	50 kts. EG	0	0	2.00K
FOUR CORNERS	08/07/2018	50 kts. EG	0	0	1.00K
CHELMSFORD CENTER	08/17/2018	50 kts. EG	0	0	3.00K
NORTH SOMMERVILLE	08/17/2018	50 kts. EG	0	0	1.00K
SOUTH WILMINGTON	09/06/2018	50 kts. EG	0	0	1.00K
METCALF	09/06/2018	50 kts. EG	0	0	1.00K
SILVER LAKE	10/23/2018	46 kts. EG	0	0	10.00K
Totals:			0	3	3.208M

*Magnitude refers to maximum wind speed, measured in knots

Source: NOAA 2018a

Winds associated with thunderstorms can knock down trees resulting in power outages and blocked evacuation and transportation routes. Extreme rain during thunderstorms can cause inland flooding around waterbodies or due to surcharged drainage systems.

Thunderstorms are considered high frequency events in Waltham. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, this hazard may occur more frequently than once in 5 years (a greater than 20% chance per year).

4.4 Winter Storms

Winter storm events are atmospheric in nature and can impact the entire planning area. All current and future buildings and populations are considered to be at risk of winter storms, which have a variety of potential impacts. Heavy snow loads may cause roofs and trees to collapse leading to structural damage. Deaths and injury are also possible impacts. Additional impacts can include road closures, power outages, business interruption, business losses (i.e. due to road closures), hazardous driving conditions, frozen pipes, fires due to improper heating, and second-hand health impacts caused by shoveling (such as a heart attack). Public safety issues are also a concern, as streets and sidewalks can become difficult to pass. This issue may be especially difficult for vulnerable populations such as elderly people who may have trouble crossing at intersections due to large accumulations of snow. Impassable streets can also complicate emergency response efforts during an extreme event.

Winter storms are a potential City-wide hazard in Waltham. These events can include wind, heavy snow, blizzards, and ice storms. Blizzards and ice storms in Massachusetts can range from an inconvenience, to extreme events that cause significant impacts and require a large-scale, coordinated response.

4.4.1 Heavy Snow and Blizzards

A plow clearing streets in Waltham. Photo by Ines Boehnert/Wicked Local Photo.

A blizzard is a winter snowstorm with sustained wind or frequent wind gusts of 35 mph or more, accompanied by falling or blowing snow that reduces visibility to or below a quarter of a mile. These conditions must be the predominant condition over a 3-hour period. Extremely cold temperatures are often associated with blizzard conditions but are not a formal part of the criteria. However, the hazard created by the combination of snow, wind, and low visibility increases significantly with temperatures below 20°F. A severe blizzard is categorized as having temperatures near or below 10°F, winds exceeding 45 mph, and visibility reduced by snow to near zero (EEA and EOPSS 2018, 4-223).

Winter storms include multiple risks, such as wind, ice, and heavy snow. The National Weather Service defines “heavy snow” as snowfall accumulating to 4" or more in 12 hours or less; or snowfall accumulating to 6" or more in 24 hours or less (NOAA 2019b). Winter storms can be combined with the nor’easters discussed previously in the “Wind-Related Hazards” section.

There is no widely used scale to classify snowstorms. The Northeast Snowfall Impact Scale (NESIS) developed by Paul Kocin of The Weather Channel and Louis Uccellini of the National Weather Service

(Kocin and Uccellini, 2004) characterizes and ranks high-impact northeast snowstorms. These storms have large areas of 10-inch snowfall accumulations and greater. NESIS has five categories, as shown in Table 4-18. The index differs from other meteorological indices in that it uses population information in addition to meteorological measurements. Thus, NESIS gives an indication of a storm's societal impacts. This scale was developed because of the impact northeast snowstorms can have on the rest of the country in terms of transportation and economics. NESIS scores are a function of the area affected by the snowstorm, the amount of snow, and the number of people living in the path of the storm. The aerial distribution of snowfall and population information are combined in an equation that calculates a NESIS score, which varies from 1 for smaller storms to over 10 for extreme storms. The raw score is converted into one of the five NESIS categories. The largest NESIS values result from storms producing heavy snowfall over large areas that include major metropolitan centers. NOAA began using the NESIS in 2005 to determine impact from snow events (MEMA and DCR 2013, 400).

Table 4-18. NESIS Categories

Category	NESIS	Value Description
1	1 – 2.499	Notable
2	2.5 – 3.99	Significant
3	4 – 5.99	Major
4	6 – 9.99	Crippling
5	10+	Extreme

Source: Massachusetts State Hazard Mitigation and Climate Adaptation Plan (EEA and EOPSS 2018)

The current winter snowfall record in Eastern Massachusetts is 108.6 inches during the 2014-2015 season ((NOAA, 2015). Map 6 in Appendix B indicates that the average annual snowfall in Waltham is between 48.1 inches to 72 inches. The City provides standard snow plowing operations and clearing snow has not posed any significant challenges. However, City officials acknowledged that due to steep areas icing conditions can occur throughout the City, making travel difficult. The spring thaw, with freezing conditions, is particularly difficult in these hilly areas.

The "Blizzard of 1978" is a well-known winter storm that deposited more than three feet of snow and led to multi-day closures of roads, businesses, and schools. Table 4-19 provides additional information on significant snow events.

Table 4-19. Severe Winter Storm Records for Massachusetts

Type of Event	Date
Blizzard	February 1978
Blizzard	March 1993
Blizzard	January 1996
Severe Snow Storm	March 2001
Severe Snow Storm	December 2003
Severe Snow Storm	January 2004
Severe Snow Storm	January 2005
Severe Snow Storm	April 2007
Severe Snow Storm	December 2010
Severe Snow Storm	January 2011
Blizzard	February 2013

Table 4-19. Severe Winter Storm Records for Massachusetts

Type of Event	Date
Blizzard	January 2015
Severe Snow Storm	March 2018

Source: National Oceanic and Atmospheric Administration

According to the National Centers for Environmental Information, there were 66 winter storm events between 1998 and 2018 totaling $1,298,000 dollars of storm damage (Table 4-20). NOAA's National Centers for Environmental Information also offers records of heavy snow events in Middlesex County. Between 1998 and 2018, there were 136 heavy snowfall events causing $229,500 in property damage. No injuries or deaths were reported. Please refer to Table 4-20 for more information.

Table 4-20. Winter Storm Events in Middlesex County, 1998 to 2018

Location	Date	Deaths	Injuries	Property Damage
Totals:		0	0	1.298M
SOUTHEAST MIDDLESEX (ZONE)	12/25/2002	0	0	15,000
WESTERN MIDDLESEX (ZONE)	12/25/2002	0	0	15,000
SOUTHEAST MIDDLESEX (ZONE)	1/3/2003	0	0	0
WESTERN MIDDLESEX (ZONE)	1/3/2003	0	0	0
SOUTHEAST MIDDLESEX (ZONE)	2/7/2003	0	0	0
WESTERN MIDDLESEX (ZONE)	2/7/2003	0	0	0
SOUTHEAST MIDDLESEX (ZONE)	2/17/2003	0	0	0
WESTERN MIDDLESEX (ZONE)	2/17/2003	0	0	0
SOUTHEAST MIDDLESEX (ZONE)	12/5/2003	0	0	0
WESTERN MIDDLESEX (ZONE)	12/5/2003	0	0	0
WESTERN MIDDLESEX (ZONE)	12/14/2003	0	0	0
SOUTHEAST MIDDLESEX (ZONE)	12/26/2004	0	0	0
WESTERN MIDDLESEX (ZONE)	12/26/2004	0	0	0
WESTERN MIDDLESEX (ZONE)	1/5/2005	0	0	0
SOUTHEAST MIDDLESEX (ZONE)	1/5/2005	0	0	0
WESTERN MIDDLESEX (ZONE)	1/8/2005	0	0	50,000
SOUTHEAST MIDDLESEX (ZONE)	1/22/2005	0	0	0
WESTERN MIDDLESEX (ZONE)	1/22/2005	0	0	0
WESTERN MIDDLESEX (ZONE)	3/1/2005	0	0	0
SOUTHEAST MIDDLESEX (ZONE)	3/1/2005	0	0	0
WESTERN MIDDLESEX (ZONE)	3/8/2005	0	0	0
WESTERN MIDDLESEX (ZONE)	3/12/2005	0	0	0
SOUTHEAST MIDDLESEX (ZONE)	2/12/2006	0	0	10,000
WESTERN MIDDLESEX (ZONE)	2/12/2006	0	0	10,000
WESTERN MIDDLESEX (ZONE)	2/14/2007	0	0	0
SOUTHEAST MIDDLESEX (ZONE)	2/14/2007	0	0	0
NORTHWEST MIDDLESEX COUNTY (ZONE)	2/14/2007	0	0	0
SOUTHEAST MIDDLESEX (ZONE)	3/16/2007	0	0	0

Table 4-20. Winter Storm Events in Middlesex County, 1998 to 2018

Location	Date	Deaths	Injuries	Property Damage
WESTERN MIDDLESEX (ZONE)	3/16/2007	0	0	0
WESTERN MIDDLESEX (ZONE)	1/28/2009	0	0	0
SOUTHEAST MIDDLESEX (ZONE)	12/26/2010	0	0	0
NORTHWEST MIDDLESEX COUNTY (ZONE)	12/26/2010	0	0	0
WESTERN MIDDLESEX (ZONE)	12/26/2010	0	0	0
SOUTHEAST MIDDLESEX (ZONE)	1/12/2011	0	0	50,000
WESTERN MIDDLESEX (ZONE)	1/18/2011	0	0	0
NORTHWEST MIDDLESEX COUNTY (ZONE)	1/18/2011	0	0	0
SOUTHEAST MIDDLESEX (ZONE)	1/21/2011	0	0	0
NORTHWEST MIDDLESEX COUNTY (ZONE)	1/21/2011	0	0	0
WESTERN MIDDLESEX (ZONE)	1/21/2011	0	0	0
NORTHWEST MIDDLESEX COUNTY (ZONE)	2/1/2011	0	0	0
WESTERN MIDDLESEX (ZONE)	2/1/2011	0	0	926,000
SOUTHEAST MIDDLESEX (ZONE)	2/1/2011	0	0	183,500
SOUTHEAST MIDDLESEX (ZONE)	2/29/2012	0	0	0
SOUTHEAST MIDDLESEX (ZONE)	3/1/2012	0	0	0
NORTHWEST MIDDLESEX COUNTY (ZONE)	12/17/2016	0	0	0
SOUTHEAST MIDDLESEX (ZONE)	1/7/2017	0	0	0
SOUTHEAST MIDDLESEX (ZONE)	2/9/2017	0	0	0
WESTERN MIDDLESEX (ZONE)	2/9/2017	0	0	0
SOUTHEAST MIDDLESEX (ZONE)	2/12/2017	0	0	0
NORTHWEST MIDDLESEX COUNTY (ZONE)	2/12/2017	0	0	0
NORTHWEST MIDDLESEX COUNTY (ZONE)	2/12/2017	0	0	0
NORTHWEST MIDDLESEX COUNTY (ZONE)	12/9/2017	0	0	0
SOUTHEAST MIDDLESEX (ZONE)	12/9/2017	0	0	0
WESTERN MIDDLESEX (ZONE)	12/9/2017	0	0	0
NORTHWEST MIDDLESEX COUNTY (ZONE)	1/4/2018	0	0	0
SOUTHEAST MIDDLESEX (ZONE)	1/4/2018	0	0	1,000
WESTERN MIDDLESEX (ZONE)	1/4/2018	0	0	2,000
NORTHWEST MIDDLESEX COUNTY (ZONE)	2/17/2018	0	0	0
WESTERN MIDDLESEX (ZONE)	2/17/2018	0	0	0
SOUTHEAST MIDDLESEX (ZONE)	2/17/2018	0	0	0
SOUTHEAST MIDDLESEX (ZONE)	3/7/2018	0	0	0
WESTERN MIDDLESEX (ZONE)	3/7/2018	0	0	25,000
NORTHWEST MIDDLESEX COUNTY (ZONE)	3/7/2018	0	0	0
NORTHWEST MIDDLESEX COUNTY (ZONE)	3/13/2018	0	0	0
SOUTHEAST MIDDLESEX (ZONE)	3/13/2018	0	0	3,000
WESTERN MIDDLESEX (ZONE)	3/13/2018	0	0	7,000
Totals:		0	0	$1.298 million

Source: NOAA 2018a

During Waltham's MVP Workshop in February 2019, participants discussed past examples of severe winter weather. This included a time when the City experienced most of their typical winter precipitation in a single month. There was a substantial amount of snow accumulation on the roofs of City buildings, which led to some roof collapses and an urgent demand for snow removal.

Blizzards are classified as high frequency events in Waltham. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, this hazard can occur more than once in five years (a greater than 20% chance of occurring each year).

4.4.2 Ice Storms

Ice storm conditions are defined by liquid rain falling and freezing on contact with cold objects creating ice build-ups of ¼ inch or more that can cause severe damage. An ice storm warning, now included in the criterion for a winter storm warning, is for severe icing. This is issued when ½ inch or more of accretion of freezing rain is expected. This may lead to dangerous walking or driving conditions and the weighing down of power lines and trees. Icy roads can also complicate emergency response efforts during an extreme event. Sleet occurs when raindrops fall into subfreezing air thick enough that the raindrops refreeze into ice before hitting the ground. Sleet differs from hail: sleet is a wintertime phenomenon, while hail usually falls during thunderstorms in the spring and summer (MEMA and DCR 2013, 462). A comparison of hail sizes in shown in Table 4-21 below:

Table 4-21. Hail Size Comparisons

Description	Diameter (inches)
Pea	0.25
Marble or mothball	0.50
Penny or dime	0.75
Nickel	0.875
Quarter	1.00
Ping-pong ball	1.50
Golf ball	1.75
Tennis ball	2.50
Baseball	2.75
Tea cup	3.00
Grapefruit	4.00
Softball	4.50

Source: NOAA 2019a

NOAA's National Centers for Environmental Information Storm Events Database offers hail events data for Middlesex County. Between 2000 and 2018, there were 129 hail events that caused $75,250 in property damage. No deaths or injuries were reported. Please refer to Table 4-22 for more information.

Table 4-22. Middlesex County Hail Events, 2000-2018

Location	Date	Magnitude*	Deaths	Injuries	Property Damage
Totals:			0	0	75.25K
FRAMINGHAM	06/02/2000	0.75 in.	0	0	0.00K
TOWNSEND	07/18/2000	0.75 in.	0	0	0.00K
TOWNSEND	07/18/2000	0.75 in.	0	0	0.00K
WESTFORD	07/18/2000	0.75 in.	0	0	0.00K
WILMINGTON	07/18/2000	1.00 in.	0	0	0.00K
STOW	07/18/2000	1.00 in.	0	0	0.00K
NEWTON	07/18/2000	1.75 in.	0	0	0.00K
STOW	06/20/2001	1.75 in.	0	0	0.00K
BILLERICA	07/12/2001	1.50 in.	0	0	0.00K
HOLLISTON	05/27/2002	1.75 in.	0	0	0.00K
ASHLAND	05/27/2002	0.75 in.	0	0	0.00K
MARLBOROUGH	05/27/2002	1.00 in.	0	0	0.00K
DRACUT	06/02/2002	0.75 in.	0	0	0.00K
BILLERICA	08/13/2003	0.75 in.	0	0	0.00K
CHELMSFORD CENTER	07/02/2004	0.75 in.	0	0	0.00K
LEXINGTON	07/02/2004	0.88 in.	0	0	0.00K
BELMONT	07/02/2004	1.00 in.	0	0	0.00K
TOWNSEND	08/20/2004	1.75 in.	0	0	25.00K
LOWELL	08/20/2004	0.75 in.	0	0	0.00K
TEWKSBURY	08/20/2004	2.00 in.	0	0	50.00K
MARLBOROUGH	08/20/2004	0.88 in.	0	0	0.00K
FRAMINGHAM	05/21/2006	0.75 in.	0	0	0.00K
FRAMINGHAM	05/21/2006	0.75 in.	0	0	0.00K
FRAMINGHAM	07/11/2006	1.00 in.	0	0	0.00K
BILLERICA	07/11/2006	1.00 in.	0	0	0.00K
WAKEFIELD	07/11/2006	1.25 in.	0	0	0.00K
FRAMINGHAM	07/28/2006	0.75 in.	0	0	0.00K
TOWNSEND	06/05/2007	1.25 in.	0	0	0.00K
LITTLETON	06/22/2007	0.75 in.	0	0	0.00K
TOWNSEND	07/09/2007	0.88 in.	0	0	0.00K
GROTON	07/09/2007	1.00 in.	0	0	0.00K
HOPKINTON	07/28/2007	0.88 in.	0	0	0.00K
TOWNSEND	06/23/2008	0.75 in.	0	0	0.00K
HUDSON	06/24/2008	0.75 in.	0	0	0.00K
HOPKINTON	06/24/2008	0.75 in.	0	0	0.00K
ACTON	06/24/2008	0.75 in.	0	0	0.00K
NORTH WOBURN	06/24/2008	1.00 in.	0	0	0.00K
WAKEFIELD	06/24/2008	0.88 in.	0	0	0.00K
MEDFORD	06/24/2008	0.75 in.	0	0	0.00K
WEDGEMERE	06/24/2008	0.75 in.	0	0	0.00K
NORTH SOMMERVILLE	06/24/2008	0.75 in.	0	0	0.00K
HUDSON	07/01/2008	1.00 in.	0	0	0.00K
STOW	07/01/2008	1.75 in.	0	0	0.25K
ACTON	07/01/2008	0.88 in.	0	0	0.00K

Table 4-22. Middlesex County Hail Events, 2000-2018

Location	Date	Magnitude*	Deaths	Injuries	Property Damage
CAMBRIDGE	07/02/2008	1.00 in.	0	0	0.00K
BELMONT	07/02/2008	0.75 in.	0	0	0.00K
NORTH SOMMERVILLE	07/02/2008	1.00 in.	0	0	0.00K
ARLINGTON	07/02/2008	0.75 in.	0	0	0.00K
NORTH WOBURN	07/02/2008	1.00 in.	0	0	0.00K
MARLBOROUGH	07/02/2008	0.75 in.	0	0	0.00K
TOWNSEND	07/02/2008	0.88 in.	0	0	0.00K
ASHLAND	08/03/2008	0.75 in.	0	0	0.00K
HUDSON	08/07/2008	1.00 in.	0	0	0.00K
MARLBOROUGH	08/07/2008	1.00 in.	0	0	0.00K
MARLBOROUGH	08/07/2008	2.00 in.	0	0	0.00K
STOW	08/10/2008	0.75 in.	0	0	0.00K
HOPKINTON	05/24/2009	1.00 in.	0	0	0.00K
ASHLAND	05/24/2009	1.00 in.	0	0	0.00K
HOLLISTON	05/24/2009	0.75 in.	0	0	0.00K
TOWNSEND	06/27/2009	0.75 in.	0	0	0.00K
TOWNSEND	06/27/2009	0.88 in.	0	0	0.00K
TOWNSEND	06/27/2009	0.75 in.	0	0	0.00K
TYNGSBORO	07/07/2009	1.00 in.	0	0	0.00K
SAXONVILLE	07/07/2009	0.75 in.	0	0	0.00K
HOPKINTON	07/08/2009	1.75 in.	0	0	0.00K
BILLERICA	05/04/2010	0.75 in.	0	0	0.00K
TOWNSEND	05/07/2011	0.75 in.	0	0	0.00K
NATICK	05/07/2011	0.75 in.	0	0	0.00K
EAST ACTON	06/01/2011	0.75 in.	0	0	0.00K
READING	08/02/2011	0.75 in.	0	0	0.00K
WEST CHELMSFORD	08/19/2011	0.75 in.	0	0	0.00K
GROTON	03/13/2012	1.00 in.	0	0	0.00K
LITTLETON COMMON	03/13/2012	1.25 in.	0	0	0.00K
WILMINGTON	03/14/2012	0.88 in.	0	0	0.00K
NORTH READING	03/14/2012	0.75 in.	0	0	0.00K
AYER	03/14/2012	1.00 in.	0	0	0.00K
WESTON	06/23/2012	0.75 in.	0	0	0.00K
DRACUT	07/18/2012	1.00 in.	0	0	0.00K
FARM HILL	07/18/2012	1.75 in.	0	0	0.00K
WEST EVERETT	07/18/2012	1.75 in.	0	0	0.00K
SAXONVILLE	07/18/2012	0.75 in.	0	0	0.00K
NATICK	07/18/2012	0.75 in.	0	0	0.00K
SAXONVILLE	07/18/2012	1.75 in.	0	0	0.00K
OAK GROVE	10/30/2012	1.00 in.	0	0	0.00K
SAXONVILLE	06/17/2013	0.75 in.	0	0	0.00K
HOVEY CORNER	05/25/2014	1.00 in.	0	0	0.00K
AYER	05/25/2014	0.75 in.	0	0	0.00K
DRACUT	07/03/2014	1.00 in.	0	0	0.00K

Table 4-22. Middlesex County Hail Events, 2000-2018

Location	Date	Magnitude*	Deaths	Injuries	Property Damage
EAST EVERETT	08/07/2014	0.75 in.	0	0	0.00K
DRACUT	09/06/2014	0.88 in.	0	0	0.00K
AYER	08/04/2015	1.00 in.	0	0	0.00K
SHIRLEY	08/04/2015	1.00 in.	0	0	0.00K
EAST ACTON	08/04/2015	1.00 in.	0	0	0.00K
HARWOOD	08/04/2015	2.00 in.	0	0	0.00K
WESTFORD	08/04/2015	1.00 in.	0	0	0.00K
TEWKSBURY	08/04/2015	0.75 in.	0	0	0.00K
WILMINGTON	08/04/2015	1.00 in.	0	0	0.00K
HUDSON	08/04/2015	1.25 in.	0	0	0.00K
LOWELL JCT	08/04/2015	1.75 in.	0	0	0.00K
MAYNARD	08/04/2015	0.88 in.	0	0	0.00K
WAYLAND	08/04/2015	1.50 in.	0	0	0.00K
FRAMINGHAM	08/04/2015	1.00 in.	0	0	0.00K
SUDBURY CENTER	08/04/2015	1.50 in.	0	0	0.00K
BLEACHERY	08/04/2015	0.75 in.	0	0	0.00K
GREEN	08/04/2015	1.50 in.	0	0	0.00K
BELMONT	08/04/2015	1.50 in.	0	0	0.00K
BLEACHERY	08/04/2015	1.00 in.	0	0	0.00K
NEWTON	08/04/2015	1.00 in.	0	0	0.00K
BLEACHERY	08/04/2015	2.00 in.	0	0	0.00K
INMAN SQUARE	08/04/2015	1.75 in.	0	0	0.00K
INMAN SQUARE	08/04/2015	1.25 in.	0	0	0.00K
NEWTON	08/04/2015	1.75 in.	0	0	0.00K
WATERTOWN	08/04/2015	1.00 in.	0	0	0.00K
EAST EVERETT	08/04/2015	1.00 in.	0	0	0.00K
BLEACHERY	08/15/2015	0.75 in.	0	0	0.00K
NATICK	08/15/2015	0.88 in.	0	0	0.00K
BURLINGTON	07/23/2016	0.75 in.	0	0	0.00K
LEXINGTON	07/23/2016	0.75 in.	0	0	0.00K
LEXINGTON	07/23/2016	0.88 in.	0	0	0.00K
NORTH WOBURN	07/23/2016	0.88 in.	0	0	0.00K
ARLINGTON	07/23/2016	0.75 in.	0	0	0.00K
HUDSON	06/27/2017	1.00 in.	0	0	0.00K
TEWKSBURY	06/27/2017	1.00 in.	0	0	0.00K
TEWKSBURY	06/27/2017	0.75 in.	0	0	0.00K
STOW	06/27/2017	1.00 in.	0	0	0.00K
HUDSON	06/27/2017	1.00 in.	0	0	0.00K
BILLERICA	06/27/2017	0.75 in.	0	0	0.00K
TEWKSBURY	06/27/2017	0.75 in.	0	0	0.00K
FARM HILL	08/02/2017	0.75 in.	0	0	0.00K
Totals:			**0**	**0**	**75.25K**

*Magnitude refers to diameter of hail stones in inches
Source: NOAA 2018a

There were four ice storms in Middlesex County between 1998 to 2018 resulting in over six million dollars of property damage (Table 4-23).

Table 4-23. Ice Storm Events in Middlesex County

Location	Date	Property Damage ($)
WESTERN MIDDLESEX (ZONE)	01/09/1998	5,000
WESTERN MIDDLESEX (ZONE)	11/16/2002	150,000
NORTHWEST MIDDLESEX (ZONE)	12/11/2008	3,000,000
WESTERN MIDDLESEX (ZONE)	12/11/2008	3,00,000
TOTAL		6,155,000

Ice storms are classified as medium frequency events. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, this hazard can occur between once in five years and once in 50 years (a 2% to 20% chance of occurring each year).

4.5 Geological Hazards

Geologic hazards can include earthquakes, landslides, sinkholes, and subsidence. City officials did not identify any local areas that were previously recorded as being vulnerable to geologic hazards. Please refer to Map 4 in Appendix B for more information on geologic hazards in Waltham.

4.5.1 Earthquakes

An earthquake is the vibration, sometimes violent, of the earth's surface that follows a release of energy in the earth's crust due to fault fracture and movement. The magnitude or extent of an earthquake is a seismograph-measured value of the amplitude of the seismic waves. The Richter magnitude scale (Richter scale) was developed in 1932 as a mathematical device to compare the size of earthquakes. The Richter scale is the most widely known scale that measures earthquake magnitude. It has no upper limit and is not a direct indication of damage. An earthquake in a densely populated area, which results in many deaths and considerable damage, can have the same magnitude as an earthquake in a remote area that causes no damage. Table 4-24 summarizes Richter scale magnitudes and corresponding earthquake effects (MEMA and DCR 2013, 220).

Table 4-24. Richter Scale and Effects

Richter Magnitudes	Earthquake Effects
Less than 3.5	Generally, not felt, but recorded
3.5- 5.4	Often felt, but rarely causes damage
Under 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1-6.9	Can be destructive in areas up to about 100 km across where people live.
7.0- 7.9	Major earthquake. Can cause serious damage over larger areas.
8 or greater	Great earthquake. Can cause serious damage in areas several hundred meters across.

Source: Louie 1996

Earthquakes occur, albeit infrequently, in New England as compared to other parts of the country. The first recorded earthquake was noted by the Plymouth Pilgrims and other early settlers in 1638. Of the over 5,000 earthquakes recorded in the Northeast Earthquake Catalog through 2008, 1,530 occurred within the boundaries of the six New England States, with 366 earthquakes recorded for Massachusetts between 1627 and 2008. Historically, moderately damaging earthquakes strike somewhere in the region every few decades, and smaller earthquakes are felt approximately twice per year. (MEMA and DCR 2013, 228-232). A summary of historic earthquakes in the Boston area is included in Table 4-25 below:

Table 4-25. Historical Earthquakes in Boston or Surrounding Area, 1727-2012

Location	Date	Magnitude
MA - Cape Ann	11/10/1727	5
MA - Cape Ann	12/29/1727	NA
MA - Cape Ann	2/10/1728	NA
MA - Cape Ann	3/30/1729	NA
MA - Cape Ann	12/9/1729	NA
MA - Cape Ann	2/20/1730	NA
MA - Cape Ann	3/9/1730	NA
MA - Boston	6/24/1741	NA
MA - Cape Ann	6/14/1744	4.7
MA - Salem	7/1/1744	NA
MA - Off Cape Ann	11/18/1755	6
MA - Off Cape Cod	11/23/1755	NA
MA - Boston	3/12/1761	4.6
MA - Off Cape Cod	2/2/1766	NA
MA - Offshore	1/2/1785	5.4
MA - Wareham/Taunton	12/25/1800	NA
MA - Woburn	10/5/1817	4.3
MA - Marblehead	8/25/1846	4.3
MA - Brewster	8/8/1847	4.2
MA - Boxford	5/12/1880	NA
MA - Newbury	11/7/1907	NA
MA - Wareham	4/25/1924	NA
MA - Cape Ann	1/7/1925	4
MA - Nantucket	10/25/1965	NA
MA - Boston	12/27/1974	2.3
VA - Mineral	8/23/2011	5.8
MA - Nantucket	4/12/2012	4.5
ME - Hollis	10/17/2012	4.0

Source: City of Boston, Natural Hazard Mitigation Plan, page 68

Ground shaking or ground motion is the primary cause of earthquake damage to man-made structures. Ground motion from earthquakes is amplified by soft soils and reduced by hard rock. Ground motion.is measured by maximum peak horizontal acceleration expressed as a percentage of gravity (%g). Peak ground acceleration in the state ranges from 10 %g to 20 %g, with a 2% probability of exceedance in 50 years. Figure 4-2 provides additional information.

Waltham is located in an area with a PGA of 14 %g to 16 %g with a 2% probability of exceedance in 50 years (Figure 4-2). This is the third/fourth highest zone in the state: in other words, a moderate area of earthquake risk. Compared to the rest of the United States, Massachusetts overall has a low risk of earthquakes.

As shown on Map 4 in Appendix B, no earthquake epicenters have been recorded within Waltham. Although new construction under the most recent building codes generally will be built to seismic standards, much of the development in the City pre-dates the current building code. If an earthquake occurs, the entire region, not just the City, would face significant challenges. Earthquakes often trigger fires. The water distribution system may be disrupted, thus posing a risk for public health and safety.

A serious earthquake in Massachusetts is possible. These events can strike without warning and can have a devastating impact on infrastructure and buildings constructed prior to earthquake resistant design considerations.

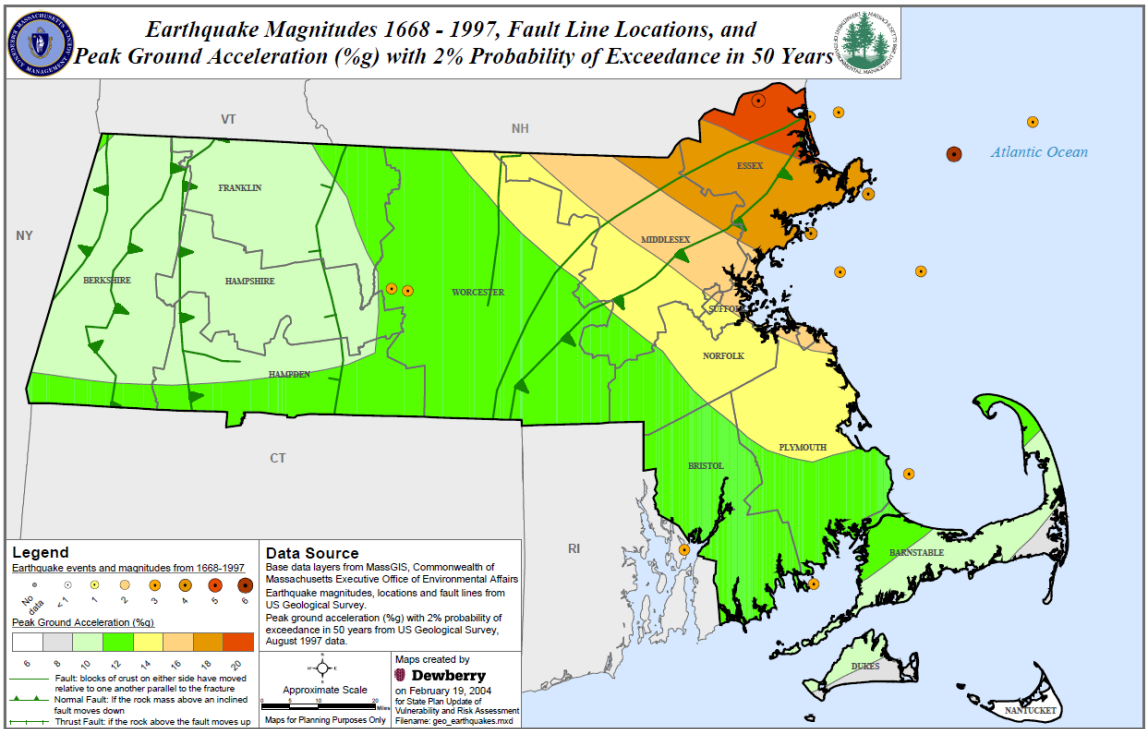

Figure 4-2. State of Massachusetts Earthquake Probability Map

Source: Massachusetts State Hazard Mitigation Plan

It can be assumed that all existing and future buildings and populations are at risk to an earthquake hazard. Impacts from earthquakes can be from slight to moderate building damage, to catastrophic damage and fatalities, depending on the severity of the earthquake event. Events may cause minor damage such as cracked plaster and chimneys, or broken windows, or major damage resulting in building collapse. Based on the Massachusetts State Hazard Mitigation and Climate Adaptation Plan, the degree of exposure "depends on many factors, including the age and construction type of the structures where people live, work, and go to school; the soil type these buildings are constructed on;

and the proximity of these building to the fault location." Furthermore, the time of day exposes different sectors of the community to the hazard. Earthquakes can lead to business interruptions, loss of utilities and road closures which may isolate populations. People who reside or work in unreinforced masonry buildings are vulnerable to liquefaction (liquefaction is the phenomenon that occurs when the strength and stiffness of a soil is reduced by earthquake).

Based on an HAZUS Earthquake module, estimated damage in Waltham from Magnitude 5 and 7 Earthquakes was assessed (Draft 2013 HMP). Historically, an earthquake with magnitude 5 occurred in 1963. This assessment assumes an earthquake epicenter at the center of the study area which would be the worst-case scenario. Table 4-26 below lists estimated damage in Waltham for this worst-case scenario.

Table 4-26. Estimated Damage in Waltham from Magnitude 5 and 7 Earthquakes

Estimated Damage	Magnitude 5.0	Magnitude 7.0
Building Characteristics		
Estimated total number of buildings	14,150	
Estimated total building replacement value (Yr 2002)	7,740,617,000	
Building Damages		
# of buildings sustaining slight damage	2,267	3,133
# of buildings sustaining moderate damage	712	1,395
# of buildings sustaining extensive damage	109	344
# of buildings completely damaged	14	63
Population Needs		
# of households displaced	211	683
# of people seeking public shelter	49	158
Debris		
Building debris generated (tons)	0	0
# of truckloads to clear building debris	0	0
Value of Damages		
Total property damage	$463,340,000	$521,060,000
Total losses due to business interruption	$29,450,000	$100,960,000

Earthquakes are classified as a very low frequency event in Waltham. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, these events occur less frequently than once in 100 years (a less than 1% chance of occurring each year).

4.5.2 Landslides

Landslide include a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity, acting on an over steepened slope, is the primary reason for a landslide, there are other contributing factors. These contributing factors can include erosion by rivers or ocean waves over steepened slopes; rock and soil slopes weakened through saturation by snowmelt or heavy rains; earthquake created stresses that make weak slopes fail; excess weight from accumulation of rain or snow; and stockpiling of rock or ore from waste piles or man-made structures (USGS 2019a).

Landslides occur throughout the United States, causing an estimated $1 billion in damages and 25-50 deaths each year. Any area composed of very weak or fractured materials resting on a steep slope will likely experience landslides. Although the physical cause of many landslides cannot be removed, geologic investigations, good engineering practices, and effective enforcement of land-use management regulations can reduce landslide hazards (USGS 2019a). Landslides can damage buildings and infrastructure and cause sedimentation of water bodies.

Landslide intensity can be measured in terms of destructiveness, as demonstrated by Table 4-27 below.

Table 4-27. Landslide Volume and Velocity

Estimate Volume (m^3)	Expected Landslide Velocity		
	Fast moving (rock fall)	Rapid moving (debris flow)	Slow moving (slide)
<0.001	Slight intensity	--	--
<0.5	Medium intensity	--	--
>0.5	High intensity	---	--
<500	High intensity	Slight intensity	--
500-10,000	High intensity	Medium intensity	Slight intensity
10,000 – 50,000	Very high intensity	High intensity	Medium intensity
>500,000	--	Very high intensity	High intensity
>>500,000	--	--	Very high intensity

Source: Cardinali et al. 2002

Map 4 in Appendix B indicates that all of Waltham is classified as having a low risk for landslides. No significant landslides have been recorded for Waltham or Middlesex County (Appendix B of EEA and EOPSS 2018). Rather, local officials indicate that there are occasionally localized issues of erosion during construction, as a result of development, or as a result of clearing vegetation. Landslides are classified as low frequency events in Waltham. These events can occur once in 50 to 100 years (a 1% to 2% chance of occurring each year).

4.6 Fire Related Hazards

Fire risk is influenced by fuel (the type of material), terrain and weather. Strong winds can exacerbate extreme fire conditions, especially wind events that persist for long periods, or ones with significant sustained wind speeds that quickly promote fire spread through the movement of embers or exposure within tree crowns. Fires can spread quickly into developed areas.

A wildfire can be defined as any non-structure fire that occurs in the vegetative wildland, including grass, shrub, leaf litter, and forested tree fuels. Wildfires can be caused by natural events, human activity or in

an intentional controlled manner, as in the case of prescribed fire, and often begin unnoticed, but spread quickly, igniting brush, trees, and homes (MEMA and DCR 2013, 252). The State Hazard Mitigation and Climate Adaptation Plan (EEA and EOPPS, 2018) states:

> *"The ecosystems that are most susceptible to the wildfire hazard are pitch pine, scrub oak, and oak forests, as these areas contain the most flammable vegetative fuels. Other portions of the Commonwealth are also susceptible to wildfire, particularly at the urban-wildland interface…. Interface communities are defined as those in the vicinity of contiguous vegetation, with more than one house per 40 acres and less than 50 percent vegetation, and within 1.5 miles of an area of more than 500 hectares (approximately 202 acres) that is more than 75 percent vegetated."*

Waltham has a few interface areas, which would be more vulnerable to fire hazards. According to the SHMCAP (Appendix B), the most recent large-scale wildfire occurred in September 1995 in the Town of Russell of Hampden County. Since wildfires are not common in Massachusetts, this plan focuses on brush and urban fires.

While brush fires have not resulted in major property damage or death in Waltham in the past, they can lead to death and property damage. All individuals whose homes or workplaces are located in brush fire hazard zones are exposed to this hazard. The most vulnerable members of this population are those who would be unable to evacuate quickly, including those over the age of 65, households with young children under the age of 5, people with mobility limitations, and people with low socioeconomic status (EEA and EOPSS 2018, 4-180). Secondary effects from brush fire include contamination of reservoirs; destroyed power, gas, water, broadband, and oil transmission lines. Brush fires can also contribute to flooding as they strip slopes of vegetation, thereby exposing them to greater amounts of runoff which may cause soil erosion and ultimately the chance of flooding. Additionally, subsequent rains can worsen erosion because brush fires burn ground vegetation and ground cover.

4.6.1 Potential Brush Fire Hazard Areas

The Waltham Fire Department responds to several brush fires annually, but they have not resulted in major property damage or deaths. In recent years, the number of brush fires has decreased, except for small brush fires deep in the woods. Causes of these fires are due to human carelessness, such as juvenile activity. Approximately 84% of brush fires are caused by humans (Balch et al. 2017). Lightning can also be a culprit, igniting a fire when striking dry tinder on the forest floor.

The following sites were identified by City staff as areas that have a higher brush fire risk. The numbers in parentheses refer to the Areas of Concern on Map 8 in Appendix B. Additionally, property and buildings surrounding these sites have an increased risk of fire.

Prospect Hill (13)
Located in the west central part of the City, just east of Route 128, Prospect Hill Park is wooded and is steeply sloped.

Stigamatines (14)
In the north central part of the City, west of Lexington Street, is wooded and steeply sloped.

Storer Conservation Land (15)
The Storer Conservation Land located in the center of the City is wooded with some steep slopes.

Figure 4-3 below shows the locations of historical brush fires and the number of acres burned in Massachusetts between 2001 and 2009. Waltham has experienced between 51 and 100 recordable fires, totaling between 10 and 99 acres burned.

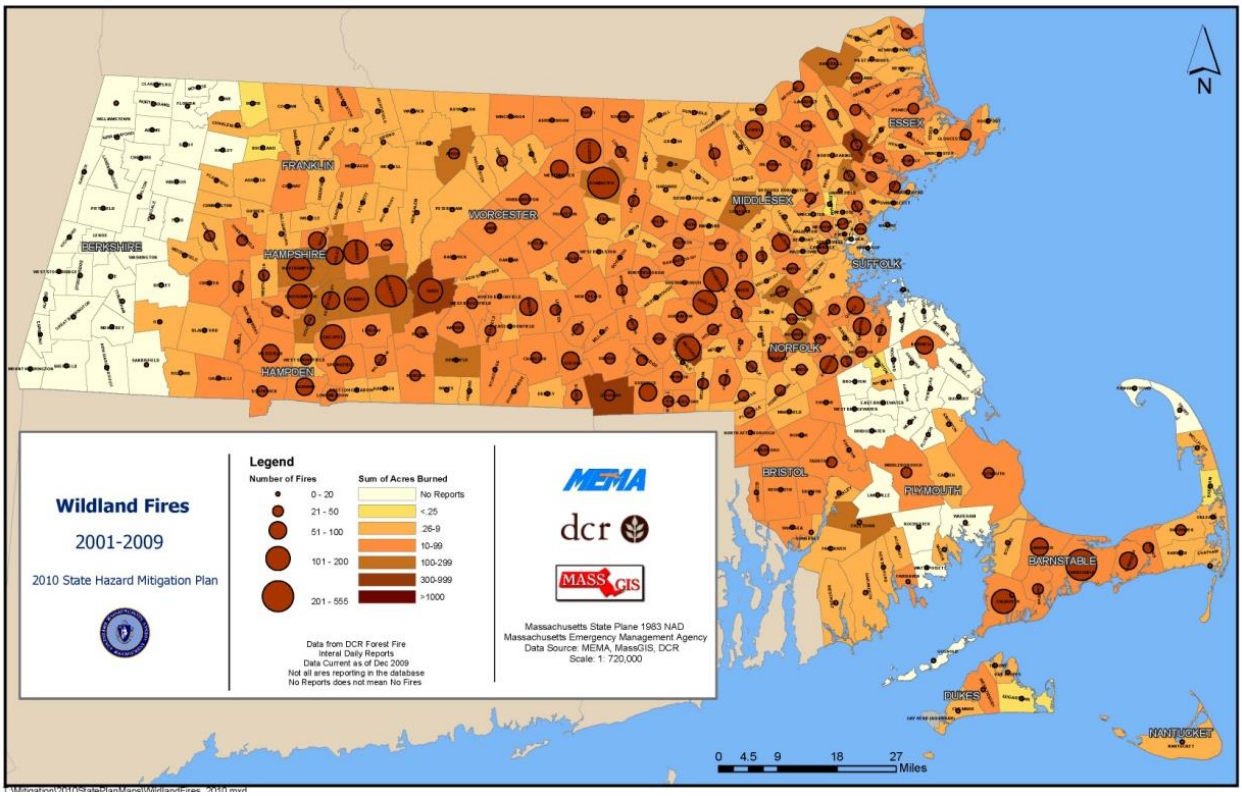

Figure 4-3. Massachusetts Brush Fires, 2001 to 2009
Source: MEMA and DCR 2013, page 261

Brush fires are classified as medium frequency events. As defined by the 2013 State Hazard Mitigation Plan, these events occur between once in 5 years to once in 50 years (a 2% to 20% chance of occurring per year).

4.7 Extreme Temperatures

Extreme temperatures are considered a City-wide hazard in Waltham. These events can include both temperatures over and under seasonal averages. These extreme temperature events can range from brief to lengthy.

The Boston area has four clearly-defined seasons. Extreme temperatures fall outside of the ranges typically experienced during these seasons. Boston's average winter temperature, from December to

February, is 32.2°F. Boston's average summer temperature, from June to August, is 73.8°F (NOAA 2018b).

4.7.1 Extreme Cold

Extremely cold temperatures are measured using the Wind Chill Temperature Index provided by the National Weather Service (NWS). The updated index was implemented in 2001and helps explain the impact of cold temperatures on unexposed skin. Figure 4-4 below provides more information.

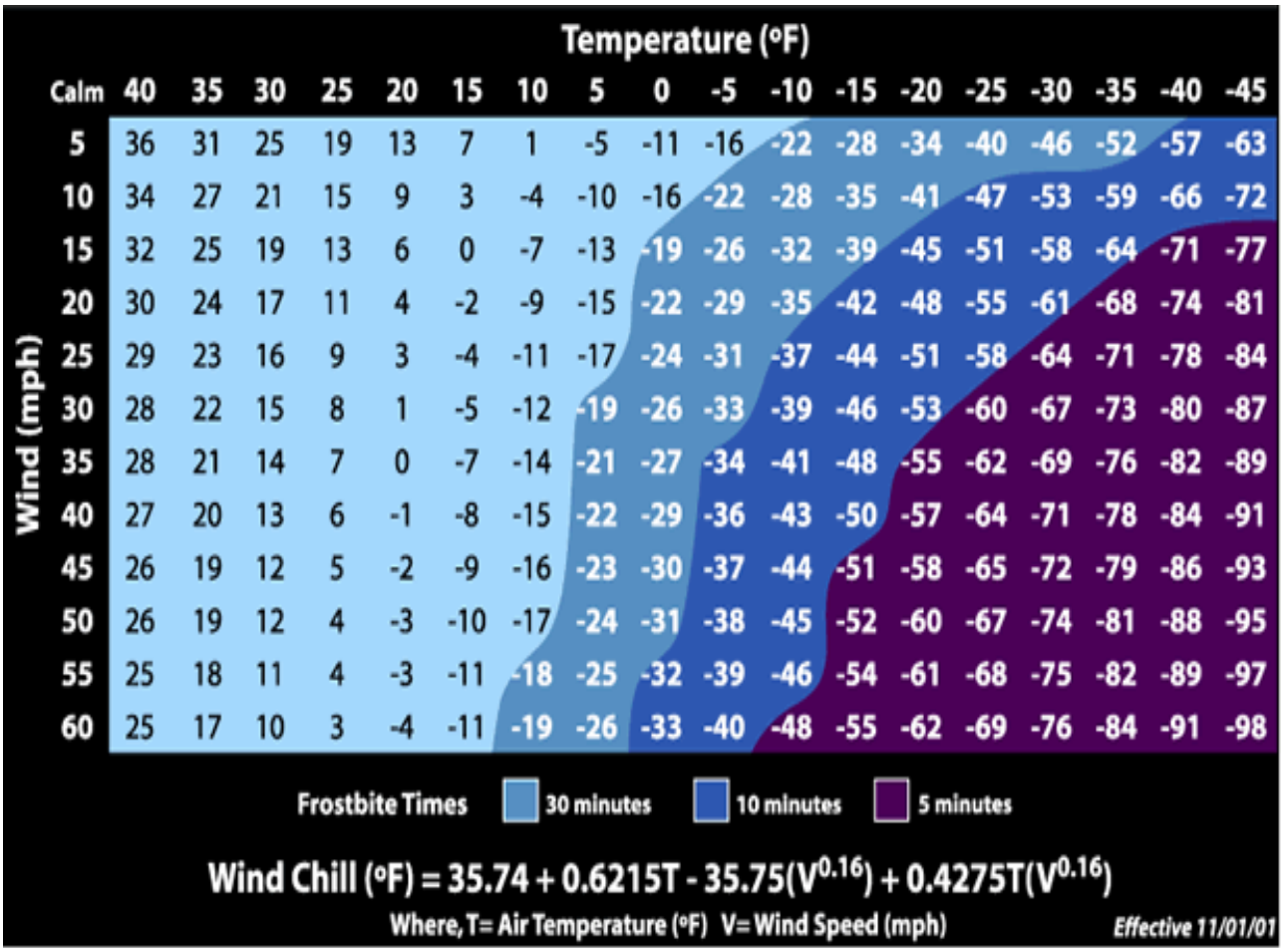

Figure 4-4. Windchill Temperature Index and Frostbite Risk

Source: National Weather Service

Extremely cold temperatures can create dangerous conditions for homeless populations, stranded travelers, and residents without sufficient insulation or heat. The homeless, the elderly, and people with disabilities are often most vulnerable. In Waltham, 13.2% of the population are over 65 years old and 9.7% percent of the population has a disability (ACS 2013-2017). Cold weather events can also have significant health impacts such as frostbite and hypothermia. Furthermore, power outages during cold

weather may result in inappropriate use of combustion heaters, cooking appliances, and generators in poorly ventilated areas which can lead to increased risk of carbon monoxide poisoning.

NOAA's National Centers for Environmental Information Storm Events Database provides data for extreme cold events. Between 2000 and 2018, Middlesex County experienced three extreme cold and will chill events, which caused no deaths, injuries, or property damage. Table 4-28 provides more information.

Table 4-28. Middlesex County Extreme Cold and Wind Chill Occurrences, 2000-2018

Date	Deaths	Injuries	Damage
2/15/2015	0	0	0
2/16/2015	0	0	0
2/14/2016	0	0	0

4.7.2 Extreme Heat

Increased temperatures will impact all locations within Waltham. Projected heat days and heat waves can have an increased impact in densely settled urban areas. These can become "heat islands" as dark-colored asphalt and roofs store the heat from the sun. According to the Centers for Disease Control and Prevention, the populations most vulnerable to extreme heat impacts include the following:

- People over the age of 65 (e.g., with limited mobility),
- Children under the age of five,
- Individuals with pre-existing medical conditions that impair heat tolerance,
- Low-income individuals who cannot afford proper cooling,
- Individuals with respiratory conditions,
- The general public who may overexert themselves during extreme heat events.

Homeless people are increasingly vulnerable to extreme heat. The capacity of homeless shelters is typically limited. Impacts from heat stress can exacerbate pre-existing respiratory and cardiovascular conditions.

Based on Figure 4-5 below, compiled by the Massachusetts Department of Public Health Bureau of Environmental Health (MA DPH 2019), Waltham has a population density of 1,270 - 5,780 or > 5,780 per square mile. The total number of population vulnerability measures in each Census Tract (2010) varies between 2 and 3. These population vulnerability measures include: low income, low English proficiency, non-white (Hispanic and non-Hispanic ethnicities), and elderly.

The NWS issues a Heat Advisory when the Heat Index (Figure 4-6) is forecast to reach 100-104˚ F for two or more hours (https://www.weather.gov/bgm/heat). The NWS issues an Excessive Heat Warning if the Heat Index is forecast to reach 105˚+F for two or more hours. Heat waves cause more fatalities in the U.S. than the total of all other meteorological events combined. In Boston, over 50 people die each year due to heat-related illnesses. From 1979-2012, excessive heat exposure caused in excess of 8,000 deaths in the United States (MEMA and DCR 2013). During this period, more people in this country died from extreme heat than from hurricanes, lightning, tornadoes, floods, and earthquakes combined.

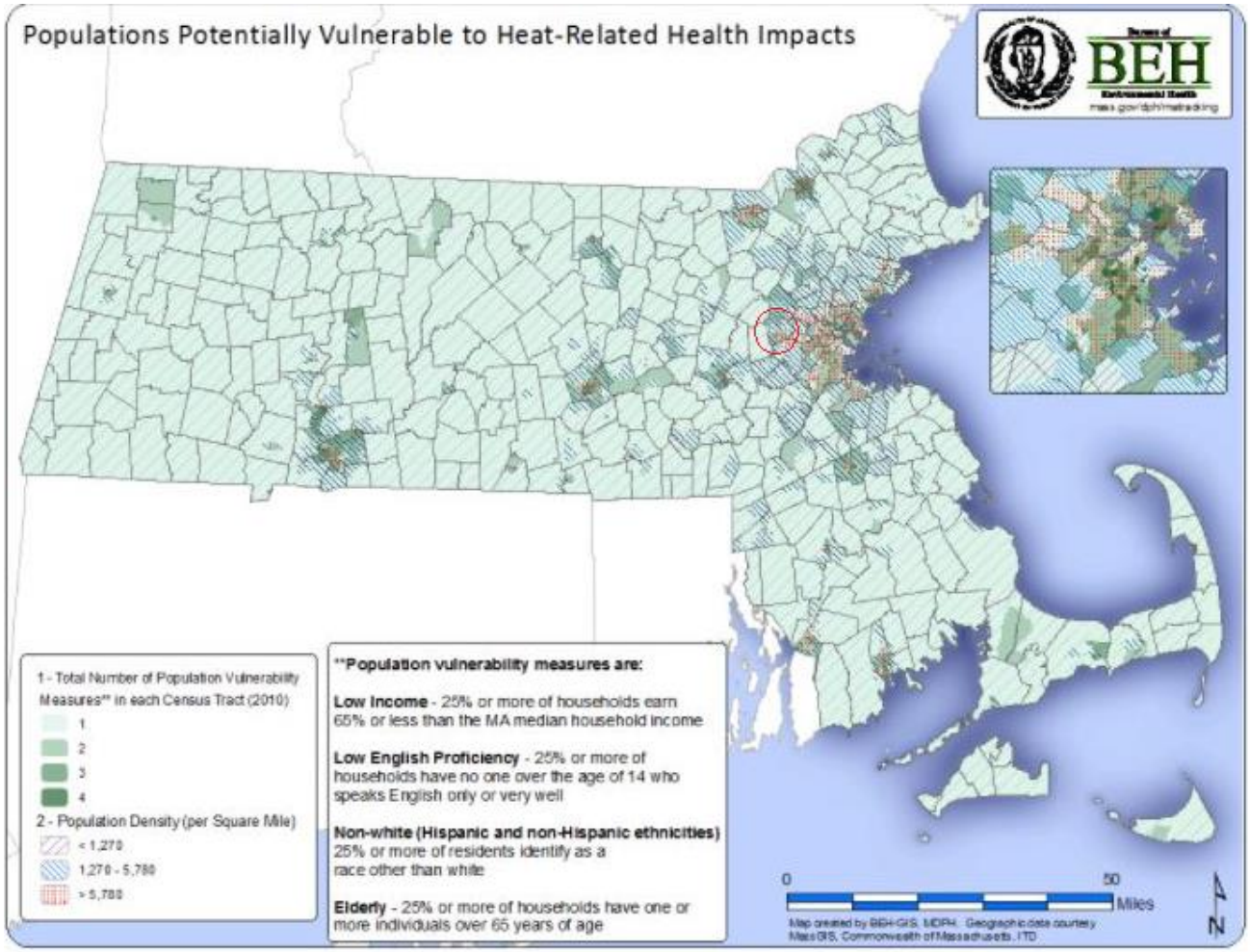

Figure 4-5. Populations Potentially Vulnerable to Heat Related Health Impacts (Waltham is shown as a red circle).

Source: Massachusetts Department of Public Health, Bureau of Environmental Health, 2019.

On July 6, 2013, a postal worker in MA collapsed and died as the Heat Index reached 100°F (EEA and EOPSS 2018). Because most heat-related deaths occur during the summer, people should be aware of who is at greatest risk and what actions can be taken to prevent a heat-related illness or death. The populations at greater risk are the elderly, children, and people with certain medical conditions, such as heart disease. In Waltham, children under five years old make up 5% of the population, and 13.2% are over 65 years old. However, even young and healthy individuals can succumb to heat if they participate in strenuous physical activities during hot weather. Some behaviors also put people at greater risk: drinking alcohol, taking part in strenuous outdoor physical activities in hot weather, and taking medications that impair the body's ability to regulate its temperature or that inhibit perspiration (MEMA and DCR 2013; ACS 2013-2017).

Relative Humidity (%) \ Temperature (°F)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Category	Heat Index	Health Hazards
Extreme Danger	130 °F – Higher	Heat Stroke or Sunstroke is likely with continued exposure.
Danger	105 °F – 129 °F	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Extreme Caution	90 °F – 105 °F	Sunstroke, muscle cramps, and/or heat exhaustions possible with prolonged exposure and/or physical activity.

Figure 4-6. Heat Index Chart

(Source: https://www.weather.gov/safety/heat-index)

Increased temperatures can lead to a longer growing season, which in turn leads to a longer pollen season. Warmer weather can also support the migration of invasive species and lead to an increase in vector-borne diseases. Increasing temperatures can also worsen air pollution, which can lead to negative health impacts such as respiratory problems.

The City of Waltham does not collect data on heat occurrences. The best available local data are for Middlesex County, through the National Environmental Information Center. NOAA's National Centers for Environmental Information Storm Events Database provides data on excessive heat. Between 1998 and 2018, Middlesex County experienced three extreme heat days, which did not result in injury or property damage. One event did result in a single death in 2013. Please refer to Table 4-29 for more information.

Extreme temperatures are classified as medium frequency events. According to the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (EEA and EOPSS 2018), between four and five heat waves (3 or more consecutive days of 90˚+F temperatures) occur annually in Massachusetts.

Table 4-29. Middlesex County Heat Occurrences, 1998-2018

Date	Deaths	Injuries	Damage ($)
7/6/2010*	0	0	0
7/7/2010	0	0	0
7/5/2013	1	0	0
Total	1	0	0

*Excess Heat Occurrences (105°F+)

Source: NOAA 2018a

4.8 Drought

Drought is an extended period of deficient precipitation. Drought conditions occur in virtually all climatic zones, yet its characteristics vary significantly from one region to another since it is relative to the normal precipitation in that region. Agriculture, the water supply, aquatic ecosystems, wildlife, and the economy are vulnerable to the impacts of drought (EEA and EOPSS 2018).

Average annual precipitation in Boston is 53.32 inches per year, with approximately two to five-inch average amounts for each month of the year (NOAA 2019c). Although Massachusetts is relatively small, it has a number of distinct regions that experience significantly different weather patterns and react differently to the amounts of precipitation they receive. In accordance with the Massachusetts Drought Management Plan, the Drought Management Task Force will make recommendations to the Secretary of Energy & Environmental Affairs about the location and severity of drought in the Commonwealth. The Drought Management Plan divides the state into six regions: Western, Central, Connecticut River Valley, Northeast, Southeast, and Cape and Islands. Waltham is located within the Northeast region (EEA and MEMA, 2013). In a proposed update to the Drought Management Plan, which is expected to be finalized in 2019, a seventh region, representing the Islands alone, has been proposed (Massachusetts Water Resources Commission, 2019).

Five levels of drought have been developed to characterize drought severity: Normal, Advisory, Watch, Warning, and Emergency; these correspond to Level 0 – Normal, Level 1 - Mild Drought, Level 2 - Significant Drought, Level 3 - Critical Drought (was Warning), and Level 4 - Emergency Drought (was Emergency), respectively, of the draft Drought Management Plan update. The drought levels are based on the severity of drought conditions and their impacts on natural resources and public water supplies.

The Drought Management Plan specifies the agency response and interagency coordination and communication corresponding to the various drought levels. During normal conditions, data are routinely collected and distributed. There is heightened vigilance with additional data collection during an advisory, and increased assessment and proactive education during a watch. Water restrictions might be appropriate at the watch or warning stage, depending on the capacity of each individual water supply system. A warning level indicates a severe situation and the possibility that a drought emergency may be necessary. A drought emergency is one in which use of emergency supplies become necessary or in which the Governor may exercise his authority to require mandatory water restrictions or (EEA and MEMA, 2013).

A variety of drought indices are available to assess the various impacts of dry conditions. The Commonwealth uses a multi-index system to determine the severity of a drought or extended period of dry conditions. A determination of drought level is based on seven indices: Standardized Precipitation Index, Precipitation (percent of normal), Crop Moisture Index, Keetch-Byram Drought Index (KBDI), Groundwater levels, Stream flow levels, and Index Reservoir levels. (In its draft updated Drought Management Plan, the Drought Management Trask Force has proposed to eliminate the precipitation index that is based on percent of normal precipitation.)

Drought level is determined monthly based on the number of indices which have reached a given drought level. A majority of the indices would need to be triggered in a region in order for a drought designation to move to a more severe level. Drought levels are declared on a regional basis for each of the six regions in Massachusetts. Drought levels may also be made county by county or be watershed-specific. The end of a drought is determined by precipitation and groundwater levels since these have

the greatest long-term impact on streamflow, water supply, reservoir levels, soil moisture and potential for forest fires (EEA and MEMA, 2013).

Figure 4-7 illustrates statewide drought levels in Massachusetts from 1850 to 2012, using the Standardized Precipitation Index (SPI). Table 4-30 below summarizes a history of Massachusetts droughts between 1879 and 2017.

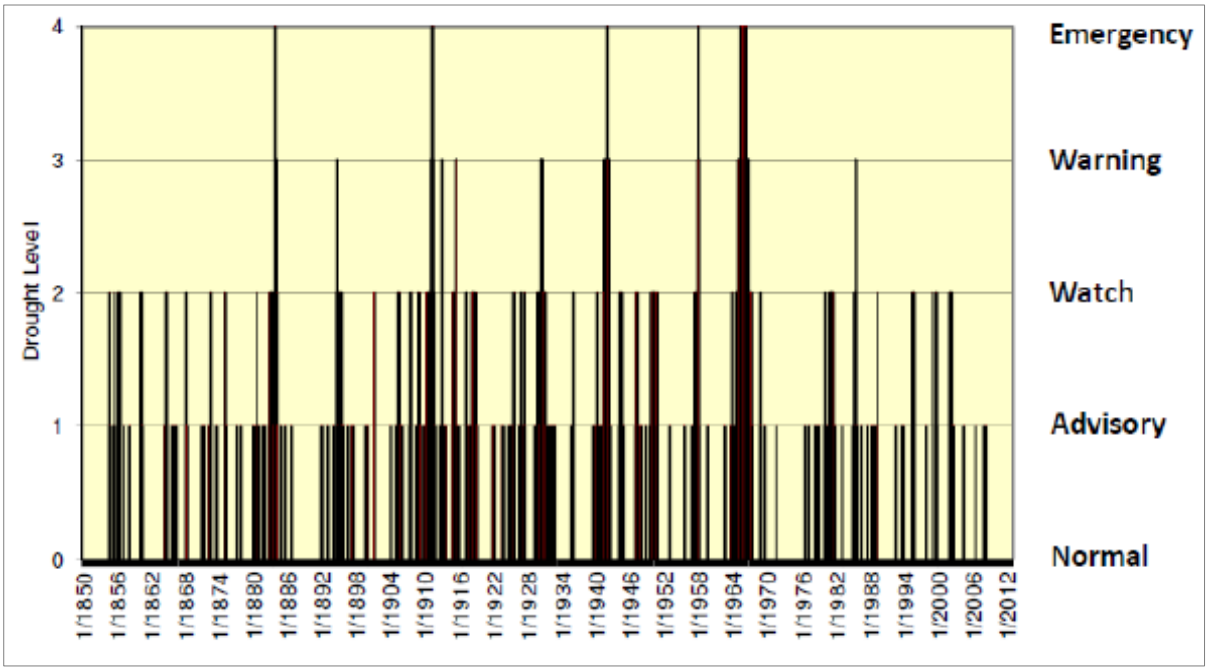

Figure 4-7. Statewide Drought Levels Using SPI Thresholds, 1850 to 2012.

Source: EEA and MEMA 2013, page 37.

Table 4-30. Droughts in Massachusetts Based on Instrumental Records

Date	Area Affected	Recurrence Interval (years)	Remarks
1879 to 1883	–	–	–
1908 to 1912	–	–	–
1929 to 1932	Statewide	10 to >50	Water-supply sources altered in 13 communities. Multistate.
1939 to 1944	Statewide	15 to >50	More severe in eastern and extreme western Massachusetts. Multistate.
1957 to 1959	Statewide	5 to 25	Record low water levels in observation wells, northeastern Massachusetts.
1961 to 1969	Statewide	35 to >50	Water-supply shortages common. Record drought. Multistate.

Table 4-30. Droughts in Massachusetts Based on Instrumental Records

Date	Area Affected	Recurrence Interval (years)	Remarks
1980 to 1983	Statewide	10 to 30	Most severe in Ipswich and Taunton River basins; minimal effect in Nashua River basin. Multistate.
1985 to 1988	Housatonic River Basin	25	Duration and severity unknown. Streamflow showed mixed trends elsewhere.
1995	–	–	Based on statewide average precipitation.
1998 to 1999	–	–	Based on statewide average precipitation.
2001 to 2003	Statewide	–	Level 2 drought (out of 4 levels) was reached statewide for several months.
2007 to 2008	Statewide except West and Cape and Islands regions	–	Level 1 drought (out of 4 levels)
2010	Connecticut River Valley, Central and Northeast regions	–	Level 1 drought (out of 4 levels)
2014	Southeast and Cape and Islands regions	–	Level 1 drought (out of 4 levels)
2016-2017	Statewide	–	Level 3 drought (out of 4 levels).

Source: EEA and EOPSS 2018, page 4-45

There are five drought emergencies on record in Massachusetts: 1883, 1911, 1941, 1957, and 1965-1966. The 1965-1966 drought is considered the most severe Massachusetts drought in modern times, given its length. On a monthly basis over the 162-year period of record, there is a one percent chance of being in a Drought Emergency (EEA and MEMA 2013, 36).

Drought Warning levels not associated with Drought Emergencies would have occurred in 1894, 1915, 1930,1985, 2016, and 2017. On a monthly basis over the 162-year period of record, there is a two percent chance of being in a drought Warning level (EEA and MEMA 2013, 36; DCR 2017b, 1).

Drought Watches not associated with higher levels of drought generally would have occurred three to four times per decade between 1850 and 1950. The Drought Emergency declarations dominated the 1960s. There were no Drought Watches or above in the 1970s. In the 1980s, there was a lengthy Drought Watch level of precipitation between 1980 and 1981, followed by a Drought Warning in 1985. A frequency

of drought Watches at a rate of three years per decade resumed in the 1990s (1995, 1998, 1999). In the 2000s, Drought Watches occurred in 2001 and 2002. The overall frequency of being in a Drought Watch is eight percent on a monthly basis over the 162-year period of record (EEA and MEMA 2013, 36). There were six drought watches in Massachusetts in 2002, five drought watches in 2016, and two drought watches in 2017 (DCR 2017b, 1). Figure 4-8 presents an example of drought conditions in the six drought regions.

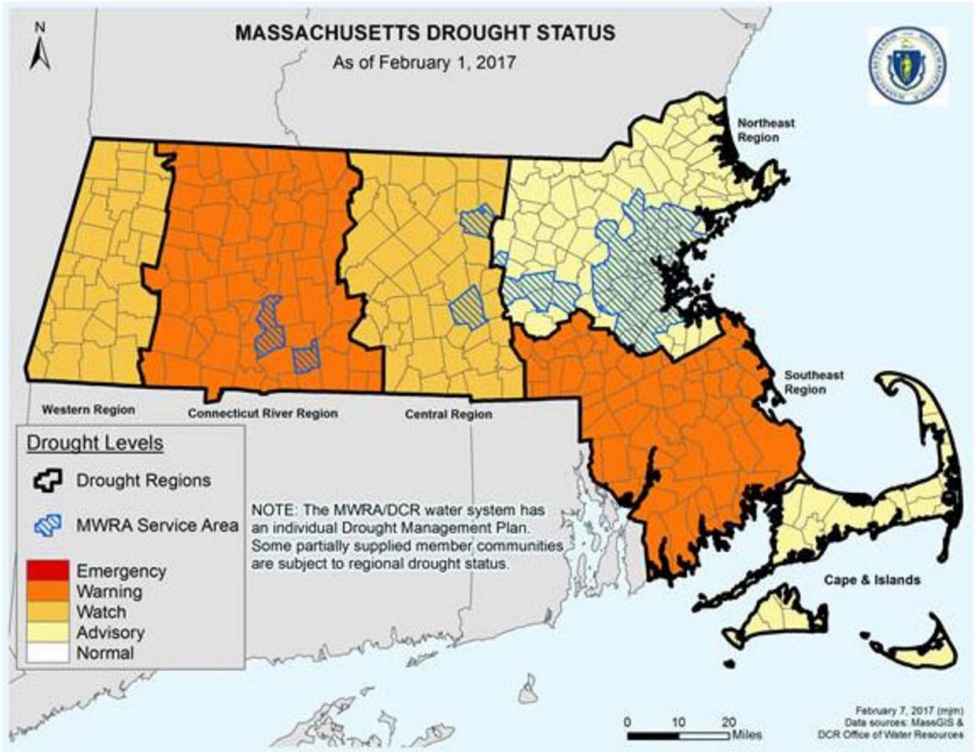

Figure 4-8. Massachusetts Drought Status, February 2017

Source: Massachusetts Department of Conservation and Recreation

Drought is a potential City-wide hazard in Waltham. As noted previously, temperature is projected to increase and may lead to exacerbated drought conditions especially in summer and fall months. Droughts can also increase fire risk: fires can be caused by lightning, and a 2014 study found that the frequency of lightning strikes could increase by more than 10% for every degree Celsius of warming (EEA and EOPSS 2018, 4-45, 4-178). During Waltham's MVP Workshop in February 2019, workshop participants discussed the connections between multiple hazards and their potential impact on the City. One example given was the potential for a severe drought to increase the risk of brush fires.

A long-term drought could lead to impacts to Waltham's wetlands and streams, and to Hardy Pond and the Charles River. It could also have significant adverse impacts to the City of Cambridge's water supply which draws its water from the Hobbs Brook and Stony Brook watershed. In a drought emergency affecting the water supply of the Massachusetts Water Resources Authority, water use restrictions would be implemented in Waltham, which could result in loss of landscaped areas and business revenues depending on the length of the water use restriction.

Droughts are classified as a low frequency natural hazard event. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, these events can occur between once in 50 years to once in 100 years (a 1% to 2% chance of occurring per year).

4.9 Impacts of Climate Change

Many of the hazards that Waltham is currently experiencing could be worsened by climate change. Participants in Waltham's MVP Workshop identified flooding, extreme temperatures, high winds, and winter storms as hazards of concern. These are described in more detail below. Drought was also included below. Note, drought and flooding will both increase with climate change because the natural precipitation cycle will be disrupted. Under climate change, the warmer atmosphere will retain precipitation longer so that it will fall in fewer, more intense events rather than small, periodic events. This will cause more flooding and longer periods with little to no rainfall.

4.9.1 Climate Change Impacts: Flooding

Boston's average annual precipitation is 53.32 inches (NOAA 2019b). Extreme rain and snow events are becoming increasingly common and severe particularly in the Northeast region of the country (Figure 4-9). Large rain or snow events that happened once a year in the middle of the 20th century now occur approximately every nine months. Additionally, the largest annual events now generate 10% more rain than in 1948. Regionally, New England has experienced the greatest increase in frequency of extreme rain and snow events. These events now occur 85% more frequently than they did 60 years ago (Madsen and Willcox 2012, 15-16).

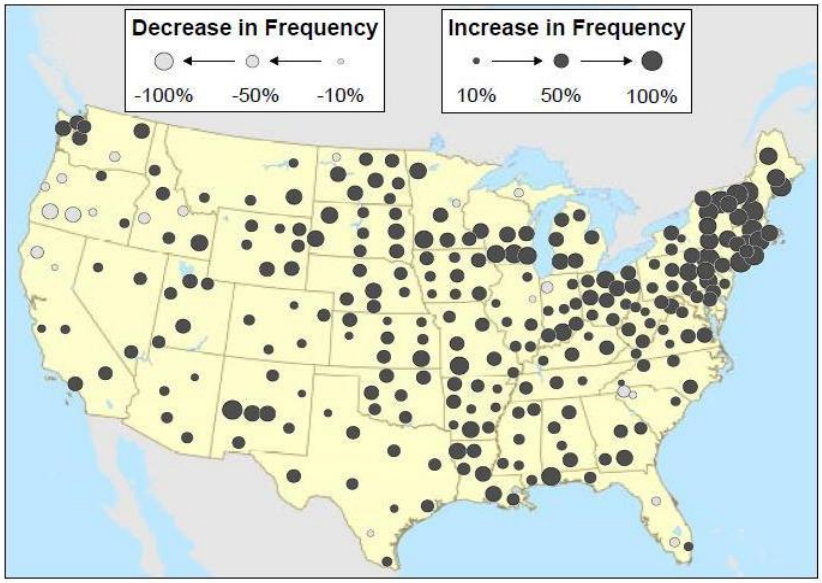

Figure 4-9. Changes in Frequency of Extreme Downpours

Source: Madsen and Willcox 2012, page 19

4.9.2 Climate Change Impacts: Drought

Under climate change, drought conditions will be exacerbated with projected increasing air temperatures and changes in precipitation. Between 1970 and 2000, the median number of

consecutive dry fall days in Massachusetts was 11.4 days. This is in comparison to a projected median of 13.5 consecutive days by the end of the century (EEA, 2018a).

4.9.3 Climate Change Impacts: Extreme Temperatures

Between 1961 and 1990, Boston experienced an average of one day per year in excess of 100°F. That could increase to six days per year by 2070, and 24 days per year by 2099. Under these conditions by the end of the century, Massachusetts's climate would more closely resemble that of Maryland or the Carolinas (refer to Figure 4-10 below). These changes in temperature would also have a detrimental impact on air quality and public health concerns including asthma and other respiratory conditions (Frumhoff et al. 2007).

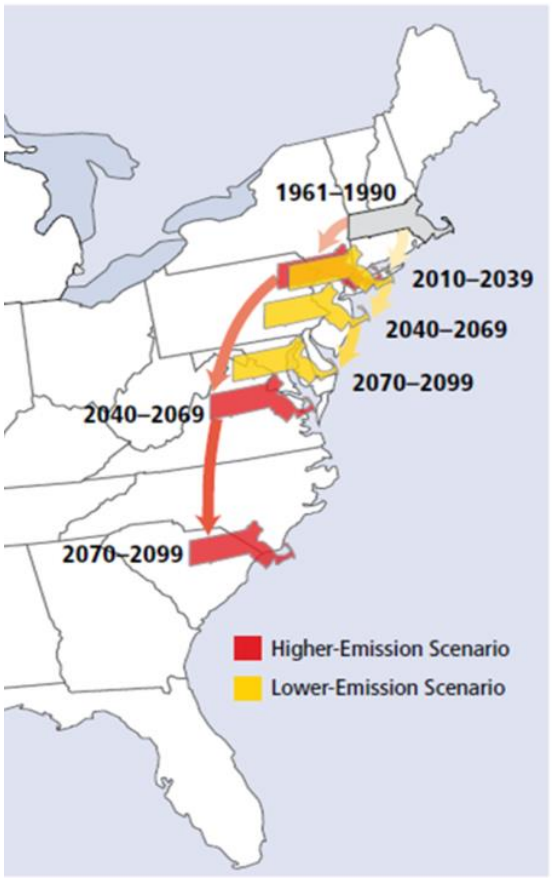

Figure 4-10. Massachusetts Extreme Heat Scenarios.

Source: Frumhoff et al. 2007

4.9.4 Climate Change Impacts: High Winds

While Waltham's current 100-year wind speed is 110 mph, climate change will likely increase the number of extreme wind events and their severity. Additionally, rising sea temperature could lengthen the hurricane season and fuel stronger hurricane events. The National Climate Assessment Report notes that hurricane "intensity, frequency, and duration have all increased since the early 1980s." This source predicts continuing intensity and associated rainfall with rising temperatures. This would result in greater losses due to increased flooding, associated building damages and business interruption impacts

(Walsh and Wuebbles, 2014). The anticipated increase in frequency and intensity of severe thunderstorms may also increase the risk of tornadoes (EEA and EOPSS 2018, ES).

4.9.5 Climate Change Impacts: Winter Storms

There is evidence suggesting that nor'easters along the Atlantic coast are increasing in frequency and intensity. Future nor'easters may become more concentrated during the coldest winter months when atmospheric temperatures are still low enough to result in snowfall rather than rain (EEA and EOPSS 2018, 4-224).

Climate projections indicate that climate change will result in more precipitation during the winter in the Northeast (EEA, 2018a). This trend may result in more frequent and/or more severe winter storms.

5.0 HAZARD MITIGATION GOALS

The Core Committee reviewed and discussed the hazard mitigation goals for the City of Waltham. The following nine goals were developed and endorsed by the Core Committee for this 2019 Waltham HMP-MVP Plan:

1. Prevent and reduce the loss of life, injury, public health impacts and property damages resulting from all major natural hazards.

2. Identify and seek funding for measures to mitigate or eliminate each known significant flood hazard area.

3. Integrate hazard mitigation planning as an integral factor in all relevant municipal departments, committees and boards.

4. Prevent and/or reduce the damage to public infrastructure resulting from natural hazards.

5. Encourage the business community, major institutions and non-profits to work with the City to develop, review and implement the HMP-MVP Plan.

6. Work with surrounding communities, state, regional and federal agencies to ensure regional cooperation and solutions for hazards affecting multiple communities.

7. Ensure that future development meets federal, state and local standards for preventing and reducing the impacts of natural hazards.

8. Take maximum advantage of resources from FEMA and MEMA to educate City staff and the public about hazard mitigation.

9. Consider the impacts of climate change and incorporate climate sustainability, mitigation, and resiliency into hazard mitigation and other City plans and policies.

6.0 EXISTING MITIGATION MEASURES

The existing protective measures available to the City of Waltham are a combination of zoning, land use, and environmental regulations, infrastructure maintenance, and drainage infrastructure improvement projects. Infrastructure maintenance generally addresses localized drainage clogging problems, while large scale capacity problems may require pipe replacement or invert elevation modifications. These more expensive projects are subject to the capital budget process.

The City's existing mitigation measures are described by hazard type here and are summarized in Table 6-2 below. Many upgrades to existing measures are noted in the following sections.

6.1 Existing City-Wide Mitigation for Flood Related Hazards

Waltham employs a number of practices to help minimize potential flooding, reduce impacts from flooding, and to proactively maintain existing drainage infrastructure. Existing city-wide mitigation measures include the following:

Participation in the National Flood Insurance Program (NFIP) – Waltham participates in the NFIP with 184 policies in force as of the September 30, 2018. FEMA maintains a database on flood insurance policies and claims. This database can be found on the FEMA website at https://www.fema.gov/policy-claim-statistics-flood-insurance

The following information is provided for the City of Waltham:

Table 6-1. National Flood Insurance Program in Waltham

Flood insurance policies in force (September 30, 2018)	184
Coverage amount of flood insurance policies	$57,736,300
Premiums paid	$370,048
Total losses (all losses submitted regardless of the status)	147
Closed losses (losses that have been paid)	110
Open losses (losses that have not been paid in full)	0
CWOP losses (losses that have been closed without payment)	37
Total payments (total amount paid on losses)	$1,166,699.17

The City complies with the NFIP by enforcing floodplain regulations, maintaining up-to-date floodplain maps, and providing information to property owners and builders regarding floodplains and building requirements.

Street sweeping – The City performs street sweeping nine times per year on major roads and seven times per year on secondary roads.

Catch basin cleaning – The City cleans on-third of its catch basins annually. Approximately 5,431 catch basins are identified as City-owned and maintained.

On-going Drainage Improvement Program – The Public Works Department provides maintenance to culverts, drainage pipes, and other drainage infrastructure on an as-needed basis.

Stormwater System and Outfalls Mapped in GIS – The City has developed a drainage system inventory and integrated the data into the City's Geographical Information System (GIS). *IDDE Program Implementation* – As part of the IDDE Program the City has sampled all the outfalls for water quality. Beginning in 2008 outfalls discharging in to the Charles River were located and sampled. In 2009, the Beaver Brook outfalls were located and sampled.

Zoning Regulations – Zoning is intended to protect the public health and safety through the regulation of land use. The Waltham Zoning Ordinance includes a Floodplain District (Section 12.2).

The City's Floodplain Overlay District (Zoning Ordinance Section 12.2) is defined by the 100-year floodplain as designated by FEMA. The Floodplain Overlay District regulates certain activities within a flood zone.

Massachusetts Stormwater Regulations – These regulations are applied to developments within the jurisdiction of the Conservation Commission.

Stormwater Management Ordinance – The City has a Stormwater Management Ordinance (Section 25 of the General Code) that applies to developments that disturb 1-acre or more. The ordinance encourages low- impact development and requires projects to meet the MA Stormwater Management Regulations. The City will also implement Stormwater Management Regulations.

Wetlands Protection Act – The Waltham Conservation Commission administers the state's Wetlands Protection Act (Chapter 131, Section 40 MGL) to protect resource areas in and around wetlands, including land subject to flooding.

Infiltration and Inflow Mitigation Fee – Per City Council Ordinance 30078, any person or entity changing, altering, repairing, adding to or improving their property in any way that may or should impact the City of Waltham sewer system is required to reduce the rate of infiltration and inflow at a rate of 4:1.

Waltham Open Space and Recreation Plan (OSRP) - Waltham has protected open space and proactive land acquisition and preservation programs, including adopting the Community Preservation Act with a 2% surcharge in 2005.

Reviews and Inspections of New Developments – City staff and boards provide drainage reviews and the Engineering Department inspects utility connections for water sewer and drains once construction of a site is completed.

Public Education on Stormwater – The City continues to implement its NPDES Phase II stormwater program, which includes public education programs. In addition, the City provides educational stormwater materials on the City website.

NPDES Phase II Stormwater Program – The City continues to implement an aggressive NPDES stormwater program that includes measures for public education and outreach, illicit discharge detection and elimination, construction and post-construction controls, and City-wide good housekeeping and stormwater maintenance procedures.

6.2 Existing Dam Mitigation Measures

DCR dam safety regulations – All jurisdictional dams are subject to the Division of Conservation and Recreation's dam safety regulations (302 CMR 10.00). The dams must be inspected regularly, and reports filed with the DCR Office of Dam Safety.

Permits Required for Construction – State law requires a permit for the construction of any dam.

In addition to the above City-wide mitigation measures, there are also several measures that focus on specific sites or areas of the City.

Moody Street/Charles River Dam – The state maintains completed upgrades to the dam and will continue to perform regular maintenance to make sure the dam is stable.

Cambridge Reservoir – The City of Cambridge and the City of Waltham help mitigate against potential spills and contamination with the following measures:

- Water quality improvements through developments that have installed stormwater management features such as sand filtering systems.
- The City of Cambridge will provide spill containment in the event of a spill. Waltham typically responds with backup from Cambridge since the water supply is located in Waltham.
- The Waltham Local Emergency Planning Committee (LEPC) has a detailed hazardous material spill procedure for locations along Route 128.

6.3 Existing City-Wide Mitigation for Wind-Related Hazards

Massachusetts State Building Code – The City enforces the Massachusetts State Building Code whose provisions are generally adequate to protect against most wind damage. The code's provisions are the most cost-effective mitigation measure against tornados given the extremely low probability of occurrence. If a tornado were to occur, the potential for severe damages would be extremely high.

Tree Maintenance by the City – The City's Street and Forestry Division maintains street trees and numerous trees on public grounds, historic sites, conservation areas, park areas and cemeteries.

Tree Maintenance by Energy Utilities National Grid and Eversource Energy) – Utilities trim trees along the power lines. Preventative maintenance of trees along the power lines would be beneficial.

6.4 Existing City-Wide Mitigation for Winter-Related Hazards

Snow Removal Requirements in the General Code –The City's general code requires that snow and ice not block roads or sidewalks, and that snow and ice may not be moved from private to public property (Section 17-16). The code also requires removal of snow and ice from roofs (Section 17-10) and snow removal from sidewalks on Main Street and Moody Street downtown areas (Section 17-23).

Snow-Plowing Operations – The Public Works Department provides standard snow plowing operations, including sanding and salting.

6.5 Existing City-Wide Mitigation for Fire-Related Hazards

Open Burning Permits Required – The City allows controlled open burning in accordance with state regulations, but a permit is required from the Fire Department for each day of intended burning. Burning is only allowed during the burning season, typically January through April each year.

Fire Department Review of Proposed Development – The Fire Department reviews all subdivision and site plans for compliance with site access, water supply needs, and other applicable regulations within their jurisdiction.

Public Education – The Fire Department provides substantial public education on fire prevention on their website at www.walthamfire.com.

Backup Firefighting Water Supplies – The City has several surface water bodies that can be used for backup water supplies for fighting fires. However, access to these rivers, streams and ponds can be difficult.

Statewide Fire Mobilization Plan – The state has a fire mobilization plan for brush fires as well as a separate plan for Waltham's fire district.

6.6 Existing City-Wide Mitigation for Extreme Temperature-Related Hazards

Local Emergency Planning Committee (LEPC) – Under the Emergency Planning and Community Right to Know Act of 1986, communities are required to establish Local Emergency Planning Committees to develop a response plan for chemical emergencies. In accordance with this legislation, the City of Waltham has identified locations where hazardous materials are stored, used, and transported.

Massachusetts State Building Code – The City enforces the Massachusetts State Building Code whose provisions are generally adequate to protect against most wind damage. The code's provisions are the most cost-effective mitigation measure against tornados given the extremely low probability of occurrence. If a tornado were to occur, the potential for severe damages would be extremely high.

Tree Maintenance by the City – The City's Street and Forestry Division maintains street trees and numerous trees on public grounds, historic sites, conservation areas, park areas and cemeteries.

Tree Maintenance by Energy Utilities National Grid and Eversource Energy) – Utilities trim trees along the power lines. Preventative maintenance of trees along the power lines would be beneficial.

Schools as Emergency Shelters – The High School and Middle School would serve as shelters in the event of a disaster. Brandeis University and Bentley College also have shelter capabilities.

Medical Reserve Corps Volunteers – Waltham has a volunteer program, which is administered through the health department, where residents can help provide critical services during emergency situations.

6.7 Existing City-Wide Mitigation for Geologic Hazards

Massachusetts State Building Code – The State Building Code contains a section on designing for earthquake loads (780 CMR 1612.0). Section 1612.1 states that the purpose of these provisions is "to minimize the hazard to life to occupants of all buildings and non-building structures, to increase the expected performance of higher occupancy structures as compared to ordinary structures, and to

improve the capability of essential facilities to function during and after an earthquake". This section goes on to state that due to the complexity of seismic design, the criteria presented are the minimum considered to be "prudent and economically justified" for the protection of life safety. The code also states that absolute safety and prevention of damage, even in an earthquake event with a reasonable probability of occurrence, is not economically achievable for most buildings.

Section 1612.2.5 establishes seismic hazard exposure groups and assigns all buildings to one of these groups according to a Table 1612.2.5. Group II includes buildings which have a substantial public hazard due to occupancy or use and Group III are those buildings having essential facilities which are required for post-earthquake recovery, including fire, rescue and police stations, emergency rooms, power-generating facilities, and communications facilities.

6.8 Existing Multi-Hazard Mitigation Measures

Comprehensive Emergency Management Plan (CEMP) – Every community in Massachusetts is required to have a Comprehensive Emergency Management Plan. These plans address mitigation, preparedness, response and recovery from a variety of natural and man-made emergencies. These plans contain important information regarding flooding, hurricanes, tornadoes, dam failures, earthquakes, and winter storms. Therefore, the CEMP is a mitigation measure that is relevant to all the hazards discussed in this plan.

Local Emergency Planning Committee (LEPC) – Under the Emergency Planning and Community Right to Know Act of 1986, communities are required to establish Local Emergency Planning Committees to develop a response plan for chemical emergencies. In accordance with this legislation, the City of Waltham has identified locations where hazardous materials are stored, used, and transported.

LECP Emergency Plan – The LEPC response plan is available via the City website. This plan specifies items such as hazardous materials in the City, transportation routes, special populations, response plans, and sheltering. The Reporting Year 2018 Tier II Reports was due to the State by March 1, 2019.

Public Education – Emergency Preparedness public education is available on the City's website, via the Fire Department, Police Department, Emergency Management Department, and the LECP.

Reverse 911 – The City has a reverse 911 system that automatically calls all residents and businesses to communicate emergency information. Residents may update their reverse 911 information on the City website.

Schools as Emergency Shelters – The High School and Middle School would serve as shelters in the event of a disaster. Brandeis University and Bentley College also have shelter capabilities.

Multi-Department Review of Developments – Multiple departments, such as Planning, Zoning, Health, Public Works, Engineering, Fire, Police, Emergency Management and Conservation, thoroughly review all subdivision and site plans prior to approval.

Stable Communications Systems – Waltham has reliable communications towers that house communications equipment for the Police and several other City departments. City officials stated that their communications systems are not at risk during high wind events.

Backup Generators – In the event of power outages due to downed limbs, the City does have backup generators at all the critical City buildings and facilities. The City also has backup generators at pumping stations.

Buried Utilities – New subdivision developments are required to install underground utilities.

Massachusetts State Building Code – The Massachusetts State Building Code contains many detailed regulations regarding wind loads, earthquake resistant design, flood-proofing, and snow loads.

Medical Reserve Corps Volunteers – Waltham has a volunteer program, which is administered through the health department, where residents can help provide critical services during emergency situations.

FEMA Deployment – FEMA can deploy vehicles in the case of an emergency.

6.9 Compilation of Existing Mitigation

There are numerous existing natural hazard mitigation measures already in place in Waltham (Table 6-2).

Table 6-2. Existing Mitigation Measures

Type of Existing Mitigation Measures	Area Covered	Effectiveness/ Enforcement	Improvements/ Changes Needed
MULTIPLE HAZARDS			
Comprehensive Emergency Management Plan (CEMP)	City-wide	Effective	Needs to be periodically updated
Communications Equipment (Stable)	City-wide	Effective	None
Massachusetts State Building Code	City-wide	Most effective for new construction.	None
Multi-Department Review of Developments	City-wide	Effective	None
Local Emergency Management Planning Committee (LEPC)	City-wide	Effective	None
LEPC Emergency Plan	City-wide	Effective	None
Backup Generators	Critical City Building and Facilities	Effective	None
Buried Utilities	City-wide	Effective	None
Reverse 911	City-wide	Effective	None
Public Education	City-wide	Effective	Continue to expand outreach
Medical Reserve Corps Volunteers	City-wide	Effective	None
FEMA Deployment	State-wide	Effective	None
Collaboration with universities, including during emergencies	City-wide	Effective	Strengthen Communication
FLOOD HAZARDS			

Table 6-2. Existing Mitigation Measures

Type of Existing Mitigation Measures	Area Covered	Effectiveness/ Enforcement	Improvements/ Changes Needed
Participation in the National Flood Insurance Program (NFIP). The City actively enforces the floodplain regulations.	Areas identified on the FIRM maps	There are 184 policies in force. FIRM map dated 2019	Encourage all eligible homeowners to obtain insurance
Stormwater System and Outfalls Mapped in GIS	City-wide	The City has developed a drainage system inventory and integrated the data into a Geographical Information System (GIS)	Should be periodically updated
IDDE Program Implementation	City-wide	Effective	Continue sampling at outfalls.
Street sweeping	City-wide	Effective	None
Catch basin cleaning	City-wide	Effective	None
Drainage system maintenance	City-wide	Effective	Ongoing maintenance needed
Ongoing Drainage Improvement Program	City-wide	Effective	Ongoing improvements needed
Zoning – Floodplain District	City-wide	Effective	None
Stormwater Management Ordinance	City-wide	Effective	None
Wetlands Protection Act	Wetland Resource Areas	Effective	None
Massachusetts Stormwater Regulations	Conservation Commission jurisdictional areas	Effective	None
Infiltration and Inflow Mitigation Fee	City-wide	Effective	None
Waltham Open Space and Recreation Plan	City-wide	Effective	The Plan was updated in 2015
Review and Inspection of New Development Drainage	City-wide	Effective	None
Public Education on Stormwater	City-wide	Effective	Continue to update and inform the public
NPDES Phase II Stormwater Program	City-wide	Effective	Continue implementation
DAM HAZARDS			
DCR dam safety regulations and permitting	State-wide.	Somewhat effective	Improvements to the statewide system for dam inspections.

Table 6-2. Existing Mitigation Measures

Type of Existing Mitigation Measures	Area Covered	Effectiveness/ Enforcement	Improvements/ Changes Needed
Permits required for construction.	State-wide	Effective	None.
Moody Street/Charles River Dam have been upgraded.	Charles River at Moody Street	Effective	Continue to perform regular maintenance
Cambridge Reservoir – Waltham and Cambridge mitigate against potential spills and contamination.	Cambridge Reservoir	Effective	Continue mitigation
WIND HAZARDS			
The Massachusetts State Building Code	State-wide	Effective for most situations except severe storms	None
Tree Maintenance by the City	City-wide	Effective	None
Tree Maintenance by Electric Utilities (National Grid and Eversource Energy)	City-wide	Effective	Further maintenance of trees along power lines would be beneficial
WINTER HAZARDS			
Snow-Plowing Operations	City-wide	Effective	None
Snow Removal Requirements in the General Code	City-wide	Effective	None
BRUSH FIRE HAZARDS			
Open Burning Permits Required	City-wide	Effective	None
Public Education	City-wide	Effective	None
Fire Department Review of Proposal Developments	City-wide	Effective	None
Statewide Fire Mobilization Plan	State-wide	Effective	None
GEOLOGIC HAZARDS			
The Massachusetts State Building Code	City-wide	Effective for most situations	None

6.10 Mitigation Capabilities and Local Capacity for Implementation

Under the Massachusetts system of "Home Rule," the City of Waltham is authorized to adopt and from time to time amend a number of local bylaws and regulations that support the City's capabilities to mitigate natural hazards. These include the Zoning Ordinance, Stormwater Ordinance, Subdivision and Site Plan Review Regulations, Wetlands Ordinance, Health Regulations, Public Works regulations, and local enforcement of the State Building Code. Local Ordinances may be amended by the City Council to improve the City's capabilities, and changes to most regulations simply require a public hearing and a vote of the authorized board or commission. The City of Waltham has recognized several existing mitigation measures that require implementation or improvements, and has the capacity based on these Home Rule powers within its local boards and departments to address them. The City also has the ability to expand on and improve the existing policies and programs listed above.

7.0 STATUS OF MITIGATION MEASURES FROM THE 2013 DRAFT PLAN

7.1 Implementation Progress on the Previous Plan

At a meeting of the Waltham Core Committee, City staff reviewed the mitigation measures identified in the draft 2013 Waltham Hazard Mitigation Plan. Although this plan was never officially adopted by the City, the Core Committee felt it was important to determine which mitigation measures were still relevant and whether each measure had been implemented or deferred. Of those measures that had been deferred, the committee evaluated whether the measure should be deleted or carried forward into this 2019 HMP-MVP Plan. The decision on whether to delete or retain a particular measure was based on the committee's assessment of the continued relevance or effectiveness of the measure and whether the deferral of action on the measure was due to the inability of the City to take action on the measure. Table 7-1 summarizes the status of the mitigation measures, along with the priority of these measures. The breakdown of high and medium priority measures, along with any other possible measures, are provided in the table. The priority "NFIP" refers to potential mitigation measures that would ensure continued compliance with the National Flood Insurance Program.

Table 7-1. 2019 Status of Mitigation Measures from the 2013 Draft Plan

Mitigation Measures and Priority Levels	Mitigation Measure	Priority	2019 Status Completed / In Progress / Not Completed	Include in 2019 Plan? Priority?
High Priority				
A) Long Term City-Wide Drainage Plan	The City is considering a long-term drainage plan which would include a mix of additional planning and detailed engineering studies to prioritize key drainage action items over the next 10-20 years.	High	Not Completed	Yes-High
B) Linden Street (Route 60) Drainage Improvements	A flood mitigation Plan for Beaver Brook that includes restoring the stream channel conveyance capacity and cleaning of culverts that would alleviate flooding.	High	In Progress – Flood Mitigation Plan has been developed - Permitting Needed	Yes - High
C) Beaver Brook Stream Cleaning	Remove sediment and debris from Beaver Brook to increase capacity.	High & NFIP	Not Completed	Yes – High
Medium Priority				
D) Household and Construction	Hold hazardous waste collection days where	Medium	Completed	No

Table 7-1. 2019 Status of Mitigation Measures from the 2013 Draft Plan

Mitigation Measures and Priority Levels	Mitigation Measure	Priority	2019 Status Completed / In Progress / Not Completed	Include in 2019 Plan? Priority?
Hazardous Waste Collection Improvements	the residents can bring hazardous waste free of change.			
E) Continuation of Open Space Protection and Land Acquisition	Waltham should continue its efforts for open space protection and purchases.	Other & NFIP	In Progress – Waltham has an Open Space and Recreation Plan. Protection and purchasing of open space is ongoing.	Yes – Other
F) Continuation of Ongoing Replacement of Drainage Pipes and Outdated Infrastructure	Develop a critical infrastructure replacement plan that prioritizes culvert/bridge replacement.	Other & NFIP	Not Completed	Yes – Other & NFIP
G) Update Flood Information Rate Maps (FIRM)	Update FIRM maps information and update City stormwater ordinance.	Other & NFIP	Not completed	Yes – Other & NFIP
H) Provide Public Information on NFIP Compliance.	Distribute and make available information on insurance and building code requirements through explanatory pamphlets, booklets and on-line resources.	Other & NFIP	Not Completed	Yes-Other & NFIP

As indicated in Table 7-1, the City completed several mitigation measures including hazardous waste collection improvements and development of a Flood Mitigation Plan for Beaver Brook.

Several mitigation measures were identified and prioritized in this plan. These include implementing a Long-Term City-Wide Drainage Plan, permitting and implementation for the Linden Street Drainage Improvements as well as cleaning Beaver Brook, continuation of open space protection and land acquisition, continuing the replacement of drainage pipes and outdated infrastructure, updating City FIRM, and providing public information of NFIP compliance.

As the City moves forward into the next five-year plan implementation period; identifying and incorporating hazard mitigation into the City's decision-making process will be a high priority. Limited staffing and financial resources are the biggest challenges the City faces in implementing the mitigations measure identified in this plan. The plan is intended to assist the City in prioritizing the proposed measures, which will provide guidance on how to best allocate the City's limited resources.

8.0 HAZARD MITIGATION STRATEGY

8.1 What is Hazard Mitigation?

Hazard mitigation is the effort to reduce loss of life and property by lessening the impact of disasters. Mitigation is the phase of emergency management that is dedicated to breaking the cycle of damage, reconstruction and repeated damage through action and long-term strategies. These actions and long-term strategies can include planning, policy changes, education programs, infrastructure projects and other activities. FEMA currently has three mitigation grant programs: the Hazard Mitigation Grant Program (HGMP) (https://www.fema.gov/hazard-mitigation-grant-program), the Pre-Disaster Mitigation (PDM) program (https://www.fema.gov/pre-disaster-mitigation-grant-program), and the Flood Mitigation Assistance (FMA) program (https://www.fema.gov/flood-mitigation-assistance-grant-program).

Developing hazard mitigation plans enables state, tribal, and local governments to:

- Increase education and awareness around threats, hazards, and vulnerabilities;
- Build partnerships for risk reduction involving government, organizations, businesses, and the public;
- Identify long-term, broadly-supported strategies for risk reduction;
- Align risk reduction with other state, tribal, or community objectives;
- Identify implementation approaches that focus resources on the greatest risks and vulnerabilities; and
- Communicate priorities to potential sources of funding.

Hazard Mitigation Measures can be categorized by their different approaches to mitigating hazards. These approaches vary in terms of the types of actions taken and how those actions are administered at the local level. Measure are generally sorted into the following groups (Source: FEMA Local Multi-Hazard Mitigation Planning Guidance):

- Prevention: Government administrative or regulatory actions or processes that influence the way land and buildings are developed and built. These actions also include public activities to reduce hazard losses. Examples include planning and zoning, building codes, capital improvement programs, open space preservation, and stormwater management regulations.
- Property Protection: Actions that involve the modification of existing buildings or infrastructure to protect them from a hazard or removal from the hazard area. Examples include acquisition, elevation, relocation, structural retrofits, flood proofing, storm shutters, and shatter resistant glass.
- Public Education & Awareness: Actions to inform and educate citizens, elected officials, and property owners about the potential risks from hazards and potential ways to mitigate them. Such actions include outreach projects, real estate disclosure, hazard information centers, and school-age and adult education programs.
- Natural Resource Protection: Actions that, in addition to minimizing hazard losses also preserve or restore the functions of natural systems. These actions include sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.

- Structural Projects: Actions that involve the construction of structures to reduce the impact of a hazard. Such structures include storm water controls (e.g. culverts), floodwalls, seawalls, retaining walls, and safe rooms.
- Emergency Services Protection: Actions that will protect emergency services before, during, and immediately after an occurrence. Examples of these actions include protection of warning system capability, protection of critical facilities, and protection of emergency response infrastructure.

8.2 Regional and Inter-Community Consideration

Several hazard mitigation issues are primarily local. The problem originates largely within the municipality and can be resolved at the municipal level. Other issues are inter-community and require a coordinated effort between two or more municipalities. Regional mitigation issues usually involve a state, regional and/or federal agency, or three or more municipalities.

Mitigation measures for the following regional issues should be considered as Waltham develops its own local plan:

A) Coordination and Review of Developments on a Regional Basis for Stormwater Management: As Waltham and the surrounding communities are undergoing development, it is vital that these communities communicate and provide input during the review process. When addressing housing, transportation, and economic development projects, the impacts to neighbors must be addressed. Waltham is particularly interested in how upstream communities mitigate for stormwater, since so much of the flow in other communities ultimately reaches Waltham and can cause flooding.

B) Reconstruction of Culvert and Road Elevation on Trapelo Road in Belmont: The City of Waltham and the Town of Belmont acting through their Public Works and Engineering Departments are working on replacement of the Trapelo Road culvert carrying Beaver Brook, which splits the City/Town boundary. Flood studies have been performed to determine the impacts downstream of incorporating flood mitigation measures into the Culvert Replacement Project. Permitting in both communities is the next step to moving forward with this project.

C) Increase Electric Utilities' Tree Maintenance Program: An issue during storms in Waltham is the damage to power and phone wires from overhanging trees that have not been trimmed by the electric utilities or the phone or cable companies. Eversource should continue with their reactive and preventative measures. Eversource clear cuts every few years.

8.3 Regional Partnerships

Mitigating natural hazards, particularly flooding, is not confined to a local issue. The drainage systems that service communities are often complex systems of storm drains, roadway drainage infrastructure, pump stations, dams, and other facilities owned and operated by a wide variety of agencies including the City, Massachusetts Department of Transportation (MassDOT) the Massachusetts Water Resources Authority (MWRA), and the Department of Conservation and Recreation (DCR). The planning, construction, operation and maintenance of these structures are integral to the flood hazard mitigation efforts of communities. These agencies are the City's regional partners in hazard mitigation efforts. These agencies also operate under the same constraints as communities do including budgetary and staffing limitations. And as all communities do, they must make decisions about numerous competing priorities. In the sections that follow, the plan provides recommendations for activities where cooperation

with these other agencies will likely be necessary. In order to implement many of these mitigation measures, all parties will need to work together towards a mutually beneficial solution.

8.4 Regional and Inter-Community Facilities in Waltham

Major facilities owned, operated and maintained by state or regional entities include:

- Cambridge Reservoir (Cambridge Water Department)
- State Routes 20, 60, 117, and 128
- MBTA Bus Lines
- Bus Routes and Commuter Rail Line
- Bentley College
- Brandeis University
- MWRA water distribution mains and wastewater collectors

8.5 Planning for New Development and Infrastructure

Hazard mitigation planning needs to consider new development and associated infrastructure in order to anticipate additional hazards that may occur with community growth. As part of the process of developing recommendations for new mitigation measures for this plan, the City considered issues related to new development, redevelopment, and infrastructure needs in an attempt to limit future risks. New development takes into consideration the Massachusetts Building Code; this is enforced by the Building Department. New development also considers local Zoning, the Wetlands and Stormwater Ordinances. Priorities for the future include stormwater management, installation of green infrastructure, and Low Impact Development to promote stormwater recharge and alleviate flooding and to promote cooling of ambient outdoor temperatures.

8.6 Recommended Mitigation Measures and Prioritization

During the Core Committee meetings, officials in Waltham determined possible mitigation measures for the various natural hazards that have impacted or could impact the City.

Local officials prioritized the measures, reviewing the project Goals, such as:

- The number of homes and businesses affected by the hazard
- Whether or not road closures occurred and what impact closures had on delivery of emergency services and the local economy
- Whether any environmental constraints existed
- Is there political support and public support to implement the mitigation measures?
- Can the City provide the necessary maintenance when the mitigation measure is completed?
- Does the cost seem reasonable when considering the size of the problem and likely benefits from mitigation?

Table 8-1 below represents the City's recommended hazard mitigation measures and prioritization of these measures. For each mitigation measure, the geographic benefit area is identified, as is a determination of overall benefit and the estimated cost associated with the measure. Each of the categories in Table 8-1 are identified below:

Mitigation Action – A brief description of each mitigation measure that was identified in this plan.

Implementation Responsibility – Most mitigation measures will require a multi-department approach where several City departments share responsibility. This determination is at the discretion of the governing body of the community. The designation of implementation responsibility in the table was assigned based on general knowledge of the responsibilities of each municipal department.

Time Frame – The time frames represented below are assigned based on the complexity of the measure, the overall priority of the measure and at what stage of design and/or funding has been attained. Because the time frame for this plan is five years, the timing for all mitigation measures has been kept within this framework. The identification of time frames is not meant to prevent a community from actively seeking out and taking advantage of funding opportunities as they arise.

Estimated Benefit – The benefit that each mitigation measure would have on the community. This was categorized in High, Medium, and Low. High represents an action that would result in a significant reduction of hazard risk to people and/or property from a hazard event. Medium represents an action that would likely result in a moderate reduction of hazard risk to people and/or property from a hazard event. Low represents an action that would likely result in a low result of hazard risk to people and/or property from a hazard event.

Estimated Cost – Cost estimates are given when cost data was available from the community. All cost data would need to be updated at the time of design and construction and is only provided as an estimate. Costs designated as “High” are estimated to be greater than $100,000. Those designated as “Medium” are estimated to between $10,000 to $100,000. “Low” costs are estimated to be less than $10,000.

Potential Funding Sources – This column identifies the most likely sources of funding for a specific measure. The identification of potential funding sources in this table is preliminary and may vary depending on numerous factors. These factors include, but are not limited to, if a mitigation measure is conceptual or has been studied, evaluated or designed. In most cases, the measure will require an assemblage of funding sources. The funding sources identified in this table are not a guarantee that a specific project will be eligible for or receive funding. Upon adoption of this plan, the local representatives responsible for implementation should begin to explore the funding sources in more detail.

Priority – Designation of high, medium, or low priority was based on overall potential benefits, areas affected, and estimated project costs. A High Priority action is very likely to have political and public support and necessary maintenance can occur following the project, and the costs seem reasonable considering likely benefits from the measure. A Medium Priority action may have political and public support and necessary maintenance has potential to occur following the project. A Low Priority action may not have political and public support for implementation or the necessary maintenance support following the project.

Table 8-1. Recommended Hazard Mitigation Measures

Mitigation Action	Geographic Coverage	Implementation Responsibility	Time Frame	Estimated Benefit	Estimated Cost	Potential Funding Sources	Priority
FLOODING							
1. Replace Trapelo Road culvert at Belmont-Waltham line and build a wall to create additional flood storage.	Trapelo Road near Belmont line	Public Works, Engineering	Culvert: 2017-2020 Wall: 2019-2022	High	High	DCR, Belmont, Waltham	High
2. Create and Implement Stormwater Master Plan and Long-Term Implementation Plan (to include flood mitigation and drainage infrastructure improvements)	City-wide	Public Works, Planning, Engineering	Planning: 2019-2021 Implementation: 2021-2026	High	Planning: $250,000 (min) Implementation: $100,000/year	City, FEMA, ACOE	High & NFIP

Table 8-1. Recommended Hazard Mitigation Measures

Mitigation Action	Geographic Coverage	Implementation Responsibility	Time Frame	Estimated Benefit	Estimated Cost	Potential Funding Sources	Priority
3. Beaver Brook Flood Mitigation – Phase II: a. Linden Street Drainage Improvements: Culvert Replacement b. Beaver Brook Maintenance – Restore Conveyance Capacity	a. Linden Street (Route 60) b. Beaver Brook	a. Public Works, Engineering b. Public Works, Engineering	a. 2019-2024 b. 2019-2021	High	a. High: $1.0M-2.0M b. Low: Staff & Volunteer Time	City, FEMA, ACOE	a. High b. High &NFIP
4. Replace Lexington Street Culvert (near Self Storage)	260 Lexington Street	Public Works, Engineering	2020-2021	High	$1.0M	City, FEMA, ACOE	High & NFIP
5. NPDES MS4 Stormwater Management Permit Compliance – Water Quality Improvements	City-wide	Public Works, Planning, Engineering	Ongoing	High	$500,000	City, FEMA, ACOE	High & NFIP
6. Continued Ongoing Routine Maintenance Replacement of Drainage Pipes and Outdated Infrastructure	City-wide	Public Works	2019-2024	Medium	High: City Staff Time and Material Costs Vary	City, FEMA, ACOE	Low

Table 8-1. Recommended Hazard Mitigation Measures

Mitigation Action	Geographic Coverage	Implementation Responsibility	Time Frame	Estimated Benefit	Estimated Cost	Potential Funding Sources	Priority
7. Participate in process to update and provide City Flood Information Rate Maps (FIRM) maps	City-wide	Public Works, GIS	2019-2022	High	Staff Time	City	Low
WIND							
8. Tree trimming and maintenance, especially near powerlines to City pumping stations and public safety buildings.	City-wide	Eversource, Public Works	Ongoing	Medium	Medium	City	Medium
MULTI-HAZARD							
9. Asset Management of critical building and culverts, with an assessment that prioritizes and identifies improvements.	City-wide	Public Works, Engineering, Traffic Engineering	2019-2023	High	$250,000	City, FEMA, ACOE	High & NFIP
11. Continuation of Open Space Protection and Land Acquisition	City-wide	City of Waltham	2019-2026	Medium	Varies from City staff time to up to $1.0M or greater to purchase land	City, Community Preservation Act Funds	Low

Table 8-1. Recommended Hazard Mitigation Measures

Mitigation Action	Geographic Coverage	Implementation Responsibility	Time Frame	Estimated Benefit	Estimated Cost	Potential Funding Sources	Priority
12. Provide Public Information on National Flood Insurance Program Compliance (on City website)	City-wide	Public Works	2019-2024	Medium	Low: City staff time and material costs vary	City	Low
13. Forest management for brush fires and wind	City-wide	Public Works, Recreation	2019-2020	Low	Low	City	Low
14. Fernald Center: Redevelop and reuse the campus for open space, stormwater detention, and historical preservation, as well as updating and adding development, and restoring wetlands and floodplains.	Northeast Portion of the City	Public Works, Conservation, Engineering	2019-2023	High	High	City, FEMA, ACOE	High
15. Adoption of a stormwater ordinance	City-wide	Conservation, Engineering, Public Works	June 2020	High	Low	City	High
16. Warming Center for homeless population	City-wide	City of Waltham	Ongoing	Moderate	Low	City Council has existing funds	High

Table 8-1. Recommended Hazard Mitigation Measures

Mitigation Action	Geographic Coverage	Implementation Responsibility	Time Frame	Estimated Benefit	Estimated Cost	Potential Funding Sources	Priority
17. Dredge Chester Brook downstream of Hardy Pond	Chester Brook	Public Works, Conservation, Engineering	June 2020	Moderate	Moderate	MVP Grant	High
18. Totten Pond flooding control and culvert replacement at Prospect Hill Park (West Chester Brook watershed)	West Chesterbrook	Public Works, Conservation, Engineering	June 2022	Moderate	Moderate	MVP Grant	High

9.0 PLAN ADOPTION AND MAINTENANCE

9.1 Plan Adoption

The Waltham HMP-MVP Plan 2019 was adopted by the City Council on September 23, 2019. SeeAppendix D for documentation. The plan was approved by FEMA for a five-year period that will expire on October 1, 2024.

9.2 Plan Maintenance

After approval of the plan by FEMA, and adoption of the plan by the City, the Core Committee that originally convened as the steering committee for establishing the Plan will transition its work to updating and keeping the Plan current. Coordinated by Waltham Planner Director Catherine Cagle, the Core Committee will meet annually or on an as-needed basis, whichever is most frequent, to monitor plan implementation and may include additional members from local businesses, non-profits and institutions. The City will engage the public during the next 5-year planning cycle and encourage local participation whenever possible. All updates and accomplishments of the Core Committee and the City, related to mitigation measure and the plan itself, will be placed on the City's web site. All public meetings to update the Plan will be publicly noticed in accordance with City and state open meeting laws and the public will be encouraged to attend and participate.

9.3 Implementation and Evaluation Schedule

Bi-Annual Survey on Progress – The coordinator of Core Committee, Catherine Cagle, will prepare and distribute a survey halfway into the five-year plan. The survey will be made available to all Core Committee members and any other interested local stakeholders. The survey will assist in determining any necessary changes or revisions to the plan that may be needed. In addition, it will help provide information on progress and accomplishments for implementation and any new hazards or problem areas that have been identified since the plan drafting.

The information collected through the survey will be used to formulate a report and/or addendum to the plan. It will be important to evaluate the status of measures accomplished and initiated towards meeting the plan's goals. Additionally, identifying areas that need to be updated in the next plan will need to be an ongoing process. The Core Committee, led by the designated coordinator, will have primary responsibility for tracking progress, evaluating, and updating the plan during the next five years and beyond.

Preparation for the Plan – FEMA's initial approval of this plan is valid for five years. During that time the City will need to continue to track progress, amend hazards and identify additional hazards and mitigation measures. By doing so, the City will maintain a plan, which will secure eligibility for FEMA mitigation grants, and future updates will be relatively easy since information will have been collected and updated throughout the five-year life of this plan. Given the lead time needed to secure funding and conduct the planning process, the Core Committee will begin drafting the full update of the plan in year four. The group will use the information from the year four biannual review, in addition to any other data and information collected, to identify the needs and priorities for the plan update. This will help the City avoid a lapse in its approved plan status and grant eligibility when the current plan expires at the end of year five.

Potential sources of funding in the future may include FEMA Pre-Disaster Mitigation grants and the Hazard Mitigation Grant Program. Both grant programs are eligible to pay for 75% of a planning project, with a 25% local cost share requirement.

Update Preparation and Adoption – Once the resources have been secured to update the plan, the Core Committee will need to determine whether to undertake the update itself or hire a consultant. If the Core Committee decides to update the plan itself, the group will need to review the current FEMA hazard mitigation plan guidelines for any change in the requirements. The Waltham HMP-MVP Plan Update will be forwarded to MEMA and DCR for review and to FEMA for ultimate approval.

9.4 Integration of the Plans with Other Planning Initiatives

Upon approval of the 2019 Waltham HMP-MVP Plan by FEMA, the Core Committee will make the plan available to all interested parties and all departments with an implementation responsibility. The group will initiate a discussion with those various departments regarding how the plan can be integrated into their ongoing work. At a minimum, the plan will be reviewed and discussed with the following departments:

Fire Department/Emergency Management
Police Department
Public Works Department
Planning
Conservation Commission
Parks and Recreation
Board of Health
Building

Coordination with large institutions, the Water District, the Chamber of Commerce, land conservation organizations and watershed groups will be required for successful implementation and continued updating. The adopted plan will be posted on the City's website. Any sections of the plan containing sensitive information that would be considered inappropriate for public posting will be removed prior to posting. The posting of the plan on the City's web site will provide a mechanism for citizen feedback, such as an e-mail address for interested parties to send comments.

Appropriate sections of the HMP-MVP Plan will be integrated into other City plans, policies and documents as those are updated and renewed, including the Open Space and Recreation Plan, Comprehensive Emergency Management Plan, and Capital Investment Program.

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APPENDIX A

Core Team Meetings

City of Waltham
Municipal Vulnerability Preparedness and Hazard Mitigation Planning Grant Project
MVP/HMP Committee (Core Team) Meeting
Thursday, January 31, 2019
1:30 pm – 3:00 pm

1. Introductions — 5 minutes

2. Project Overview — 10 minutes
   a. MVP & Hazard Mitigation Planning
      i. Municipal and stakeholder driven process
      ii. Workshop(s) to identify strengths and vulnerabilities
      iii. Matrix and report identifying MVP Key Actions/HMP Mitigation Strategies
   b. MVP Action Grants

3. Committee (Core Team) Role — 5 minutes
   a. Develop schedule
   b. Organize implementation of the Community Resilience Building Workshop
   c. Inform community priorities/Determine how decisions from Workshop will be used

4. Community Resilience Building Workshop/HMP Meetings — 15 minutes
   a. Overview of climate projections
   b. Map of key resources/assets
   c. Discuss hazards and key features (infrastructure, society, environment)
   d. Prioritize MVP Key Actions/HMP Mitigation Strategies
   e. MVP Risk Matrix

5. Data Needs and Sources — 10 minutes
   a. Interviews with municipal officials
   b. Applicable reports and materials
   c. Critical assets and infrastructure

   W&S Action Item: Review materials and interview officials; incorporate information into Workshop and Report(s)
   Waltham Action Item: Identify and provide any additional resources

6. Workshop Participants
   a. Review list of workshop invitees — 10 minutes
   b. Invitations and RSVPs
   c. Table Assignments

   W&S Action Item: Draft invitation to stakeholders
   Waltham Action Item: Finalize list of invitees; send invitation and track RSVPs, assign participants to tables

Weston & Sampson

7. Workshop Schedule — 5 minutes
    a. One 8-hour meeting on February 14, 2019

8. Workshop Materials — 20 minutes
    a. Draft Powerpoint
    b. Draft map for discussion at tables
    c. Other

    W&S Action Item: Finalize Workshop materials based on Core Team input
    Waltham Action Item: Help to fill mapping and Powerpoint gaps

9. Workshop Staffing — 5 minutes
    a. Facilitators and Note-takers

    W&S Action Item: Identify table facilitators and note-takers

10. Wrap Up and Next Steps — 5 minutes

City of Waltham
Municipal Vulnerability Preparedness and Hazard Mitigation Planning Grant Project
MVP/HMP Committee (Core Team) Meeting Notes
Thursday, January 31, 2019
1:30 pm – 3:00 pm

Attendance

Waltham
Catherine Cagle, Project Manager & Planning Director
Steve Casazza, Engineering
Michael Chiasson, Public Works Department
J. Michael Garvin, Traffic Engineering
Deputy Chief Richard Grant, Police Department
Tim Kelly, Wires Department
Lt. Tim Maher, Fire Department
Joe Pedulla, Purchasing
Captain Jeff Rodley, Fire Department

Weston & Sampson
Kathy Baskin, Project Manager

SSV Engineering, Inc.
Sam Bade

Discussion

MVP Program Overview

- MVP Planning and Hazard Mitigation Planning
  - 70+ municipalities in 2017-2018
  - 80+ municipalities in 2018-2019
  - Municipal and stakeholder driven process
  - 8-hour Community Resiliency Building Workshop (divided into two consecutive 4-hour meetings because of contract) to identify strengths, vulnerabilities and strategies and relationship to HMP process
  - Development of Risk Matrix to identify MVP Key Actions/HMP Mitigation Strategies
- MVP Action Grant
  - Funding is available for implementation of Key Actions
  - MVP program ties into other funding programs; MVP certified communities receive extra points awarded on other EEA grant/loan applications

Core Team Role

- Core Team defines goals and develops schedule
- Organizes implementation of the Community Resilience Building Workshop, Listening Session, and HMP community and public meetings
- Determines how information and decisions from Workshop will be used
- Reviews recommendations and prioritizes Action Items

MVP Community Resilience Building Workshop/HMP Community Meetings

- Components of the Workshop are:
  - Provide an overview of climate projections
  - Use of large map depicting key resources, assets and infrastructure
  - Discussion of strengths and vulnerabilities
  - Prioritize MVP Key Actions/HMP Mitigation Strategies
  - Use of the Risk Matrix to organize ideas

Data Needs and Sources

- Reports and materials previously identified by Weston & Sampson:
  - Massachusetts Climate Change Projections (NECSC, 2018)
  - Massachusetts Climate Change Adaptation Report (MA EEA, 2011)
  - Massachusetts State Hazard Mitigation and Climate Change Adaptation (Commonwealth of MA, 2018)
  - City of Waltham Hazard Mitigation Plan 2016 Update, Revised Draft (MAPC, 2013)
  - 2015-2022 Open Space & Recreation Plan (Waltham, 2015)
- Additional resources identified by Committee members were:
  - Local Emergency Planning Committee report
  - City maps, including hazmap
  - Environmental reports for Fernald School
  - Transportation Master Plan (identifies areas that could be disrupted by weather, affecting emergency personnel)
  - Fire Department (Emergency Management)
  - Cambridge Department's Watershed Management staff
- Weston & Sampson's Team (especially Sam Bade) will hold side meetings with various staff to gather additional information on critical assets and infrastructure

Workshop Attendees

- Potential invitees for the Workshops are:
  - Elected officials (state and local, including mayor, city departments, auditor)
  - Chamber of Commerce
  - MAPC
  - Massachusetts General Hospital
  - Children's Hospital
  - Other towns
  - US Army Corps of Engineers
  - US Environmental Protection Agency
  - Route 128 business community
  - MBTA
  - Keolis
  - MA Department of Environmental Protection
  - MA Department of Conservation and Recreation
  - Not-for-Profit organizations
  - Brandeis University
  - Bentley University
  - Conservation Commission
  - Council on Aging
  - Charles River Washed Association

- MA State Police (Lt. Tony Dear of Brighton Barracks)
- Long-term care facilities (The Leland Home)
- Social service groups (such as Middlesex Human Services and Community Day Center)
- Hardy Pond Association
- Latinos en Accion
- Africano-African Cultural Services
- Massachusetts Water Resources Authority

- Kathy will send a revised invitation list and a draft invitation letter to Catherine.

Schedule

- Two consecutive 4-hour Workshops are planned for Thursday, February 14, 2019 from 8:30 am to 4:30 pm.
- The meeting will be at Waltham Government Center, 119 School St, Waltham, MA in the Auditorium.

Workshop Materials

- Kathy reviewed the general schedule of the workshop describing the sequence of events.
- Draft Powerpoint: The Core Team reviewed the draft workshop presentation which includes existing hazards, existing climate change, climate change projections, features that will be vulnerable or offer strength to the community under climate change, and types of actions that can be taken to alleviate impacts.
- Draft GIS Map for Discussion: The Core Team reviewed the large GIS map of the assets and vulnerabilities. Remove reference to neighborhoods, add public and private schools.

Workshop Staffing

- Weston & Sampson will provide table facilitators for the Workshop and will be looking for participants to volunteer as table scribes/note-takers for Workshop.

Wrap Up and Next Steps

- List of invitees to be finalized and invitations to be sent out for February 14 Workshop.
- Send previous draft HMP to MVP/HMP Committee (Core Team).

City of Waltham
Municipal Vulnerability Preparedness and Hazard Mitigation Planning Grant Project
MVP/HMP Committee (Core Team) Meeting
Tuesday, February 20, 2019
9:30 am – 11:30 am

1. Introductions — 5 minutes
2. Endorsement of Mitigation Goals — 15 minutes
3. Draft MVP/HMP Priority Actions — 50 minutes
    a. Missing Actions
    b. Order of Priority
    c. Redundancies
4. Review/Update Mitigation Measures of 2012 Hazard Mitigation Plan — 45 minutes
5. Wrap Up and Next Steps — 5 minutes

City of Waltham
Municipal Vulnerability Preparedness and Hazard Mitigation Planning Grant Project
MVP/HMP Committee (Core Team) Meeting Notes
Tuesday, February 20, 2019
9:30 am – 11:30 am

Attendance

Waltham
Catherine Cagle, Planning Department
Michael Chiasson, Public Works Department
Louis DiDino, Wires Department
J. Michael Garrin, Traffic
Tim Maher, Police Department
Jeff Rodley, Police Department

Weston & Sampson
Kathy Baskin, Project Manager

Discussion

Endorsement of Mitigation Goals

- The Team reviewed, revised and endorsed mitigation goals for the Hazard Mitigation Plan.

Review Draft Priority Actions from the Community Resilience Building Workshop

- The Team reviewed a draft list of the Draft MVP Report's recommended MVP Actions/Hazard Mitigation Strategies, which were developed during the February 14, 2019 Workshop, considering order of priority, redundancies, and missing Actions/Strategies.
- The Team proposed revisions to the language, fine-tuning the language to combine redundant Actions and to ensure that the Actions represented the intent of the Town and Workshop participants.
- Actions were reorganized slightly, to differentiate between High Priority, Medium Priority and Other Actions.

Review/Update Mitigation Strategies of 2013 Hazard Mitigation Plan

- Weston & Sampson has compiled sections of the draft 2013 Hazard Mitigation Plan related to current and potential mitigation strategies. These sections need to be updated by the Town.
- The Team offered updates to some of these previous mitigation strategies, updating those related to drain system maintenance frequency, communications, overnight parking, and wires.

Next Steps

- Weston & Sampson will to continue reviewing sections of the 2013 Hazard Mitigation Plan related to hazards, critical infrastructure, current mitigation measures, and potential mitigation measures with applicable departments. Sam Bade will be the consultant's point of contact. He will confirm local areas of flooding and identify/confirm critical infrastructure.
- A Listening Session, at which the general public will have an opportunity to comment on the findings and recommendations of the February 14, 2019 Workshop will be held on Wednesday, February 27, 2019 at 6:00 pm in the Auditorium of Waltham Government Center, 119 School Street, Waltham. A second Listening Session to provide the public an opportunity to comment on the draft Hazard Mitigation/MVP Plan, is scheduled for Thursday, March 14, 2019 at 6:00 pm in the same location.

City of Waltham
Municipal Vulnerability Preparedness and Hazard Mitigation Planning Grant Project
MVP/HMP Committee (Core Team) Meeting
Tuesday, April 17, 2019
9:30 am – 11:30 am

1.	Introductions	5 minutes
2.	HMP-MVP Plan Implementation/Potential MVP Action Grant Application(s)	75 minutes
3.	Status of Draft HMP-MVP Plan	10 minutes
4.	Wrap Up and Next Steps	5 minutes

City of Waltham
Municipal Vulnerability Preparedness and Hazard Mitigation Planning Grant Project
MVP/HMP Committee (Core Team) Meeting
Wednesday, March 27, 2019
9:30 am – 11:30 am

1.	Introductions	5 minutes
2.	Existing Mitigation Strategies	15 minutes
3.	Proposed Mitigation Strategies	75 minutes
4.	Gaps Between Workshop Recommended Actions and Proposed Strategies	20 minutes
5.	Wrap Up and Next Steps	5 minutes

APPENDIX B

Hazard Mapping

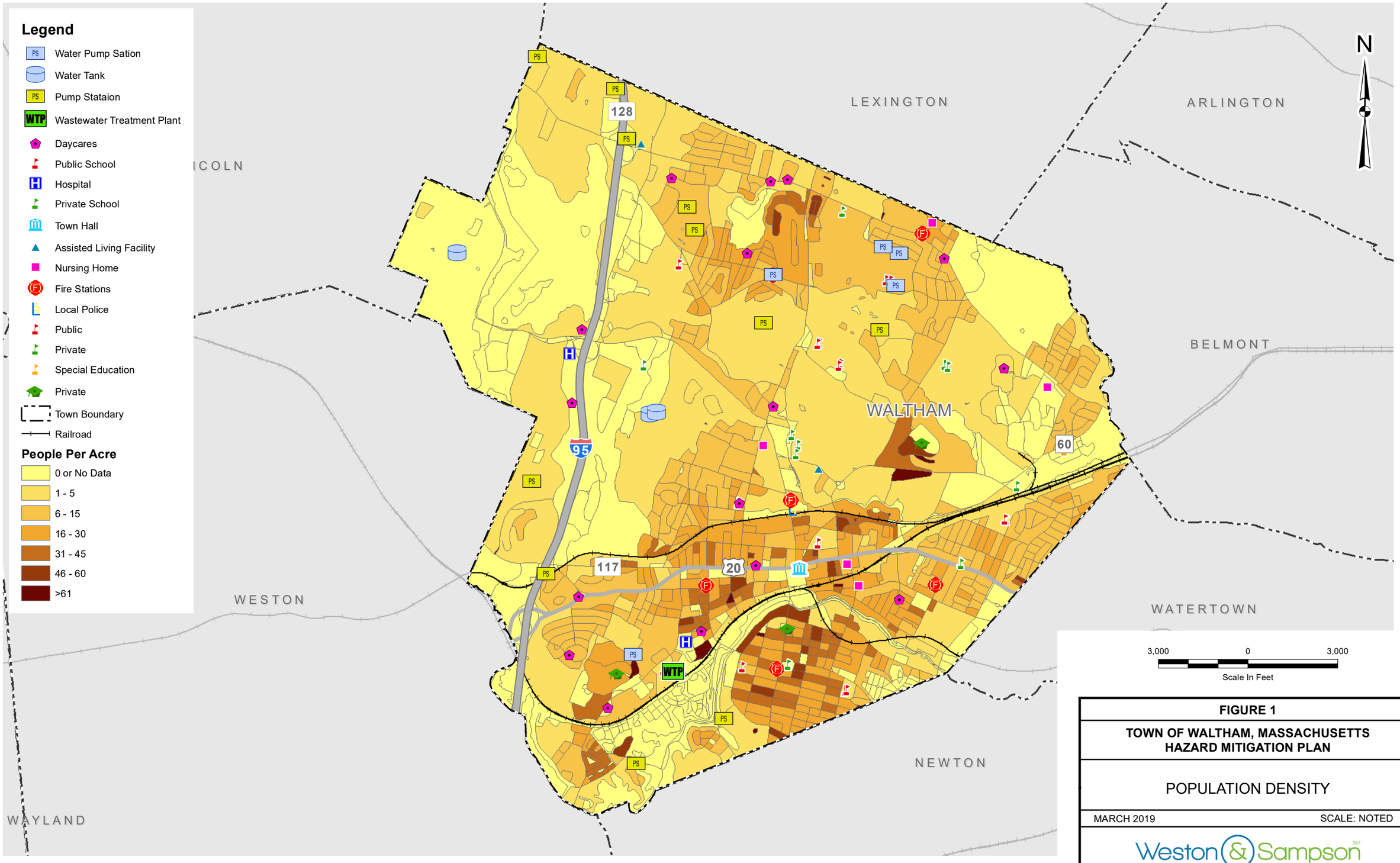

FIGURE 1

TOWN OF WALTHAM, MASSACHUSETTS
HAZARD MITIGATION PLAN

POPULATION DENSITY

MARCH 2019 SCALE: NOTED

Weston & Sampson

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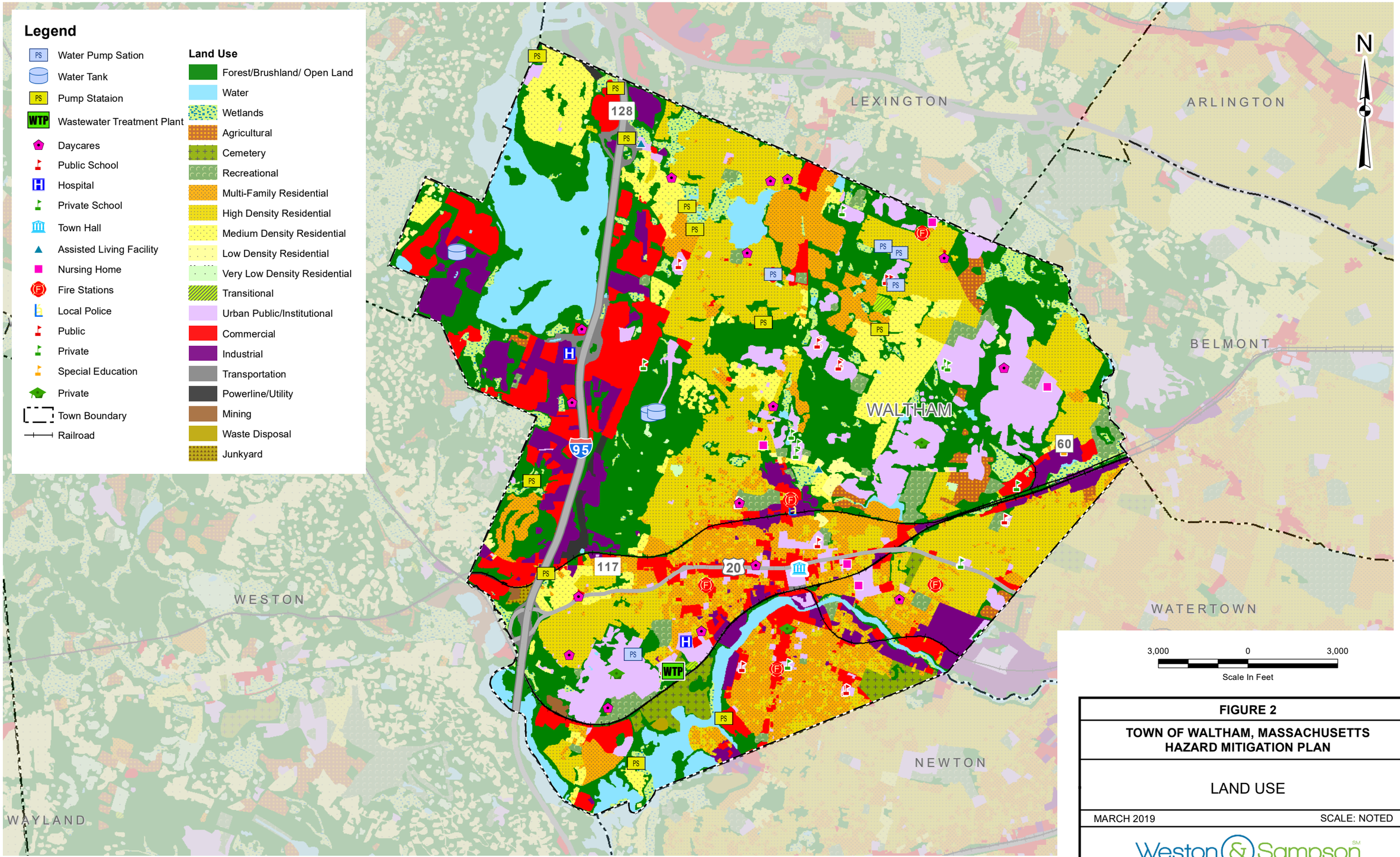
Legend

- Water Pump Sation
- Water Tank
- Pump Stataion
- Wastewater Treatment Plant
- Daycares
- Public School
- Hospital
- Private School
- Town Hall
- Assisted Living Facility
- Nursing Home
- Fire Stations
- Local Police
- Public
- Private
- Special Education
- Private
- Town Boundary
- Railroad

Land Use

- Forest/Brushland/ Open Land
- Water
- Wetlands
- Agricultural
- Cemetery
- Recreational
- Multi-Family Residential
- High Density Residential
- Medium Density Residential
- Low Density Residential
- Very Low Density Residential
- Transitional
- Urban Public/Institutional
- Commercial
- Industrial
- Transportation
- Powerline/Utility
- Mining
- Waste Disposal
- Junkyard



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Scale In Feet

FIGURE 2

TOWN OF WALTHAM, MASSACHUSETTS
HAZARD MITIGATION PLAN

LAND USE

MARCH 2019 SCALE: NOTED

Weston & Sampson SM

Legend

- Water Pump Sation
- Water Tank
- Pump Stataion
- Wastewater Treatment Plant
- Daycares
- Public School
- Hospital
- Private School
- Town Hall
- Assisted Living Facility
- Nursing Home
- Fire Stations
- Local Police
- Public
- Private
- Special Education
- Private
- Town Boundary
- Railroad
- Open Water

Flood Zone Designations

- 1% Annual Chance of Flooding (Zones A, AE, AH, AO)
- AE: Regulatory Floodway
- X: 0.2% Annual Chance of Flooding

LEXINGTON
ARLINGTON
BELMONT
WALTHAM
WATERTOWN
NEWTON
WESTON
WAYLAND
128
95
60
117
20
PS
WTP

N

3,000 0 3,000
Scale In Feet

FIGURE 3

TOWN OF WALTHAM, MASSACHUSETTS
HAZARD MITIGATION PLAN

FLOOD ZONES

MARCH 2019 SCALE: NOTED

Weston & Sampson

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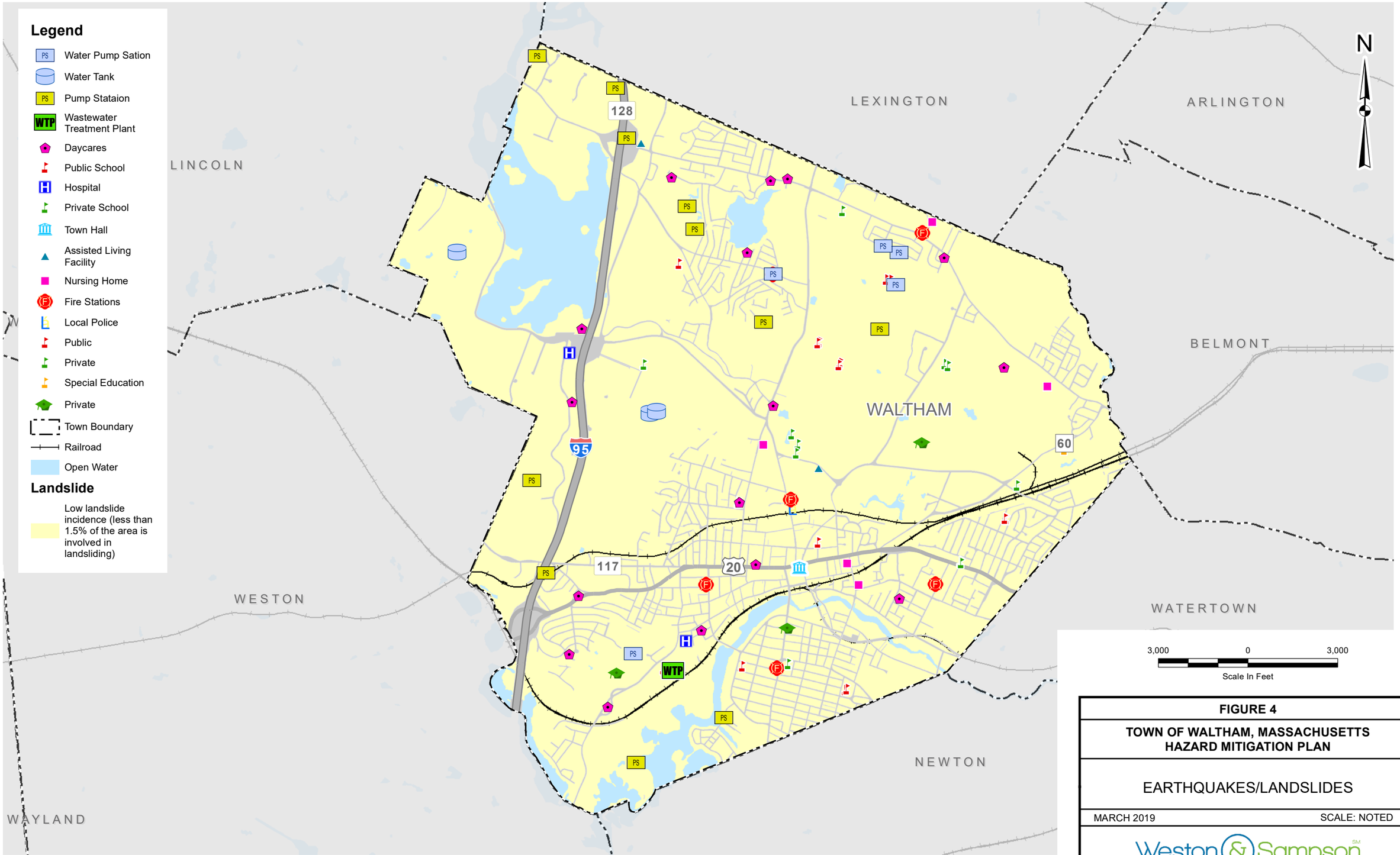


FIGURE 4

TOWN OF WALTHAM, MASSACHUSETTS
HAZARD MITIGATION PLAN

EARTHQUAKES/LANDSLIDES

MARCH 2019 SCALE: NOTED

Weston & Sampson SM

Legend

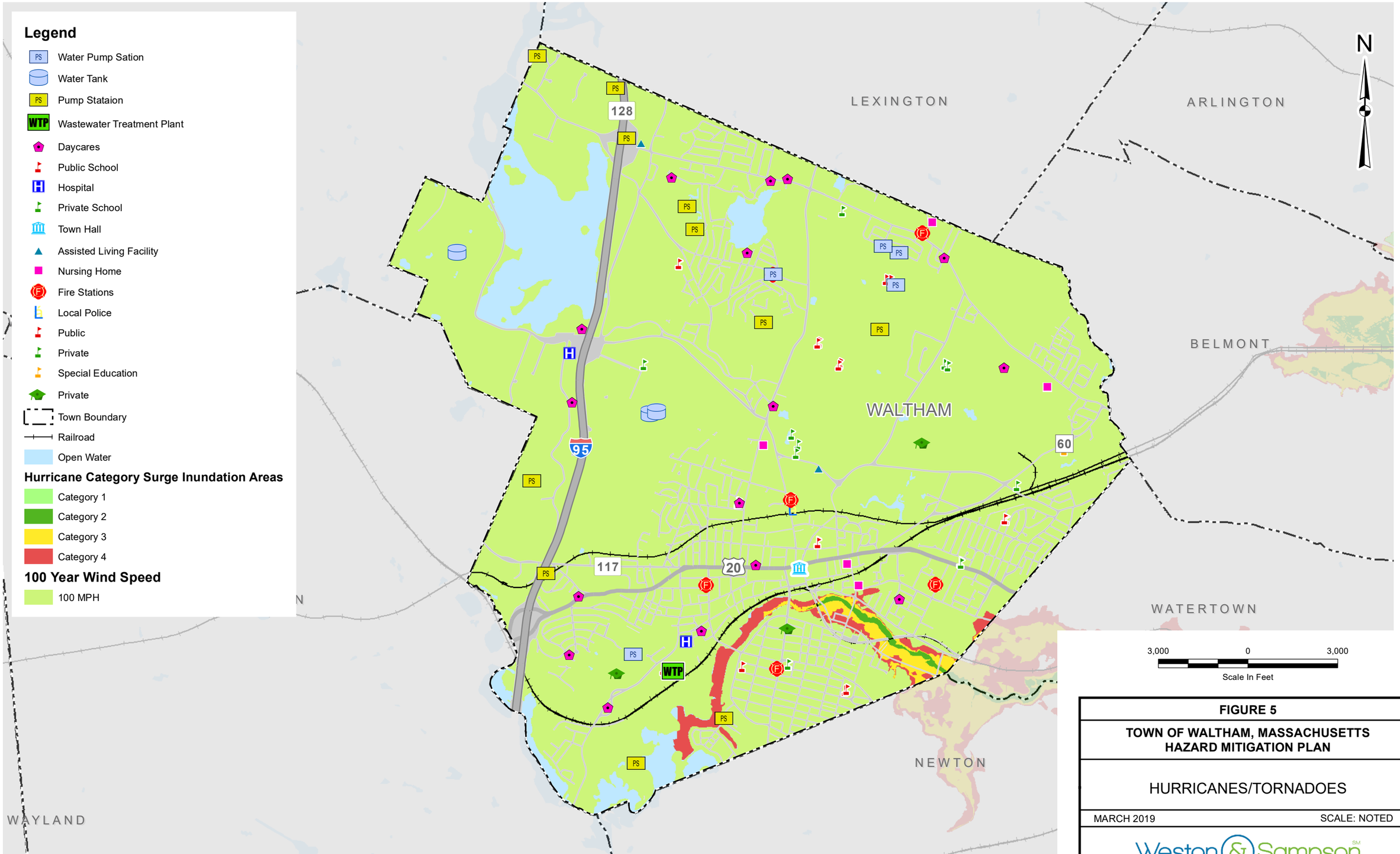
- Water Pump Sation
- Water Tank
- Pump Stataion
- Wastewater Treatment Plant
- Daycares
- Public School
- Hospital
- Private School
- Town Hall
- Assisted Living Facility
- Nursing Home
- Fire Stations
- Local Police
- Public
- Private
- Special Education
- Private
- Town Boundary
- Railroad
- Open Water

Hurricane Category Surge Inundation Areas

- Category 1
- Category 2
- Category 3
- Category 4

100 Year Wind Speed

- 100 MPH



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Scale In Feet

FIGURE 5

TOWN OF WALTHAM, MASSACHUSETTS
HAZARD MITIGATION PLAN

HURRICANES/TORNADOES

MARCH 2019 SCALE: NOTED

Weston & Sampson

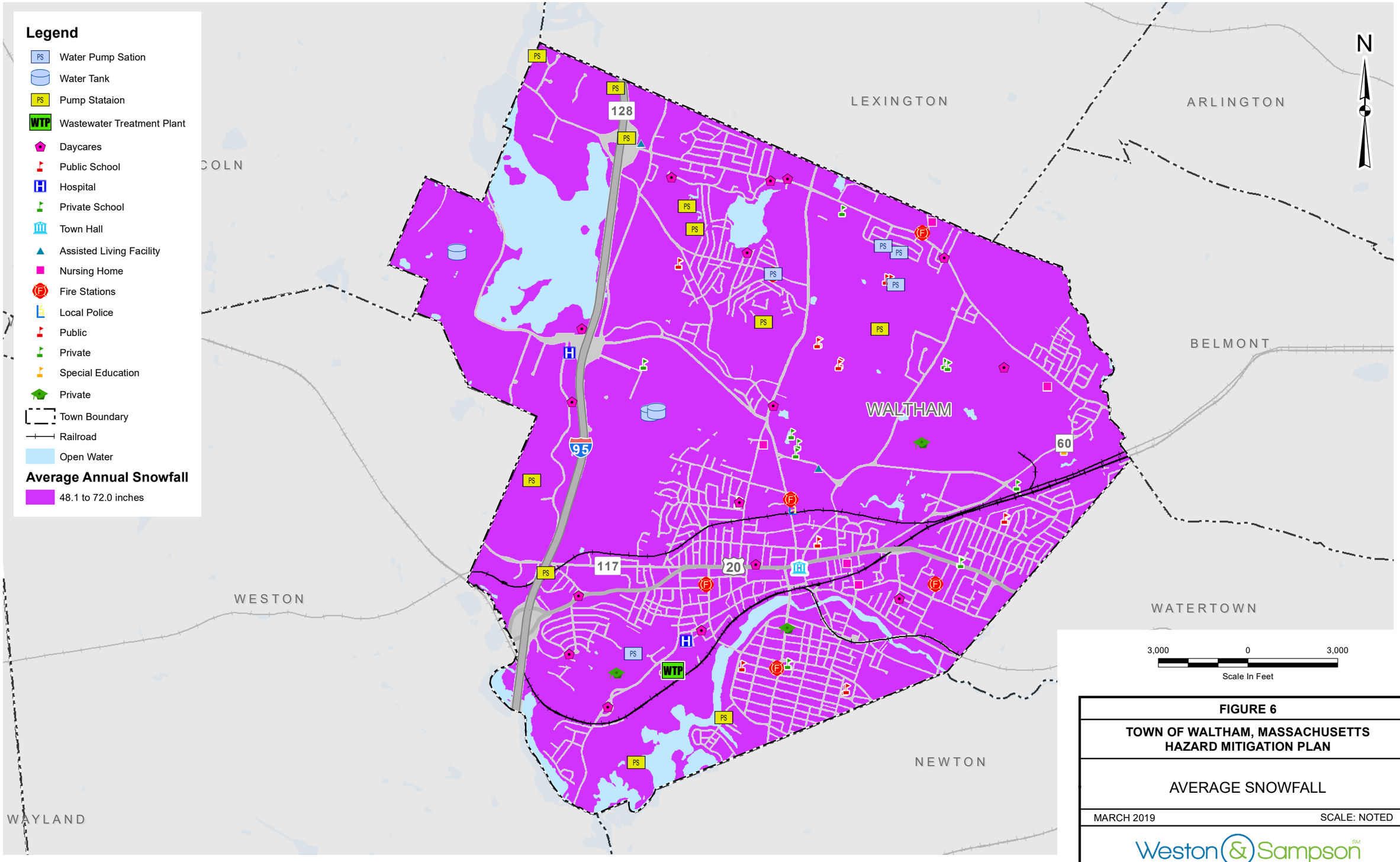

FIGURE 6

TOWN OF WALTHAM, MASSACHUSETTS
HAZARD MITIGATION PLAN

AVERAGE SNOWFALL

MARCH 2019 SCALE: NOTED

Weston & Sampson

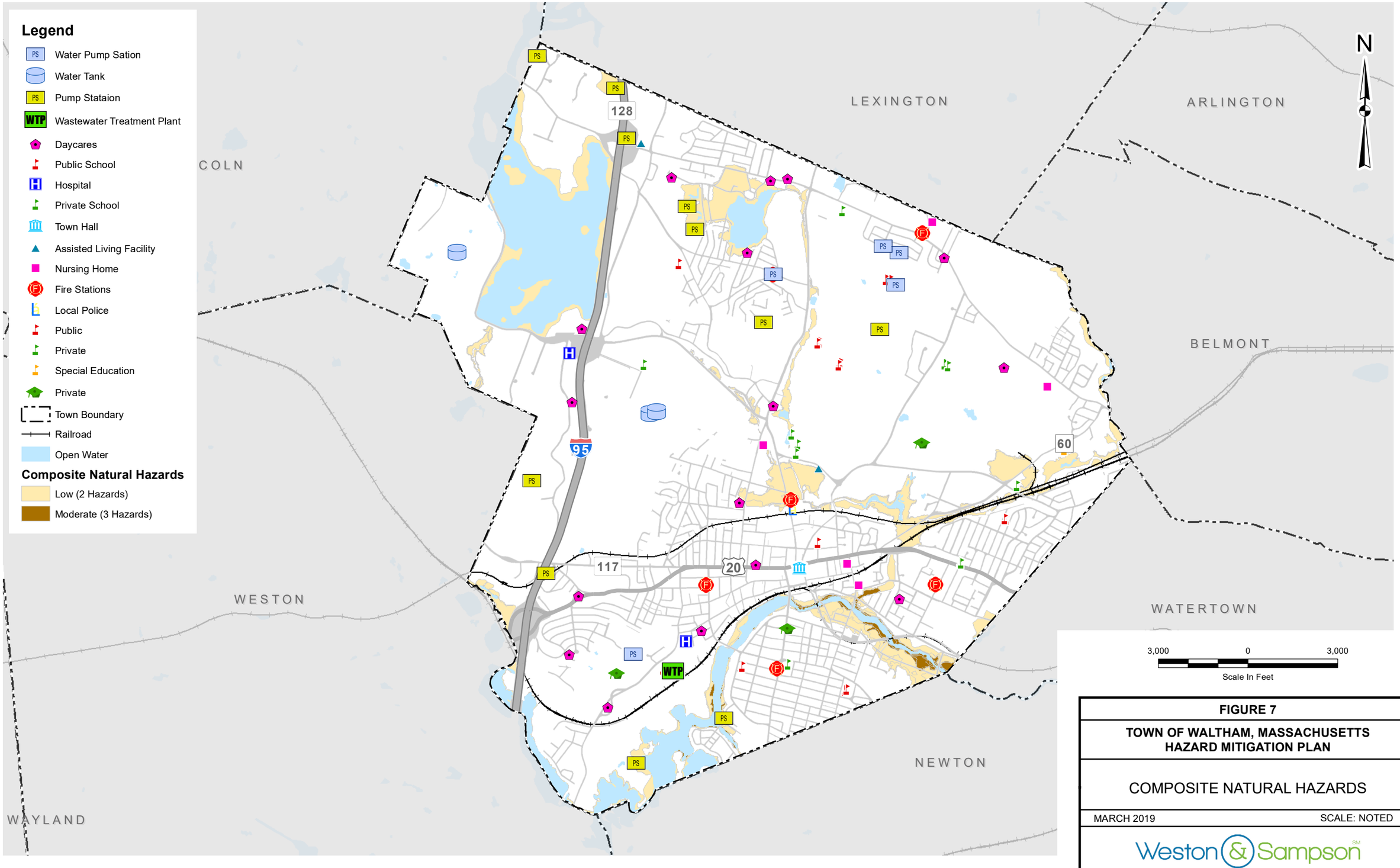

FIGURE 7

TOWN OF WALTHAM, MASSACHUSETTS
HAZARD MITIGATION PLAN

COMPOSITE NATURAL HAZARDS

MARCH 2019 SCALE: NOTED

Weston & Sampson

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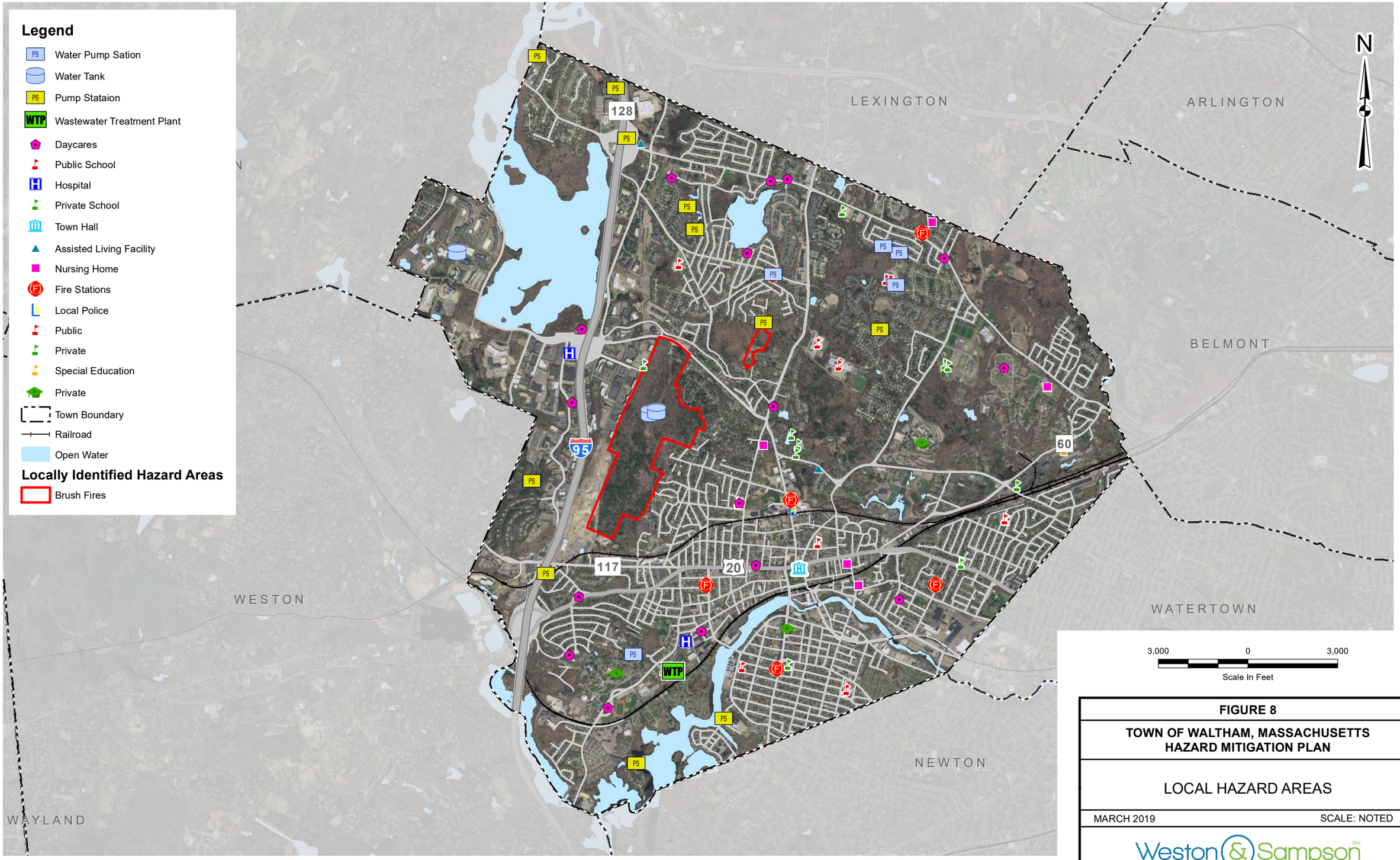

FIGURE 8

TOWN OF WALTHAM, MASSACHUSETTS
HAZARD MITIGATION PLAN

LOCAL HAZARD AREAS

MARCH 2019 SCALE: NOTED

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APPENDIX C

Public Meetings

City of Waltham
Municipal Vulnerability Preparedness & Hazard Mitigation Planning Project
HMP Stakeholder Meeting/MVP Workshop
Auditorium, Waltham Government Center, 119 School St, Waltham, MA
Thursday, February 14, 2019
8:30 am – 4:30 pm

Stakeholder Meeting #1: Identifying Hazards and Vulnerabilities

8:30 am – 9:00 am **Registration and Refreshments**

9:00 am – 9:15 am **Welcome and Introductions**
- Mayor Jeannette A. McCarthy
- Catherine Cagle, Project Manager & Planning Director
- MVP/HMP Committee Members
- Weston & Sampson Team
- Participant Introductions

9:15 am – 9:25 am **MVP / HMP Workshop Purpose and Overview**
- MVP Program Background
- Purpose, Desired Outcomes, Objectives, Expectations
- Review Agenda
- Logistics

9:25 am – 10:00 am **Data Resources and Overview of Science**
- Hazards
- Existing Climate Change
- Projected Climate Change
- Recent Planning Efforts
- Overview of Data and Maps Being Used During Workshop

10:00 am – 10:25 am **Large Group Exercise #1**
- Identify Major Hazards in Community
- Prioritize Top Four Hazards

10:25 am – 10:40 am **BREAK**

10:40 am – 10:55 am **Risk Matrix**
- Hazards
- Features
  - Infrastructure, Societal, Environmental
  - Vulnerability or Strength
  - Location
  - Ownership
- Actions

10:55 am – 11:35 am **Small Group Exercise #1**
- Infrastructure and Buildings Features
  - Vulnerability or Strength, Location, Ownership

11:35 am – 11:55 pm **Small Group Exercise #2**
- Societal Features
  - Vulnerability or Strength, Location, Ownership

11:55 pm – 12:15 pm **Small Group Exercise #3**
- Environmental Features
  - Vulnerability or Strength, Location, Ownership

City of Waltham
Municipal Vulnerability Preparedness & Hazard Mitigation Planning Project
HMP Stakeholder Meeting/MVP Workshop
Auditorium, Waltham Government Center, 119 School St, Waltham, MA
Thursday, February 14, 2019
8:30 am – 4:30 pm

Stakeholder Meeting #2: Identifying Mitigation Strategies/Priority Actions

12:15 pm – 1:15 pm	LUNCH
1:15 pm – 1:45 pm	HMP Mitigation Strategies/MVP Community Actions • Infrastructure • Nature-Based Solutions
1:45 pm – 2:35 pm	Small Group Exercise #4 • Define HMP Mitigation Strategies/MVP Community Actions
2:35 pm – 2:50 pm	BREAK
2:50 pm – 3:50 pm	Large Group Exercise #2 • Identify High Priority HMP Strategies/MVP Priority Actions
3:50 pm – 4:30 pm	Wrap-up and Closing Remarks

welcome

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Community Resilience Building Workshop

Waltham, Massachusetts

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Welcome & Introductions

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Waltham Introductions

Municipal Leadership

- Jeannette A. McCarthy, Mayor
- MVP/HMP Committee Members
  - Planning Director - Catherine Cagle
  - Director of Consolidated Public Works - Michael Chiasson
  - City Engineer - Steve Casazza
  - Inspector of Wires, Superintendent Fire Alarm and Director of Communications - Tim Kelly
  - Traffic Engineer - J. Michael Garvin
  - Fire Deputy Chief - Richard Grant
  - Police Captain - Jeff Rodley
  - Police Lieutenant -Tim Maher

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Weston & Sampson Introductions

Assisting with the Workshop

- Kathy Baskin, Project Manager/Facilitator
- Table Facilitators
  - Lindsey Adams
  - Sam Bade, SSV Engineering
  - Adria Boynton
  - Jill Getchell
  - Lydia Kifner
  - Deanna Lambert

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Participant Introductions

- Your name
- Relationship to Waltham
- Why you are here today

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Workshop Outline

Workshop-Wide
- Overview of Science & Data Resources
- Characterize Hazards

BREAK

Individual Tables
- Identify Community Features
  - Infrastructure
  - Societal
  - Environmental

Post-Workshop
- Combine Ideas
- Prepare Report

LUNCH

Individual Tables
- Identify and Prioritize Actions

BREAK

Workshop-Wide
- Determine Overall Priority Actions

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Municipal Vulnerability Preparedness (MVP)	Hazard Mitigation Planning (HMP)
MA State Government (EEA) program: • Helps municipalities plan for climate change resiliency and implement priority projects	Federal Government (FEMA) program: • Helps municipalities reduce loss of life and property by lessening the impact of natural disasters through a long-term mitigation plan
Communities: • Define extreme weather hazards and climate change impacts • Identify key features • Determine vulnerabilities and strengths • Complete vulnerability assessments • Develop/prioritize actions • Implement key actions	Communities: • Define natural hazards (hurricanes, tornadoes, winter storms and earthquakes) • Identify key features • Determine vulnerabilities and strengths • Complete vulnerability assessments • Develop/prioritize mitigation strategies • Implement mitigation strategies

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What is the Municipal Vulnerability Preparedness (MVP) Program?

Massachusetts program:

- Assist municipalities plan for climate change resiliency and implement priority projects

Helps communities:

- Define extreme weather hazards and climate change impacts
- Identify key features
- Determine vulnerabilities and strengths
- Develop and prioritize actions
- Complete vulnerability assessments
- Implement key actions

(Source: https://www.wcvb.com/article/remnants-of-florence-bring-heavy-rain-flooding/23304720)

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What the MVP/HMP Program offers

- Improved **resilience and preparedness** of natural and climate-driven hazards
- **Collaboration with stakeholders** about climate change, natural hazards and impact
- **Increased education, planning, and implementation** of priority actions/mitigation strategies

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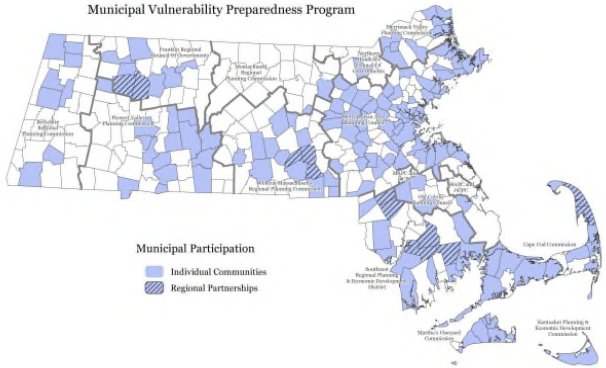
Eligible Communities

Complete MVP program; become certified; apply for MVP Action grant funding



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Data Resources & Overview of Science

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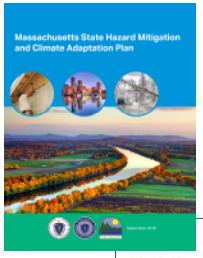
Data Resources

Lots of great work has already taken place recently!

- Massachusetts Climate Change Projections (NECSC, 2018)
- Massachusetts Climate Change Adaptation Report (MA EEA, 2011)
- Massachusetts State Hazard Mitigation and Climate Change Adaptation (Commonwealth of MA, 2018)
- City of Waltham Hazard Mitigation Plan 2016 Update, Revised Draft (MAPC, 2013)
- 2015-2022 Open Space & Recreation Plan (Waltham, 2015)
- Waltham Transportation Master Plan (McMahon, 2017)



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Waltham's Land Use

- Residential (36%)
- Commercial & Industrial (15.6%)
- Forest (21.8%)
- Urban/Public (8.3%)
- Water (7.7%)
- Wetlands (3.6%)
- Transportation (2%)
- Agricultural (0.8%)
- Other (4.2%)

(Source: walthamlocalfirst.org)

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Major Natural Hazards in Waltham

Current and Future under Climate Change

Heavy Precipitation/Flooding

Severe Winter/Nor'easter

Other Severe Weather (i.e. Wind)

Hurricane

Erosion

Dam Failure

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More Major Natural Hazards

Current and Future under Climate Change

Rising Temperature/ Extreme Heat

Drought

Wildfires/Brush Fires

Landslides

Tornadoes

Earthquakes

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Heavy Precipitation

Riverine and Stormwater Flooding

- Boston region's most frequent and costly natural disaster
- Affects infrastructure, property damage, natural resources

(Source: https://patch.com/massachusetts/waltham/fd-makes-multiple-flood-rescues-waltham-0)

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Floodplain & Repetitive Loss

Flood insurance policies in force	186
Coverage amount of flood insurance policies	$49,436,600
Premiums paid	$317,884
Total losses (all losses submitted regardless of the status)	143
Closed losses (Losses that have been paid)	107
Open losses (Losses that have not been paid in full)	0
CWOP losses (Losses that have been closed without payment)	36
Total payments (Total amount paid on losses)	$1,145,585

Flood Insurance Policies and Claims in Waltham as of September 26, 2013

Flood Zone	Single Family Residential	Condo or Multi-family Residential	Non-Residential	Total
Number of Properties	10	2	3	15
Number of Losses	28	6	14	48
Total Claims	$168,806	$125.033	$204,427	$498,266

Source: Department of Conservation and Recreation, data as of 5-31-13

(Source: Waltham Hazard Mitigation Plan, 2013)

Repetitive Loss Properties

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Severe Winter/Nor'easter

- Past few decades: more rain in winter
- Example: serious damage caused by Dec 2008 ice storm
- Projected: more rainy and icy winters

(Source: http://waltham.wickedlocal.com/news/20180313/third-storm-pummels-Waltham)

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Wind

- NWS Wind Advisory:
  - 31 to 39 mph for at least one hour
  - Any wind speed between 46 to 57 mph
- NWS High Wind Warning:
  - 58 mph or higher

Impacts: town resources, infrastructure, trees, private and public property

(Source: WGNS Radio)

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Hurricanes

2013 HMP: Estimated Damages from using HAZUS Software

Btw 1858-2004:
10 hurricanes hit Waltham

50% = Category 1
20% = Category 2
40% = Category 3

	100 Year	500 Year
Building Characteristics		
Estimated total buildings	14,150	
Estimated total building replacement value*	$7,740,617,000	
General Building Damage		
# of buildings sustaining minor damage	1,516	4,700
# of buildings sustaining moderate damage	268	2,387
# of buildings sustaining severe damage	9	282
# of buildings destroyed	2	133
Population Needs		
% of hospital beds available on day of event	100%	100%
# of households displaced	111	970
# of people seeking public shelter	26	228
Debris		
Building debris generated	9,914	50,578
Tree debris generated	4,665	17,771
# of truckloads to clear building debris	395	2,037
Value of Damages		
Total property damage	$58,065,890	$467,392,560
Total business interruption loss	$9,938,180	$76,261,440

*Year 2002 dollars

(Source: Waltham Hazard Mitigation Plan, 2013)

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Erosion

- Caused by riverine flow & stormwater
- Increased precipitation, including winter rains, could increase erosion
- Drier soils will reduce resistance to erosion

Charles River, Waltham MA

(Source: http://www.patriotledger.com/article/20141017/blogs/310179974)

(Source: MA Climate Change Adaptation Report, 2011)

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Dam Failure

Dam Name	Impoundment	Dam Owner	Hazard Potential Classification
Stony Brook Reservoir Dam	Stony Brook Reservoir	Cambridge, Water Dept	High Hazard
Moody Street Dam	Charles River	Mass. DCR	High Hazard
Cambridge Reservoir Dam	Cambridge Reservoir	Cambridge, Water Dept	High Hazard
Bleachery Dam	Charles River	Mass. DCR,	Low Hazard
Hardys Pond Dam	Hardys Pond	City of Waltham	Small Unregulated Dam
Lyman Pond Dam #1	Lyman Pond	Private owner N/A	Small Unregulated Dam
Lyman Pond Dam #2	Lyman Pond	Private owner N/A	Small Unregulated Dam
Chapel Hill School Dam	Chapel Hill Pond	Private owner N/A	Small Unregulated Dam
Clark'S Pond Dam	Clark's Pond	Private owner N/A	Small Unregulated Dam

Source: MA Department of Conservation and Recreation, Office of Dam Safety

Dams fail from:
- Structural problems independent of storm event (i.e. earthquake)
- Storm-related flooding (overspill)
- Released water and energy of the water can cause loss of life and property damage downstream

(Source: https://www.waltham-community.com/photographs/phBleachery.html)

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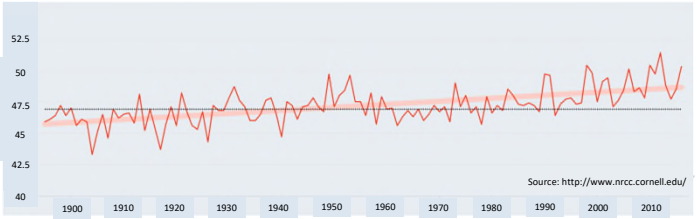
Rising Temperature/Extreme Heat

- Extreme heat can stress:
  - Vulnerable populations: over 65 years, infants, low income, language barriers
  - General population: Highest risk inland and in urban areas
  - Infrastructure: utility failure, materials stress
- Rising Temperatures can stress:
  - Individual species, ecosystems



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Drought

- Higher risk of drought in summer and fall
- Projected impacts to:
  - Water supply
  - Rivers, streams, wetlands
  - Vegetation and crops

Waltham Fields Community Farm

(Source: https://www.localharvest.org/waltham-fields-community-farm-M159)

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Wildfires and Brush Fires

- Approxmiately 90% of wild fires caused by humans and 10% by lightning
- Several brush fires occur annually
- Areas with frequent brushfires:
  - Prospect Hill
  - Stigamatines
  - Storer Conservation land

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Geologic Related Hazards

- Types include: earthquakes, landslides, sinkholes, subsidence and unstable soil
- New England experiences an average of five earthquakes per year

The Great New England Earthquake 1663

(Source: http://www.newenglandhistoricalsociety.com/the-great-new-england-earthquake-1663/)

Historical Earthquakes in Massachusetts (1772-2012)

Location	Date	Magnitude*
MA - Cape Ann	11/10/1727	5
MA - Cape Ann	12/29/1727	NA
MA – Cape Ann	2/10/1728	NA
MA – Cape Ann	3/30/1729	NA
MA – Cape Ann	12/9/1729	NA
MA – Cape Ann	2/20/1730	NA
MA – Cape Ann	3/9/1730	NA
MA - Boston	6/24/1741	NA
MA - Cape Ann	6/14/1744	4.7
MA - Salem	7/1/1744	NA
MA - Off Cape Ann	11/18/1755	6
MA – Off Cape Cod	11/23/1755	NA
MA - Boston	3/12/1761	4.6
MA - Off Cape Cod	2/2/1766	NA
MA - Offshore	1/2/1785	5.4
MA – Wareham/Taunton	12/25/1800	NA
MA - Woburn	10/5/1817	4.3
MA - Marblehead	8/25/1846	4.3
MA - Brewster	8/8/1847	4.2
MA - Boxford	5/12/1880	NA
MA - Newbury	11/7/1907	NA
MA - Wareham	4/25/1924	NA
MA – Cape Ann	1/7/1925	4
MA – Nantucket	10/25/1965	NA
MA – Boston	12/27/74	2.3
VA –Mineral	8/23/11	5.8
MA - Nantucket	4/12/12	4.5
ME - Hollis	10/17/12	4.0

Source: Boston HIRA

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HMP 2013: Estimated Damages from Earthquakes

- Estimations developed using HAZUS-MH software
- Minimal data available
- 2 earthquakes were selected in Massachusetts history: a 1963 earthquake with a magnitude of 5.0 and an earthquake with a magnitude of 7.0.

	Magnitude 5.0	Magnitude 7.0
Building Characteristics		
Estimated total number of buildings	14,150	
Estimated total building replacement value (Year 2002 $)	$7,740,617,000	
Building Damages		
# of buildings sustaining slight damage	2,267	3,133
# of buildings sustaining moderate damage	712	1,395
# of buildings sustaining extensive damage	109	344
# of buildings completely damaged	14	63
Population Needs		
# of households displaced	211	683
# of people seeking public shelter	49	158
Debris		
Building debris generated (tons)	0	0
# of truckloads to clear building debris	0	0
Value of Damages		
Total property damage	$463,340,000	$521,060,000
Total losses due to business interruption	$26,450,000	$100,960,000

(Source: Waltham Hazard Mitigation Plan, 2013)

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Tornadoes

- No tornadoes have been recorded in Waltham
- On average (1950–2008), more than 2 per year in MA
- Weak tornadoes occur in all areas of New England
- Strongest tornadoes occur just east of the Berkshires

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Existing Climate Change

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Increased Temperatures in Northeast

- Warmer annual temperatures - up 2°F since 1970
- Warmer winters - up 1.3°F per decade since 1970
- Decreasing winter snowpack
- Earlier flowering plants
- More frequent extreme summer heat

Drake Playground

(Source: https://www.bostoncentral.com/activities/waltham-spray-parks/p2359.php)

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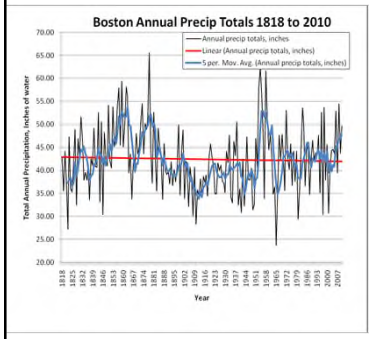
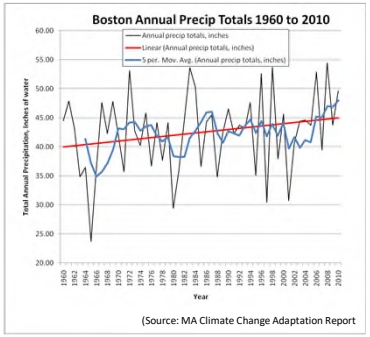
Annual Precipitation in Boston

January 1818 to December 2010





(Source: MA Climate Change Adaptation Report

The blue line represents a five-year moving average and the red line a least squares regression.

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Change in Precipitation

6-hour, 10-year event

- 1961 = 3.2 inches
- 2015 = 3.35 inches

24-hour, 100-year event

- 1961 = 6.5 inches
- 2015 = 8.40 inches

(Sources: NOAA TP-40 (1961) and NOAA Atlas Volume 10 (2015)

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Predicted Climate Change

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Increased Temperatures/Extreme Heat

	Observed Baseline	Projected Change 2050's	Projected Change End of Century
MA Average Temp (°F)	47.6	+2.8 to +6.2	+3.8 to +10.8
Waltham Average Temp (°F)	49.4	+2.7 to +6.1	+3.5 to +10.7
Days with Temperatures Above 90°F	9	+10 to +35	+15 to +76
Days with Temperatures Above 100°F	<1	<1 to 5	1 to 20
Days with Temperatures Below 32°F	136	-17 to -39	-22 to -63

(Source: NECSC, 2018)

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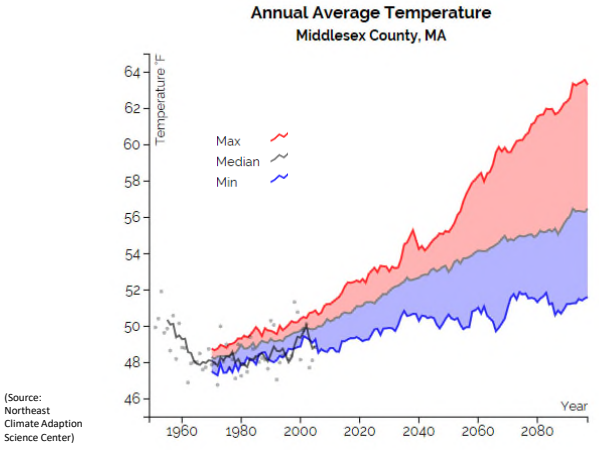
Projected: Annual Average Temperature in Middlesex County



(Source: Northeast Climate Adaption Science Center)

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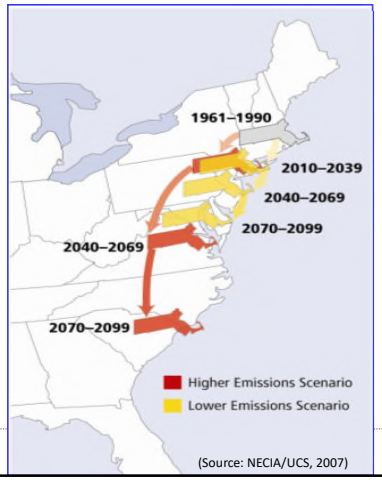
Extreme Heat

Temperatures Predicted to Increase

Winter: 15 to 40% ↑

Summer: 6 to 18% ↑



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Heavy Precipitation

Predicted:

- Higher winter flows and flooding
- Earlier peak flows in spring
- Extended summer low flows

(Source: https://boston.cbslocal.com/video/3980587-wayland-considers-changing-school-start-times/)

Increased flooding, polluted stormwater and wastewater discharges

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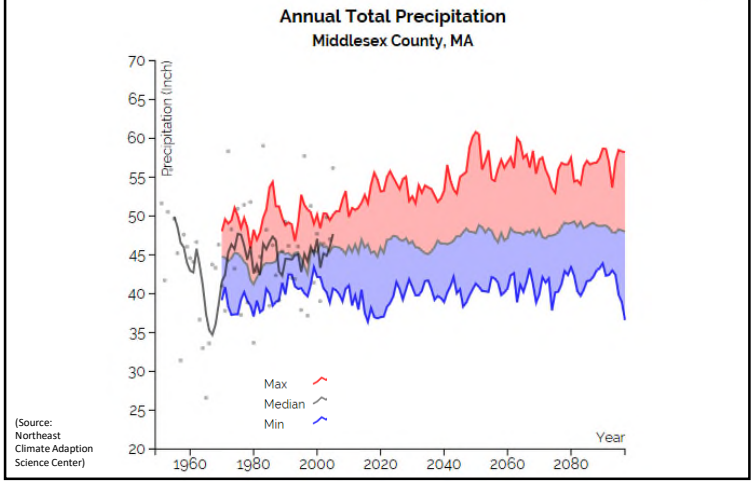
Heavy Precipitation



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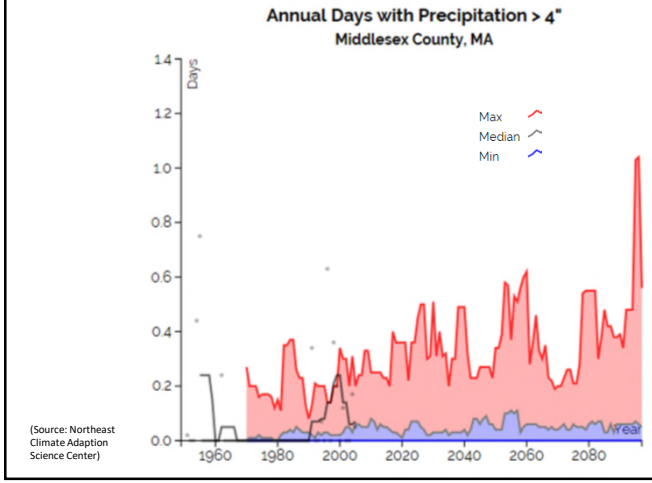
Heavy Precipitation



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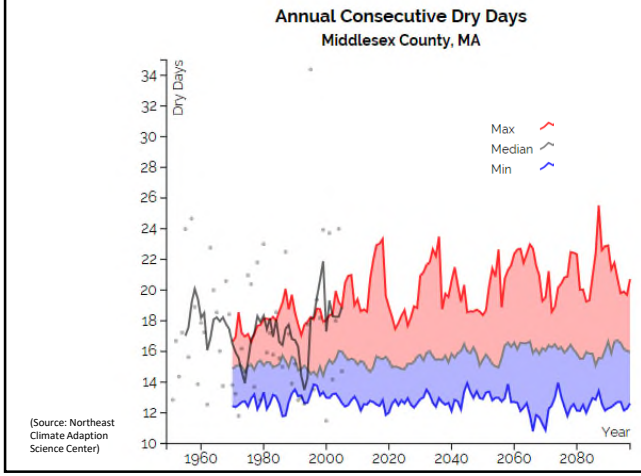
Drought



(Source: Northeast Climate Adaption Science Center)

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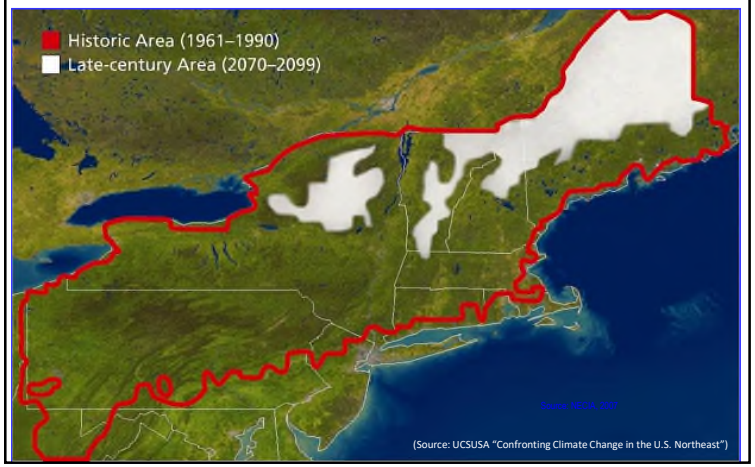
Predicted Snow Cover



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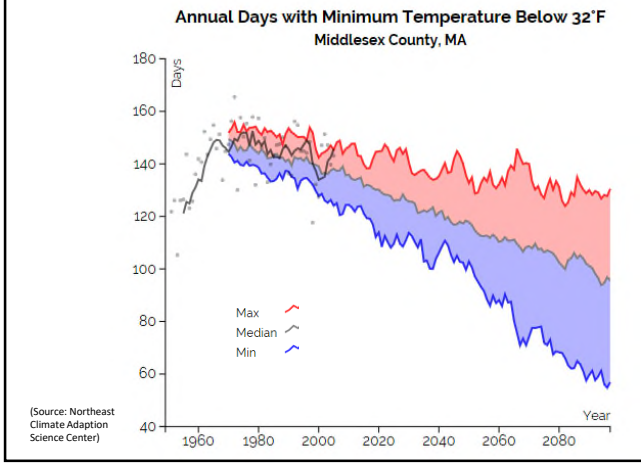
Projection: Annual Days in Middlesex County with Minimum Temperature Below 32°



(Source: Northeast Climate Adaption Science Center)

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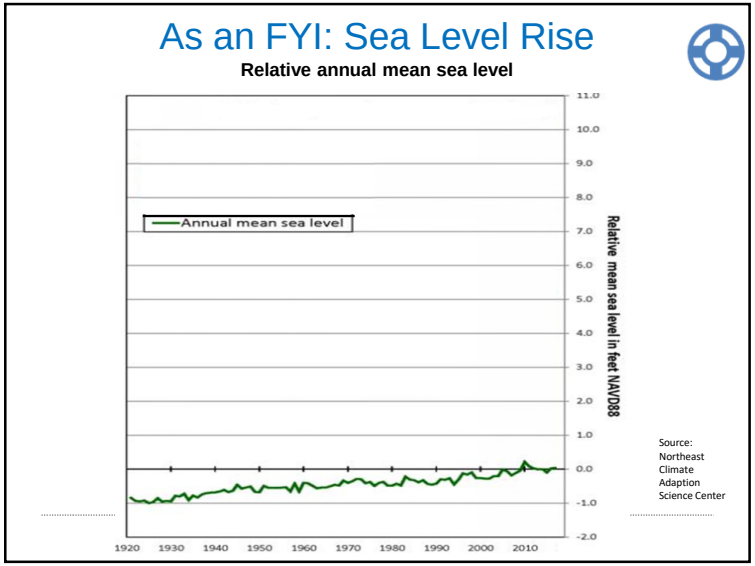
As an FYI: Sea Level Rise



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As an FYI: Boston Sea Level Rise Projections

Threatens barrier buildings, infrastructure, beach and dune systems, and people

Emission Scenario	2030 (ft)	2050 (ft)	2070 (ft)	2100 (ft)
Intermediate	0.7	1.4	2.3	4.0
Intermediate-High	0.8	1.7	2.9	5.0
High	1.2	2.4	4.2	7.6
Extreme	1.4	3.1	5.4	10.2

- Increased coastal flooding
- Permanently inundated low-lying coastal areas
- Increased shoreline erosion

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(Source: Northeast Climate Adaption Science Center)

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Identify Hazards

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Hazards in Waltham

Hazard	Frequency in State	Severity in State	Issues in Waltham
Flood	High	Serious	Same as state
Dam Failure	Very Low	Extensive	Same as state
Hurricanes	Medium	Serious	Same as state
Tornadoes	Medium	Serious	Not a major issue in Waltham
Winter Storms	High	Minor	Same as state
Earthquakes	Very Low	Serious	Same as state
Landslides	Low	Minor	Not a major issue in Waltham
Brush Fires	Medium	Minor	Same as state

(Source: Waltham Hazard Mitigation Plan, 2013)

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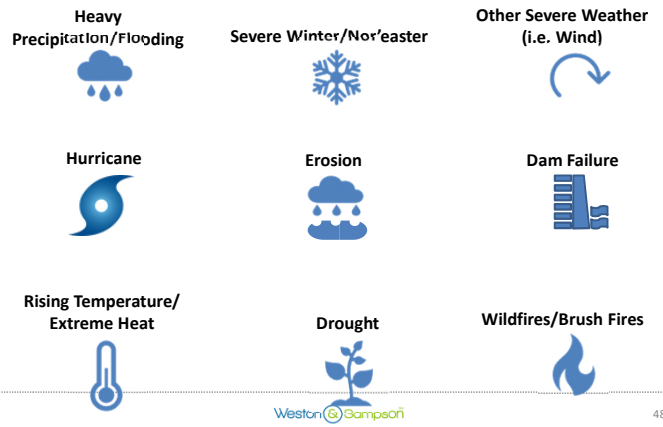
Major Natural Hazards in Waltham

Choose 4 for MVP Action Plan



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15-Minute Break!

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Risk Matrix

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Risk Matrix

Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.com

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

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

Features	Location	Ownership	V or S					Priority H-M-L	Time Short Long Ongoing
Infrastructural									
Societal									
Environmental									

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Risk Matrix - Hazards

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

				Priority H - M - L	Time Short Long Ongoing

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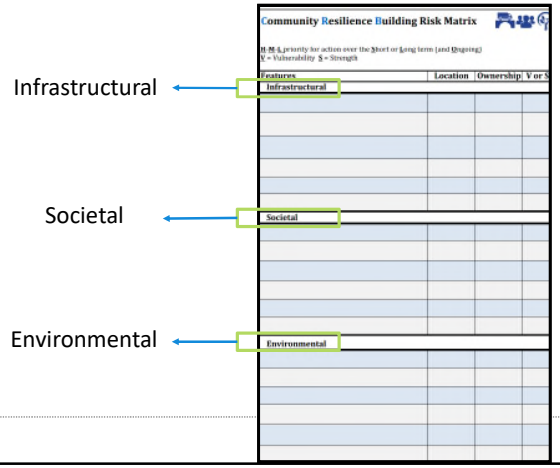
Risk Matrix- Features



53

Features in Waltham

Infrastructural, societal, and environmental features

Features — **Location** — **Ownership** — **Vulnerability or Strength**

Infrastructural
Societal
Environmental

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Features in Waltham
Location

Infrastructural, societal, and environmental features

Features — **Location** — **Ownership** — **Vulnerability or Strength**

Infrastructural
Societal
Environmental

Town-wide
Multi-Neighborhood
Single-Neighborhood
Specific Location

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Features in Waltham
Ownership

Infrastructural, societal, and environmental features

Features — **Location** — **Ownership** — **Vulnerability or Strength**

Infrastructural
Societal
Environmental

Town-wide
Multi-Neighborhood
Single-Neighborhood
Specific Location

State
Town
Private
Shared

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Features in Waltham

Vulnerability or Strength

Infrastructural, societal, and environmental features

Features	Location	Ownership	Vulnerability or Strength
Infrastructural Societal Environmental	Town-wide Multi-Neighborhood Single-Neighborhood Specific Location	State Town Private Shared	Vulnerability Strength Both

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Infrastructure Features

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Infrastructure

- Utilities such as electric power, gas, water, hydraulics, compressed air, municipal
- Water supply and treatment plants
- Wastewater treatment plants, sanitary & stormwater sewer systems
- Energy
- Manufacturing equipment and pollution control equipment
- Communication, data and voice computer networks
- Transportation

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(Source: Boston Herald, 2018)

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Infrastructure: Police

(Source: thepatch.com)

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Infrastructure: Fire Department

(Source: Firenews.org)

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Infrastructure: Roadways

(Source: WHDH.com)

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Infrastructure: Water Supply

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Infrastructure: Bridges
(Moody Street Bridge)

(Source: Flickr.com)

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Critical Areas in Waltham, MA

Critical Area	Hazard
Linden Street (Route 60) extended to Waverly Oaks Road	Flooding
Hardy Pond Neighborhoods and Hardy Pond Road	Flooding
Bow Pond along Lexington border	Flooding
North of Trapelo Road and South of Lexington border	Flooding
Area around Square Pond and near Kendall Brook	Flooding
Shriver Center/ Shriley Road	Flooding
Hobbs Road	Flooding
Livermore and Bigelow Road	Flooding
Greenwood Lane	Flooding
West of Moody Street	Flooding
Cedarwood Area	Flooding
Cambridge Reservoir	Water Quality

(Source: Waltham Hazard Mitigation Plan, 2013)

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Critical Dams in Waltham, MA

Dam Name	Impoundment	Dam Owner	Hazard Potential Classification
Stony Brook Reservoir Dam	Stony Brook Reservoir	Cambridge, Water Dept	High Hazard
Moody Street Dam	Charles River	Mass. DCR	High Hazard
Cambridge Reservoir Dam	Cambridge Reservoir	Cambridge, Water Dept	High Hazard
Bleachery Dam	Charles River	Mass. DCR,	Low Hazard
Hardys Pond Dam	Hardys Pond	City of Waltham	Small Unregulated Dam
Lyman Pond Dam #1	Lyman Pond	Private owner N/A	Small Unregulated Dam
Lyman Pond Dam #2	Lyman Pond	Private owner N/A	Small Unregulated Dam
Chapel Hill School Dam	Chapel Hill Pond	Private owner N/A	Small Unregulated Dam
Clark'S Pond Dam	Clark's Pond	Private owner N/A	Small Unregulated Dam

Source: MA Department of Conservation and Recreation, Office of Dam Safety

(Source: Waltham Hazard Mitigation Plan, 2013)

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Estimated Damages from Flooding in Waltham, MA

Flood Hazard Area	Approx Area (Acres)	% of Total Land Area in Waltham	# of Struct.	Replacement Value	Low Estimate of Damages	High Estimate of Damages
Linden Street (Route 60)	31.83	0.36%	52	$28,446,084	$2,844,606	$14,223,042
Hardy Pond	192.74	2.19%	310	$169,582,422	$16,958,242	$84,791,211
Bow Pond	62.78	0.71%	101	$55,251,047	$5,525,105	$27,625,524
North of Trapelo Road	76.47	0.87%	123	$67,285,929	$6,728,593	$33,642,964
Square Pond	37.45	0.43%	61	$33,369,444	$3,336,944	$16,684,722
Shriver Center / Shirley Road	18.80	0.21%	31	$16,958,242	$1,695,824	$8,479,121
Hobbs Road	55.81	0.63%	90	$49,233,606	$4,923,361	$24,616,803
Livermore and Bigelow Road	25.89	0.29%	42	$22,975,683	$2,297,568	$11,487,841
Greenwood Lane	45.65	0.52%	74	$40,480,965	$4,048,097	$20,240,483
West of Moody Street	54.08	0.61%	87	$47,592,486	$4,759,249	$23,796,243
Darwood Ave	28.36	0.32%	46	$25,163,843	$2,516,384	$12,581,922
Total	629.86	7.15%	1017	$556,339,752	$55,633,975	$278,169,876

(Source: Waltham Hazard Mitigation Plan, 2013)

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Flooding at Linden Street Area

- Known frequent flooding at Creonte Tire and Aston Martin Dealership
- Area is at the confluence of Beaver, Chester and West Chester Brooks
- MDC/DCR plan of 1993 to mitigate flooding – Not implemented

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Flooding at Linden Street Area

Culvert Restriction - Upstream of Linden Street
MDC/DCR 1993 Design Plans included replacement with twin culvert system

Existing Culvert under Main Street (Route 20)
MDC/DCR 1993 Design Plan included flood relief culvert by tunneling under Main Street

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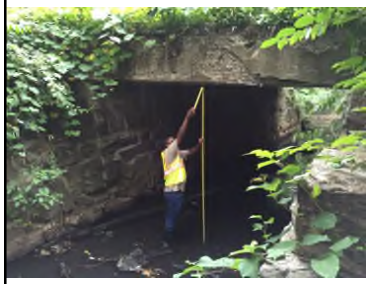
Other Examples of Hazards at Critical Infrastructure



RR Culvert at Aston Martin Dealer
Linden Street

Flooding – 9/30/2015
Lower Level - Aston Martin Dealer
Linden Street

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Societal Features

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Societal: Waltham's People

- Population
  - 2010 Census: 59,771
  - 2035 Projection: 66,824
- Age
  - Under age 20 = 20.2%
  - Age 65 or older = 13.3%
- Education
  - 91.2% high school
  - 50.0% Bachelors degree
- Income
  - Median household = $82,188
  - 30% low to moderate income
  - 10.0% below poverty level

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Societal: Waltham's Jobs

- Number of Jobs
  - 2010 Census: 63,866
  - 2040 Projection: 60,583
- 6,672 Companies
  - Educational Service
  - Healthcare & Social Assistance
  - Professional, Scientific, Tech Services

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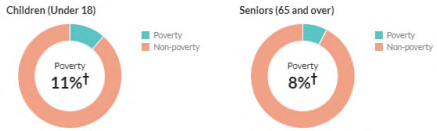
Societal: Vulnerable Populations

Elderly, low/moderate income, special income, language barriers, infirmed



Low to moderate income = 38.43%

Census data: ACS 2016 5-year
(Source: Censusreporter.com)

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Societal: Assisted Living and Senior Centers

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(Source: https://www.senioradvisor.com/local/waltham-crossings-waltham-ma)

75

Societal: Institutions

(Source: https://www.bentley.edu)

(Source: https://www.brandeis.edu/hiatt/employers/visiting.html)

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Environmental Features

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Environmental: Natural Resources

- Cambridge Reservoir
- Hardy Pond
- Charles River
- Purgatory Cove
- Coldwater Streams
- Forests
- Marshes & Wetlands
- Aquifers

Cambridge Reservoir

(Source: http://sanjay-explores.blogspot.com/2015/09/cambridge-reservoir-in-waltham.html)

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Environmental: An Economic Driver

(Source: https://newbostonpost.com/2015/10/16/watch-get-to-know-moody-street-in-waltham/)

(Source: http://www.newenglandwaterfalls.com/ma-beaverbrookfalls.html)

WALTHAM LAND TRUST

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Environmental: Climate Stressors

- Flooding
- Erosion
- Water quality/quantity impacts
- Invasive fauna and flora
- Wetland soil Impacts
- Increase in stormwater runoff
- Less groundwater recharge
- Disruption of salt marsh

(Source: https://www.city.waltham.ma.us/sites/walthamma/files/file/file/bsw_flyer.pdf)

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Environmental: Watershed and Aquifers

- Surface water and groundwater most important resources
- Cambridge Reservoir
- Stony Brook Reservoir
- Charles River
- Hardy pond
- Water Pump Station (MWRA, Cedarwood)

Hardy Pond Waltham, MA

(Source: https://waltham-community.com/photographs/1995shurr/199510HardyPond2b.jpg)

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1-Hour Lunch

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Examples of Community Actions/ Hazard Mitigation Strategies in our Community and Beyond

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HMP 2013: Mitigation Measures

<u>High Priority</u>

- Long-Term City-Wide Drainage Plan
- Detention Basins at Prospect Hill Park
- Linden Street (Route 60) Drainage Improvements
- Beaver Brook Stream Cleaning

<u>Medium Priority</u>

- Access to Roads in Conservation Areas
- Household and Construction Hazardous Waste Collection Improvements

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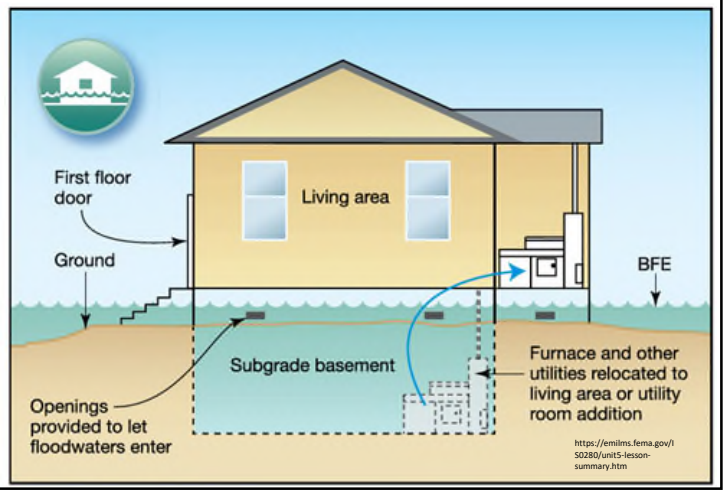
Wet Floodproofing



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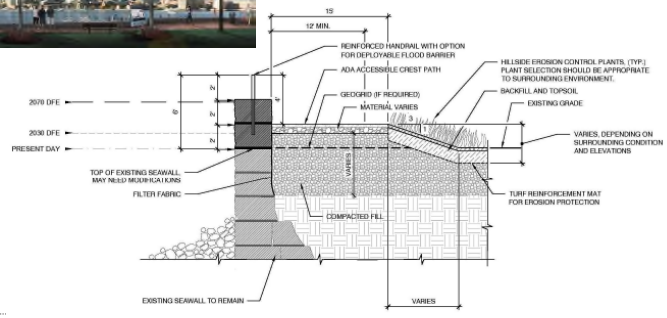
Flood Walls



HARBORWALK BARRIER SEAWALL SAMPLE SECTION

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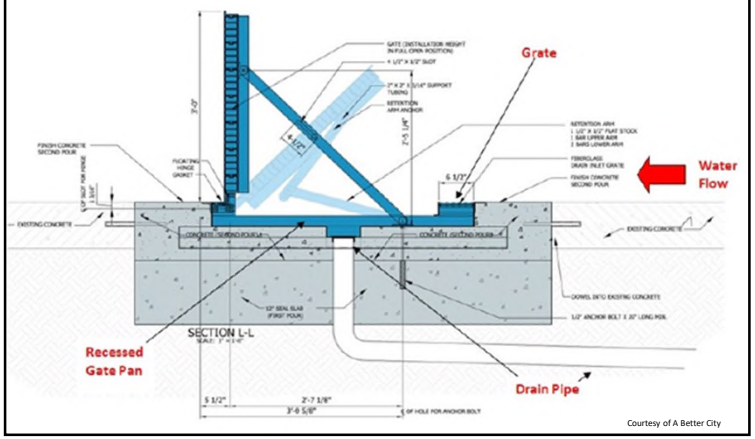
Deployable Flood Barriers



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Preventing Sewer Backflow

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Vegetated Berms

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Multi-Purpose Flood Storage

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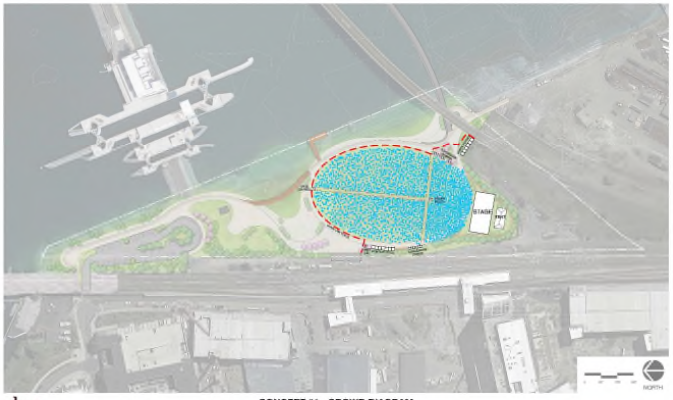
90

Landscape Design to Accommodate Water

Draw Seven Park, Somerville – Existing Conditions



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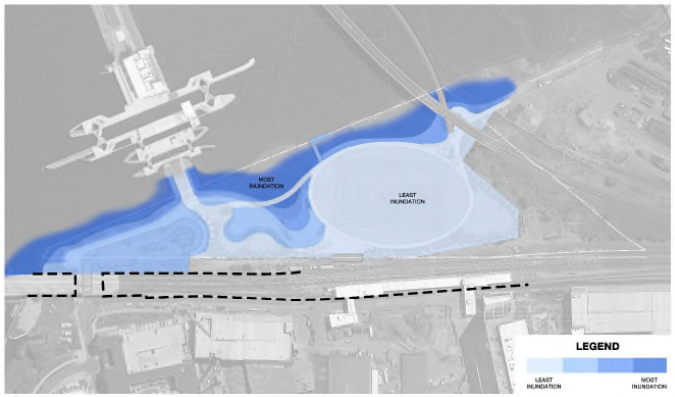
Landscape Design to Accommodate Water

Draw Seven Park, Somerville – Flooded Conditions



92

Low Impact Development (LID)

An innovative, ecosystem-based approach to land development and stormwater management

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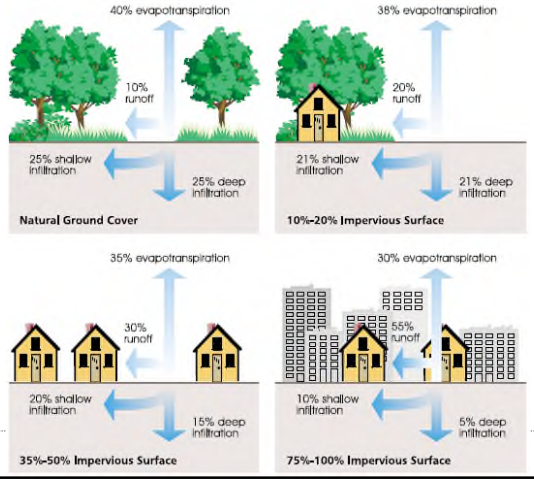
Reduce Impervious Areas



Source: Federal Stream Corridor Restoration Handbook (1998)

94

Porous Asphalt and Permeable Pavers

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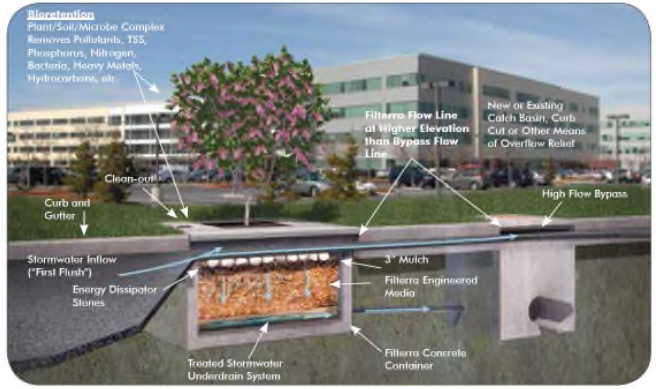
Street Trees & Tree Box Filters



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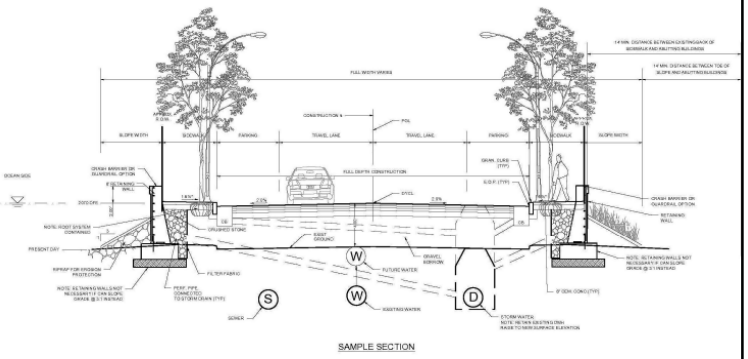
Raised Roadways



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Stormwater Detention & Retention

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Culvert Widening to Improve Flow and Habitat

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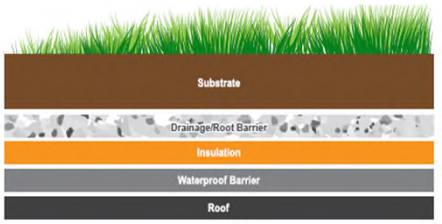
Green Roofs



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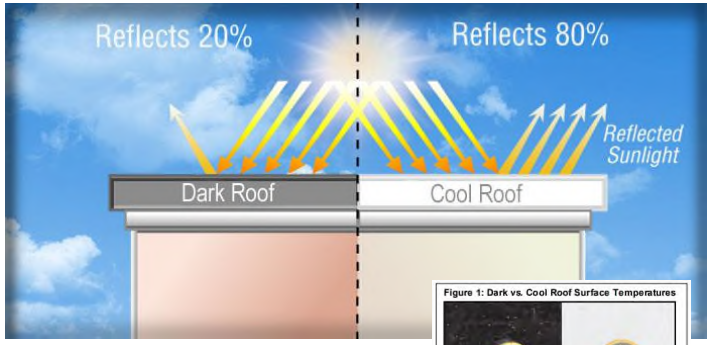
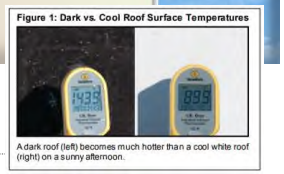
Cool Roofs



Source: Heat Island Group at Lawrence Berkeley National Laboratory



Source: U.S. Department of Energy Guidelines for Selecting Cool Roofs

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Cooling Centers

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Source: The Mercury News

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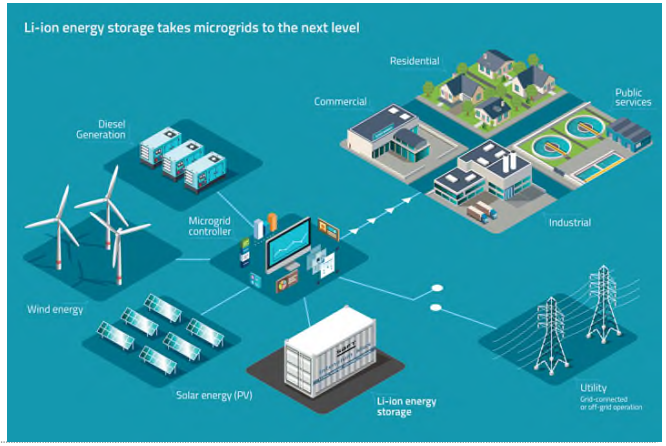
Renewable Micro-Grids



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Source: altenergymag.com

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Retrofitted Floodproof Doorways

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Re-evaluate Local Regulations & Policies


BROOKLINE MUNICIPAL VULNERABILITY PREPAREDNESS (MVP) ACTION PROJECT

town of brookline, massachusetts

105


Rain Garden in a median strip of a townhouse project. Please note the depressed curb and grate inlet structure

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Cloudburst Streets

MATTHÆUSGADE - CLOUDBURST STREET

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15-Minute Break!

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Define Community Actions

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Identify Priority Actions

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Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.com

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

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

Features	Location	Ownership	V or S					Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Societal									
Environmental									

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Wrap-up & Closing Remarks

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thank you

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transform your environment

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Community Resilience Building Workshop/Hazard Mitigation Plan Meeting

City of Waltham

Waltham Government Center, 119 School Street, Waltham, MA

Municipal Vulnerability Preparedness/ Hazard Mitigation Planning

February 14, 2018 - 8:30am to 4:30pm

Name and Affiliation	Signature	Table #
Adria Boynton, Weston & Sampson		2
Amanda King, Bentley University		4
Audrey Horst, Senator Barrett's Office, Legislative Aid		1
Bill Doyle, Conservation Commission		2
Bill Forte, Building Inspector		4
Bob Perry, Charles River Museum Innovation & Industry		4
Catherine Cagle, Planning Department		4
Deanna Lambert, Weston & Sampson		4
Ed Dowling, City of Cambridge Water		4
Hillary Monahan, MA Water Resources Authority	Hillary Monahan	2
Jeff Rodley , Police	Jeffrey Rodley - Waltham P.D.	3
Jim Perry, Fire Department & Local Emergency Planning Committee		3
Joe Pedulla, Purchasing		3
Jimmy LaCrosse, Planning		2
Kathy Baskin, Weston & Sampson		--
Lindsey Adams, Weston & Sampson		3
Louie DiDino, Wires Department	Wires Department	4
Martin Pillsbury, MAPC		1

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Catherine Cagle, Planning Department		4
Deanna Lambert, Weston & Sampson		4
Ed Dowling, City of Cambridge Water		4
Hillary Monahan, MA Water Resources Authority		2
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Louie _____, Wires Department		4
Martin Pillsbury, MAPC		1

Community Resilience Building Workshop/Hazard Mitigation Plan Meeting

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Municipal Vulnerability Preparedness/ Hazard Mitigation Planning

February 14, 2018 - 8:30am to 4:30pm

Name and Affiliation	Signature	Table #
Mary Fisher, Brandeis University		3
Michael Delfino, Health Department & LEPC member		2
Mike Chiasson, Consolidated Public Works		2
Mike Garvin, Traffic		3
Natalie Hayes, Bentley University		1
Nishaila Porter, Charles River Watershed Association		3
Randy Mullin, Fire		1
Sam Bade, SSV Engineering		1
Sarah White, MEMA		2
Sonja Wadman, Waltham Land Trust		4
Steve Casazza, Engineering		1
Steve Roy, Weston & Sampson	✓	--
David Kaplan, CWD		1
Tim Maher, Police	✓	
	✓	

Community Resilience Building Workshop/Hazard Mitigation Plan Meeting

City of Waltham

Waltham Government Center, 119 School Street, Waltham, MA

Municipal Vulnerability Preparedness/ Hazard Mitigation Planning

February 14, 2018 - 8:30am to 4:30pm

Name and Affiliation	Signature	Table #
Tim Mahr Waltham P.D	T-M	2

Lyman Pond

Limit of Sediment Debris Removal

Sediment Debris Removal

Clean and CCTV

Two Culverts

Clean and CCTV

Limit of Work

Sediment Debris Removal

Sediment Debris Removal

P.S

R

R

Maintenance Limit of Work

CCTV and Clean

CCTV and Clean

CCTV and Clean

Limit

USGS Flow Gage

Grove Street Interceptor Sewer

MIDDLESEX ROAD

LINDEN STREET

MAIN STREET

MAIN STREET

MARSHALL STREET

MAIN STREET

MANN ROAD

MANN ROAD

Legend

Drain Structures
- Drain Manhole
- Catch Basin
- Inlet
- Junction
- Outfall, Outlet
- Stormceptor

Drain Lines
- Catch Basin Lateral
- Gravity
- Culvert

Sewer Structures
- Sewer Manhole

Sewer Lines
- Gravity Main
- Service

1 Foot Contours
- Index Contour
- Intermediate Contour

- Rail Lines
- Fence
- Guard Rail
- Retaining Wall
- Stone Wall
- Stream

FEMA Flood Zones
- FEMA Flood Zone AE
- Building Footprints
- Water Bodies
- Vegetated Area
- Cemetery
- Parcel Lines

0 25 50 100
Feet
1 inch = 50 feet

PHASE 1
BEAVER BROOK LINDEN STREET FLOOD MITIGATION MAINTENANCE PLAN

The Purpose of this Maintenance Project is to establish additional flood storage by the sediment debris removal and to clean the existing culverts to improve flow through them.

Total Distance of Brook Maintenance Excluding Culverts: 1,045 Feet

Document Path: G:\Mapping\Beaver Brook Flood Mitigation Design Map - Maintenance Plan.mxd

FIX

Legend

- MBTA Commuter Rail Station
- MBTA Commuter Rail
- MBTA Bus Stops
- Bridge
- Parks
- Boys and Girls Club
- Propane Refill
- Daycares
- Food/Grocery/Supply Stores
- Gas Stations; Gas Station
- Homeless Shelter
- Hotels/Motels
- Low Income Housing Areas
- Parking Garage
- Parking Garage (Private)
- Public Telephones
- YMCA
- City Tunnel Aqueduct
- Town Hall
- Fire Stations
- Local Police
- Powerline
- Powerline Arbitrary Extension
- Railroad

Waster Water Structures

- Pump Stataion
- Wastewater Treatment Plant
- Water Pump Sation
- Water Tank

Hospitals

- Hospital with ER

Colleges and Universities

- Private

Long Term Care Residences

- Assisted Living Facility
- Nursing Home
- Rest Home

Dams

- High Hazard
- Significant Hazard
- Low Hazard
- N/A

DEP Wetlands

- Marsh/Bog
- Wooded marsh
- Open Water

FEMA National Flood Hazard Layer

- 1% Annual Chance of Flooding (Zones A, AE, AH, AO)
- AE: Regulatory Floodway
- X: 0.2% Annual Chance of Flooding

BELMONT
WATERTOWN
BOSTON
NEWTON
WALTHAM
LINCOLN
WESTON
NEWTONVILLE
WEST NEWTON
KENDAL GREEN
HASTINGS
BRANDEIS/ROBERTS

WATERTOWN FIRE DEPARTMENT Station 3
WATERTOWN POLICE DEPARTMENT
NEWTON FIRE DEPARTMENT Station 1
NEWTON FIRE DEPARTMENT Station 4
NEWTON FIRE DEPARTMENT Station 2
WALTHAM FIRE DEPARTMENT Engine 8 Station
WALTHAM FIRE DEPARTMENT Engine 7 Station
WALTHAM FIRE DEPARTMENT Engine 3 Station
WALTHAM FIRE DEPARTMENT Headquarters
WALTHAM FIRE DEPARTMENT Moody Street Station
NEWTON POLICE HEADQUARTERS BUILDING
NEWTON POLICE ANNEX BUILDING

Mill Pond Dam
Duck Pond Dam
Watertown Dam
Nonantum Dam
Bleachery Dam
Hardys Pond Dam
Lyman Pond Dam #1
Lyman Pond Dam #2
Clark'S Pond Dam
Chapel Hill School Dam
Moody Street Dam
Cambridge Reservoir Dam
Hobbs Pond Dam
Valley Pond Dike
Valley Pond Dam
Stony Brook Reservoir Dam

Beaver Brook
Clematis Brook
Chester Brook
Cheese Cake Brook
Hobbs Brook
Stony Brook
Bird Mill Brook

1,200 0 1,200
Feet

FIGURE 1

CITY OF WALTHAM

HAZARDS AND RESOURCES

FEBRUARY 2019 SCALE: NOTED

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Legend

- MBTA Commuter Rail Station
- MBTA Commuter Rail
- MBTA Bus Stops
- Bridge
- Parks
- Boys and Girls Club
- Propane Refill
- Daycares
- Food/Grocery/Supply Stores
- Gas Stations; Gas Station
- Homeless Shelter
- Hotels/Motels
- Low Income Housing Areas
- Parking Garage
- Parking Garage (Private)
- Public Telephones
- YMCA
- City Tunnel Aqueduct
- Town Hall
- Fire Stations
- Local Police
- Powerline
- Powerline Arbitrary Extension
- Railroad

Waster Water Structures

- Pump Stataion
- Wastewater Treatment Plant
- Water Pump Sation
- Water Tank

Hospitals

- Hospital with ER

Colleges and Universities

- Private

Long Term Care Residences

- Assisted Living Facility
- Nursing Home
- Rest Home

Dams

- High Hazard
- Significant Hazard
- Low Hazard
- N/A

DEP Wetlands

- Marsh/Bog
- Wooded marsh
- Open Water

FEMA National Flood Hazard Layer

- 1% Annual Chance of Flooding (Zones A, AE, AH, AO)
- AE: Regulatory Floodway
- X: 0.2% Annual Chance of Flooding

BELMONT
WAVERLEY
BOSTON
WATERTOWN
WALTHAM
NEWTON
NEWTONVILLE
WEST NEWTON
LINCOLN
WESTON
HASTINGS
KENDAL GREEN
BRANDEIS/ROBERTS

WALTHAM FIRE DEPARTMENT Engine 8 Station
WALTHAM FIRE DEPARTMENT Engine 7 Station
WALTHAM FIRE DEPARTMENT Engine 3 Station
WALTHAM FIRE DEPARTMENT Headquarters
WALTHAM FIRE DEPARTMENT Moody Street Station
WATERTOWN FIRE DEPARTMENT Station 3
WATERTOWN POLICE DEPARTMENT
NEWTON FIRE DEPARTMENT Station 1
NEWTON FIRE DEPARTMENT Station 4
NEWTON FIRE DEPARTMENT Station 2
NEWTON POLICE HEADQUARTERS BUILDING
NEWTON POLICE ANNEX BUILDING

Mill Pond Dam
Duck Pond Dam
Watertown Dam
Honantum Dam
Bleachery Dam
Lyman Pond Dam #1
Lyman Pond Dam #2
Clark'S Pond Dam
Chapel Hill School Dam
Moody Street Dam
Hardys Pond Dam
Cambridge Reservoir Dam
Hobbs Pond Dam
Valley Pond Dike
Valley Pond Dam
Stony Brook Reservoir Dam

Beaver Brook
Clematis Brook
Chester Brook
Cheese Cake Brook
Hobbs Brook
Iron Mine Brook
Stony Brook

Flooding at Highway
Flood Protection
Culvert flooding
Flooding at Pump Station

1,200 0 1,200
Feet

FIGURE 1

CITY OF WALTHAM

HAZARDS AND RESOURCES

FEBRUARY 2019 SCALE: NOTED

Weston & Sampson

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.org

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

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

Features	Location	Ownership	V or S	Flooding	Extreme Temperatures	High Winds	Winter Storms	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Moody Street Dam	Mody St. and Charles River	DCR	Both	DCR Maintain			DCR Maintain	H	O
Neighborhoods Vulnerable to Flooding	Linden St., 2nd Ave/Winter St., the Lanes - Worcester, Clark, Greenwood	City	V	Upgrade infrastructure, maintain, create upstream storage, cleaning catch basins, LID				H	SLO
Power Grid	Above Ground	Eversource	V		Capacity problems	Downed lines, put under ground in priority areas	Downed lines, proactive tree pruning	H	O/L
Communication Network	Above Ground	Verizon, Comcast, RCN (Comm. Utils)	V/S		"	"	"	H	O/L
Pump Stations	6 in City	City	V/S		Power outage, mobile trailer unit	Power outage, join Regional Emergency backup (NERAC)		M	L
First responders	Citywide 6 Stations	City	V/S	Swift water rescue training, duck boats	Ongoing refresher training			L	O
Societal									
Schools (Universities/Private Schools)	Bentley, Brandeis, Chapell Hill, Carroll School, Gann	Private	V/S	Stormwater master plan	Emergency power			M	L
Undocumented Population	South Side	Private	V	Educational outreach in multiple languages				M	L
Homeless Population	Fernald River Near Shelters	Public Space	V		Cooling and warming locations		Overnight shelters, day centers	M	O
Elderly	48 Pine, 190 Waltham Housing	Public Housing Auth.	V	Targeted outreach because of lack of communication				M	O
English as a Second Language	South Side	Private	V	Educational outreach in multiple languages				M	O
Non-profit Support (Council on Aging, WATCH, Salvation Army, Day Center, Churches)	Citywide	Private	S	Build partnerships with City to leverage value				M	O
Environmental									
Open Space Owned by City	Citywide	City	S/V	Enhance capacity for runoff, look for opportunities for multiuse	Integrate more trees into urban landscape to help prevent heat island effect	Make sure open space is protected by CR's conservat restrictions		M	O
Large Bodies of Drinking Water (Cambridge)	Cambridge Reservoir	Cambridge	S/V	Cambridge maintain				M	O
Other Bodies of Water	Charles River, Hardy Pond, Brooks	City	S	Pay attention/maintain watershed, upgrade infrastructure, hydraulic				H- beaver brook, M	O/L
Wetland Resources	Citywide	City	S	Wetlands ordinance to require green infrastructure				M	S
Wildlife	Citywide	No One	V					L	L
Fernald	NE Waltham	City	S	Restoration will greatly reduce flooding risk downstream of b r brook				M	S

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Infrastructural									
Stormwater	City	Public, Private	Both	Regs - ordinance/utility, stormwater cooperation and planning	Green/blue roofs	Keep groundwater thaw, cleaning drains		H	All
City Buildings	City	Pubic, City	S	Access					
Wires	City	Public, Private	S, Both?						
Transportation	City	Both	S	Culvert on Lexington by public storage	Fix Route 60/ Duffy by Raising Road		Gather salt, plan & prioritize, need bigger salt shed, need more strategic locations	H	S
Sewer/ Water	City	Public	S						
Hospital/ Medical				Access					
Societal									
Universities		GORDON	Both	Collaboration with campus public safety					O
Public Safety	City	PRIVATE	S		Outreach, fresh water, shelters, capacities, shuttle service, communication - police to campus, colaboration w/ big bix stores				
Elderly	City	PRIVATE	V						
Homeless	City	PRIVATE	V						
Halfway Houses/Community	City	PRIVATE	Both						
Language/Social Barriers	City	PRIVATE	V						
Environmental									
Local Streams	City	City		Stream guaging for water balance, FEMA mapping	Rizzo report				
Charles River	South Side	State							
Ponds (Hardy)	City	State							
Parks/Open Space	City	City	S	Drainage/stream rail trail from Duffy to Chester Brook					
Cambridge Water	West		S						
Wetlands	City	Both	S						

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Features	Location	Ownership	V or S	Flooding	Extreme Temperatures	High Wind	Winter Storms	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Commercial/ Industrial Building	City	Private	S	Exceed FEMA requirements for freeboard (2' higher), compensatory storage 2:1, elevate, retreat, zoning for flood zones, access					
Universities	Bentley, Brandeis	Private	S	Access, coordination w/ private security at Boston properties and other major property owners			Information sharing update City website use of scial media		O
Societal									
Youth Population	City		Both						
Undocumented Population	City		V						
Commuter Population	City		S	Communication/outreach/educations, 128 business council, chamber of commerce, share mvp report, listening seesion					O
Environmental									
Invasives/ Native Species	City	Both	Both			Invasives control, evaluate condition of trees		M - L	
Air Quality	City	City	V						
Vector Born Disease	City	City	V		Mosquito control, maintain existing mosquito channels, training & education for staff				O

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Features	Location	Ownership	V or S	Flooding	Extreme Temperatures	High Wind	Winter Storms	Priority H - M - L	Time S Short L Long O Ongoing
Infrastructural									
Sewer Pumping Stations	Several	Town	V/S	Pump station failures - redundancies, tie into other systems, newer technologi				M	L
Brandeis Water Tank	Brandeis	Brandeis	V/S	Water tank failure - protection, maintenance & inspections, monitoring				L	L
Aging Water Mains	Citywide	City	V	Inspect water mains & prioitize replacement or repai				H	O
Roadways/ Traffic	Citywide	City	V	Green infrastructure, updating streets to work w/ stormwater	Tree filters	Update traffic signals	Snow storage	M	O
Stormwater Storage			V	Stormwater systems, wetland creation				M	O
Culverts (Lake St., Lexington St.	Citywide	City	V	Regular maintenance & update				H	O
Societal									
Elderly/ Assisted Living (the Mill)		Private	V	Update evacuation plans	Green infrastructure			H	O
Group Homes/ Halfway Homes		Private	V	Update evacuation plans				M	O
Childrens Hospital/ Mass General Hospital		Private	V/S	Update evacuation plans				L	O
Undocumented Population/ Can't Speak English			V	Work w/ high school to get a translator, community outreach, shelter for cold				H	L/O
Homeless/ Low Income Households			V/S	Housing department help for low income				H	O
Schools/ Colleges		Private/ Public	V/S	S: Use colleges for shelter, V: Brandeis accsessibility, green infrasructure, look for alternative snow storage & treatment				L	L
Environmental									
Charles River			S	Water containment, work w/ region mitig				H	
Hardy Pond			V/S					M	
Cambridge Reservoir		Cambridge	V		Drought - MWRA			L (regional prior.)	O
Parks			S	Water storage				M	
Topography	Citywide		S/V					L	
Beaver Brook Resrvation (Boundaries)	Citywide		V	Larger culverts				H	S/O

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Features	Location	Ownership	V or S	Flooding	Extreme Temperatures	High Wind	Winter Storms	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Houses near Wetlands/ Ponds			V	More LEPC involvement, regulations for development				L	O
Dams			V	Technical evaluation - correction plan (regional)				H	S
Warming Shelters, Colab. w/ Schools & Hotels for Temp Sheters & Transportation	Citywide		S	Help w/ translations from schools				L	
Hydrants along 128 by Cambridge Reservoir	128		V		No hydrants located along 128			H	S
Societal									
128 Offices	128		V	Congestion during a hazard - one way out. Need 2 exits				L	L
Environmental									
Trees			V/S	Water retention	Cooler temps	Maintain trees to reduce damage & power outages			
Control of Impervious Surfaces	Citywide		V	Decrease impervious, water storage incentive for pervious					

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

Features	Location	Ownership	V or S	Wind	Extreme Temperatures	Flooding	Winter Storms	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Police	Lex & Other Locations	City	S						
Fire	Lex & Other Locations	City	S						
City Hall	Main St.	City	S						
Government Center	Lex	City	S						
Culvert System	Citywide	Varies	V			Capital funding, evaluation and survey assets		H	O
Universities/Campus	South Beaver/ Forest	Private	S/V	Joint emergency planning/preparedness with city police, fire, building, LEPC, and university facility management.				M	O
Societal									
Childrens Hospital	Hope/South	Private	S/V	State support in emergency, evacuation plans in place with entity				M	O
Mass General Hospital	By 128	Private	S/V	State support in emergency, evacuation plans in place with entity				M	O
Universities (Bentley & Brandeis)	By 128	Private	S/V	More vulnerable than hospitals - could use overall emergency plan				M	O
Public Schools/ Private Schools	Around City	Public and Private	S/V					H+	O
Homeless Population	Varies	Varies	V	ERP - in place				M	L
Undocumented Population	Varies	Varies	V		Have cooling/warming stations			L	O
Environmental									
Cambridge Reservoir	W of 128	Cambridge	S/V		Dams	$ Spillway improvments, maintenance. Greater communication/ coordination along watersheds. Greater		L	O
Charles River	W-E	State	V		Dams flooding			L	L
Parks and Trails	Citywide	Private, City, State	S/V	Support native plantings and stewardship				L	L
Native Plant & Animal Ecosystems	Everywhere	None	S/V	Support native plantings and stewardship				L	SLO
Hardy Park		City	S/V			$$ Green infrastructure		M	SLO
U of Mass. Field Station	Beaver	State	S/V		Impact to food production			L	O

Community Resilience Building Risk Matrix

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

Features	Location	Ownership	V or S	Wind	Extreme Temperatures	Flooding	Winter Storms	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Commuter Rail	Citywide	State	S/V	Improved communication/coordination with city and MassDOT (contact in secrrtarys office)				M	O
Bus Network	Citywide	State	S/V	Improved communication/coordination with city and MassDOT (contact in secrrtarys office)				M	O
Pump Stations	Varies	City	V	Asset management and buy in, $$$ capital funding evaluation of assets				H	L
Overhead Wires	Citywide	Private	V	Assessment of ownership and "live status"				H!	S
Electrical Transformers	Smith/Lex	Private	V	Strength - our wires department has great communication with utilies				H	S
Cambridge Reservoir (Dam at Winter, Dam at Stony Brook)	West of 128	Cambridge	s/V			Strength - maintenance and inspections		L	O
Societal									
High-rise Pine Street (Senior Housing)	Pine St	State	V	Recent fire, smoke was issue, showed evacuation worked				H	S
Mill (Senior Housing)	Moody St	Varies	V	Recent fire, smoke was issue, showed evacuation worked				H	S
Community Center & Senior Center	Moody/ Main	City	S/V		Good temporary shelter option				
Cultural, Community, Civic, Volunteer Groups	Citywide	Everyone	S+						
Environmental									
Beaver Brook North	Waverly/ Forest	State/City	S/V					L	O
Stony Brook Dam	Near 128	Cambridge Water	V					L	O

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

Features	Location	Ownership	V or S	Flooding	Extreme Temperatures	High Wind	Winter Storms	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Cambridge Reservoir Dam (s) Raw Water Supply Line	Winter St/ South St	City of Cambridge	V/S	Inter-municipal agreement?				L	L
Gov't center/City Hall	School St/ Main St	City of Waltham	V	G. I. grants, improve resiliency, WQ/ quantity			Capital improvement	M	O
Culverts/Drainage ●●●	Lexington St (Ex.)	City of Waltham	V	CIP, rank order, funding (MS4) ●●●				H	O
Power Lines/Delivery Systems	Citywide	Eversource/ Utility	V	Establish contact, identify priority sservice areas				M	S
Highway/Roadway	State/ Muni.	DOT/ City of Waltham	V	Support, resources, awareness				H	O
Bridges	Farwell St (Ex.)	State/ City	V	Responsibility, ownership?				M	S
MWRA		State	S	Improve communications, identify grant opportunities				L	O
Societal									
Students ●	University/ K-12	Multiple	V	Institutional planning, ERP coordination w/ city ●●				H	S
Nursing/Group Homes (Elderly/Infirm)	Citywide	Multiple	V/S	LEPC, COA assessments, resiliency planning status				M	O
Homeless/ Undocumented	Citywide		V						
1st Responders ●●		City/State	S		Needs assessment, resources				
Childrens/Hospitals			S/V						
Tranportation/Access/Congestion			S/V	Regional transportation planning involvement ●					
Environmental									
Prospect Hill Park			V	Identify improvement ops for floodwater storage/ storage tank assessment ●				M	L
Watersheds (Hyd. Cycle) Water Quality ●●	Water Resource Areas	(MS4)	V	Implement permit ●●●					
Trees/Canopy			V						
Parks/Open Space ●●			S	Fernald SMS ●●					
Redevelop Contaminate Sites			S		Continue, upgrade			L	O
Cambridge Watershed ●			V	Implement permit, continue, upgrade ●					

Community Resilience Building Risk Matrix

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Features	Location	Ownership	V or S	Flooding	Extreme Temperatures	High Wind	Winter Storms	Priority H - M - L	Time S Short L Long O Ongoing
Infrastructural									
Neighborhoods Vulnerable to Flooding	Linden St., 2nd Ave/Winter St., the Lanes - Worcester, Clark, Greenwood	City	V	Upgrade infrastructure, create upstream storage, maintain basins, LID				H	S/L
Power Grid	Above Ground	Eversource	V			Put critical sections underground, proactive tree pruning		H	O
Stormwater	City	Public, Private	Both	Ordinance, utility, collaboration between departments, public/private, planning				H	SLO
Transportation	Culvert on Lex St, RT60 by Duffys			Fixing culver, raising road, cooperation with Arlington, Lexington, Belmont for water			Getting salt, prioritizing where salt goes, salt storage (capacity, location)	H	SLO
Commercial/Industrial Buildings	City	Private	S	Elevate, zoning, retreat, general access				M	
Water Distribution				Repair and replace, greater inspections				H	O
Sewer Pumping Stations	6 in City	City	Both	Redundancies, tie into other systems, new technology				H	O
Electrical/Wires	Citywide	Varies	V			Assessment of ownership		H	S
Culverts	Citywide	Varies	V	More wetlands, CIP maintenance, LEPC involvement, asset assessment,				H	O
Bridges	Farwell St (Ex.)	State/City	V	Responsibility and ownership for maintenance				M	S
Societal									
Public Safety (Elderly, Homeless, Language Barriers, Halfway House/ Community)			Both		Better outreach, increased shelter and their capacities, shuttles to shelters, quick communication and collaboration with big box stores			H	O
Universities			Both	Access, communication/coordination/outreach, EM planning, in-house and community coordination - High priority			Communication using social media	H as noted, M	O/S
1st Responders		City/ State	S		Needs assesment, resources				
Environmental									
Wetland Resources	Citywide	City	S	Ordinance (wetlands), green infrastructure				M	S
Open Space	Citywide	Varies	Both	Open space conservation restrictions, new parks to treat stormwater, integrating more trees into landscape				M	O
Fernald Property	NE Waltham	City	S	Restore wetlands for flood storage, flood mitigation				M	S

Charles River and Hardy Pond			Both	Water containment/flood mitigation, cooperation/coordination between communities/regional approach to green infrastructure				H	
Control of Impervious Surfaces	Citywide		V	Better development and management				H	
Watershed Management/Water Quality			V	Wetlands restoration for flood mitigation				H	

Waltham Planning Department Public Meeting

Event Date: Wednesday, February 27, 2019 - 6:00pm

WALTHAM'S NATURAL HAZARDS PLAN UPDATE IS FOCUS OF FEBRUARY 27, 2019 PUBLIC MEETING

A meeting will be held to present an overview of the update of Waltham's Natural Hazards Mitigation Plan and solicit public comments

Who: Waltham residents, business owners, representatives of non-profit organizations and institutions, and others who are interested in preventing and reducing damage from natural hazards.

What: The Waltham Planning Department will hold a public meeting to present an overview of the development of the City of Waltham's Natural Hazards Mitigation Plan. The plan will identify natural hazards affecting Waltham, including floods, hurricanes, winter storms, and extreme temperature. It will also present strategies that the City can take to

reduce the impacts of these hazards. The plan will be submitted to the Federal Emergency Management Agency (FEMA) for approval.

When: February 27, 2019, 6:00 PM

Where: Auditorium, Waltham Government Center, 119 School Street, Waltham

Contact: Waltham Planning Department at 781-314-3370

 february_27_2019_public_meeting_notice.pdf

The City of Waltham
Written by Abby Leigh [?] · February 26, 2019 at 4:00 PM ·

The Waltham Planning Department is holding a Public Meeting TOMORROW, February 27th at 6pm in Government Center Auditorium, to present an overview of the development of the City of Waltham's Natural Hazards Mitigation Plan.

The plan will identify natural hazards affecting Waltham, including floods, hurricanes, winter storms, and extreme temperature. It will also present strategies that the City can take to reduce the impacts of these hazards. The plan will be submitted to the Federal Emergency Management Agency (FEMA) for approval.

Any Waltham residents, business owners, representatives of non-profit organizations and institutions, and others who are interested in preventing and reducing damage from natural hazards are welcome to join and give their comments. Questions can be forwarded to the Waltham Planning Department at 781-314-3370.

Public Meeting Notice

City of Waltham MVP/HMP Project

Production of Hazard Mitigation Plan

Wednesday, February 27, 2018, 6:00pm
Waltham Government Center - Auditorium
119 School Street
Waltham, MA 02452

Public Meeting Notice

City of Waltham MVP/HMP Project

Production of Hazard Mitigation Plan

Wednesday, February 27, 2018, 6:00pm
Waltham Government Center - Auditorium
119 School Street
Waltham, MA 02452

The location of this meeting is accessible to people with disabilities and reasonable accommodations will be provided to persons requiring assistance. If you have an accommodation need, please contact the Planning Department (781) 314-3370

4:00 PM · Tue 26 February 2019

City Of Waltham @CityofWaltham

The Waltham Planning Department is holding a Public Meeting tomorrow, February 27th, to present an overview of the update of Waltham's Natural Hazards Mitigation Plan and solicit public comments: http://bit.ly/2H4Vm14

CALENDAR LISTING / MEDIA ADVISORY

WALTHAM'S NATURAL HAZARDS PLAN UPDATE IS FOCUS OF FEBRUARY 27, 2019 PUBLIC MEETING

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When: February 27, 2019, 6:00 PM

Where: Auditorium, Waltham Government Center, 119 School Street, Waltham

Contact: Waltham Planning Department at 781-314-3370

City of Waltham
Municipal Vulnerability Preparedness and Hazard Mitigation Planning Grant Project
Public Listening Session
Auditorium, Waltham Government Center, 119 School Street, Waltham, MA
Wednesday, February 27, 2019
6:00 pm – 7:30 pm

Agenda

1. **Welcome and Introductions** — 5 minutes
   Catherine Cagle, Project Manager and Planning Director

2. **Municipal Vulnerability Preparedness and Hazard Mitigation Planning Overview** — 5 minutes
   Kathy Baskin PE, Project Manager, Weston & Sampson

3. **Summary of Hazards, Vulnerabilities & Strengths, and Priority Actions** — 20 minutes
   Catherine Cagle, Project Manager and Planning Director

4. **Questions and Answers** — 35 minutes
   All

5. **Public Comment Period** — 20 minutes

6. **Conclusions** — 5 minutes
   Catherine Cagle, Project Manager and Planning Director

City of Waltham
Municipal Vulnerability Preparedness and Hazard Mitigation Planning Grant Project
Public Listening Session
Auditorium, Waltham Government Center, 119 School Street, Waltham, MA
Wednesday, February 27, 2019
6:00 pm – 7:30 pm

Meeting Notes

The MVP/HMP Public Listening Session began at 6:10 pm.

Welcome and Introductions

Catherine Cagle, Waltham's Director of Planning and Development introduced the Municipal Vulnerability Preparedness (MVP) and Hazard Mitigation Planning (HMP) Grant Project to the public. She explained that the purpose of the Listening Session was to engage the public and receive public comment on the City of Waltham's MVP/Hazard Mitigation Planning.

Municipal Vulnerability Preparedness and Hazard Mitigation Planning Overview

Kathy Baskin described the Core Team/Hazard Mitigation Planning Team, which is working under the leadership of Mayor Jeannette A. McCarthy. Members of the Core Team are:

- Planning Director - Catherine Cagle
- Director of Consolidated Public Works - Michael Chiasson
- City Engineer - Steve Casazza
- Inspector of Wires, Superintendent Fire Alarm and Director of Communications - Tim Kelly
- Traffic Engineer - J. Michael Garvin
- Fire Deputy Chief - Richard Grant
- Fire Deputy Chief – Andrew Mullin
- Fire Lieutenant/James Perry
- Police Captain - Jeff Rodley
- Police Lieutenant -Tim Maher

Ms. Baskin described the Massachusetts: Municipal Vulnerability Preparedness (MVP) program as a Massachusetts program that helps municipalities plan for climate change resiliency and implement priority projects. The Hazard Mitigation Planning (HMP) process is a federal program administered through FEMA and helps communities reduce loss of life and property by lessening the impact of natural disasters through a long-term mitigation plan.

Ms. Baskin explained that the MVP Program offers Waltham:

- Preparedness for natural & climate hazards
- Collaboration with stakeholders
- Education and planning
- Grant funding for priority actions

Community Resilience Building Workshop

Ms. Baskin described the February 14 Hazard Mitigation Stakeholder/MVP Community Resilience Building Workshop, at which attendees:

- Defined extreme weather hazards and climate change impacts
- Identified key features
- Determined vulnerabilities and strengths
- Developed and prioritized actions
- Completed vulnerability assessments
- Next: Implement key actions

She noted that the Workshop included a diverse group of participants. The city appreciated everyone's participation. There were representatives from the following groups:

Municipal Government

- Mayor
- Building Inspector
- Conservation Commission
- Engineering
- Health
- Fire
- Local Emergency Planning Committee
- Planning Board
- Police
- Public Works
- Purchasing
- Traffic
- Wires

Environmental Groups

- Charles River Watershed Association
- Waltham Land Trust

Institutions

- Bentley University
- Brandeis University
- Charles River Museum of Innovation & Industry

Regional

- Metropolitan Area Planning Committee
- City of Cambridge Water Department

State

- MA Emergency Management Agency

Summary of Hazards, Vulnerabilities & Strengths, and Priority Actions

Ms. Cagle described the top hazards identified at the Workshop, which were: 1) flooding; 2) high winds; 3) winter storms; and 4) extreme temperatures (both hot and cold). She noted that Waltham is already experiencing higher temperatures and more extreme precipitation (more floods and more droughts). These are predicted to increase with climate change. Although sea level rise is a concern along coastal Massachusetts, it is not a concern in Waltham.

Ms. Cagle reviewed vulnerabilities identified during the Workshop. They were:

Infrastructural

- Stormdrain system
- Culverts
- Power Grid
- Electrical/wires
- Transportation
- Buildings
- Bridges
- Moody Street Dam
- Water supply
- Wastewater services
- Communication network
- Hospitals

Environmental

- Wetlands/Watersheds
- Charles River & Hardy Pond
- Open space/Trees
- Cambridge Reservoir
- Invasive species
- Vector-borne diseases
- Air quality

Societal

- Elderly/infirmed
- Language barriers
- Homeless population
- Schools/universities & students
- Undocumented population
- Non-profits providing assistance

Ms. Cagle listed strengths identified during the Workshop that will help the city move forward with resilience and hazard mitigation. They are:

Infrastructural

- Fire
- Police
- City Hall and Government Center
- MWRA (water supply, wastewater services)
- Communication network
- Hospitals
- Stormwater Management
- Transportation

Environmental

- Wetlands
- Open space
- Fernald
- Cambridge Reservoir

Societal

- Schools/universities
- Non-profits providing assistance
- Halfway houses
- Warming centers

Summary of Findings Report and Priority Actions

Ms. Cagle reported on actions identified during the Workshop for increasing resilience to hazards and climate changes, as identified during the Workshop. They were:

High Priority Actions

- Reduce riverine and stormwater flooding
    - Replace culverts
    - Improve stormdrains and roads (raised roads, if needed)
    - Create flood storage (examples at Linden St, Second Ave at Winter St, and the Lanes)
    - Invest in low impact development/green infrastructure
    - Cooperate with surrounding communities
- Restore wetlands & floodplains for flood storage (example is Fernald property to reduce flooding of Beaver Brook)
- Improve strategies to reduce impervious surfaces. Create incentives use of green infrastructure.
- Collaborate between City departments & private entities to improve stormwater

Medium Priority Actions

- Encourage installation of underground powerlines
- Proactively prune trees to prevent down lines
- Consider innovative best practices and policies for stormwater management.
- Create/rehabilitate parks for cooling and to treat stormwater
- Integrate more trees into the landscape to reduce temperatures
- Continue offering extreme weather-related centers

Additional Priority Actions

- Inventory City policies, regulations, and zoning to promote stormwater management, green infrastructure, resilience measures
- Educate property owners about the benefits of green infrastructure
- Continue coordinated communication via Local Emergency Planning Committee
- Enhance access and collaboration between universities and the City during emergencies.
- Determine management and responsibility of electrical wires during emergency response

Public Comments, Questions and Answers

City Councilor (Ward 3) George Darcy supports the process. He suggested that the City Council, School Department, Gant Academy, MBTA, and hospitals be added to the process. Linden and Waverley Streets are at the confluence of three rivers. Flood storage at Fernald would provide a benefit to the City. Sam Bade is working on this. A failure of Hardy Pond Dam would affect Lexington Street. Electrical utilities should all go underground. Cambridge Water Supply may need a forebay to capture a spill before it enters the reservoir. The city could hold 2 million gallons of stormwater at Fernald and even more if including other locations like behind the City Yard. The City should consider a backup water supply such as the Cambridge Reservoir or at Met State or Fernald. Between Jackson Road and Moody Street, the MBTA commuter rail should not be a single track.

Leo Keightley said that a lot of this plan is intended to preserve of restore infrastructure like roads, power, and transportation. What to do when power is out for 3 days or road are inaccessible? Are there generators so that the City can survive several days? How long can Waltham last as an isolated city? Pipes will freeze if the city loses power. Need to teach people to turn off water so that pipes do not burst.

Catherine noted that, in completing this plan, the City will be eligible for three federal grants and one state grant.

Another member of the public asked about FEMA Flood Insurance Rate Maps. The project is using the most recently available maps. The maps are being updated by FEMA but this process is separate from Waltham's HMP/MVP project.

Councilor Darcy asked whether the project would make suggested zoning changes. Linden Street gets about 8 ft of flooding but a 4-story storage facility is being built there. There should be a feedback loop of this study back to the City Council.

There were concerns that there is a lot of pavement in Waltham. Also, the 100-year flood occurs more frequently than every 100 years.

Sam Bade mentioned the former MDC project that proposed to tunnel under Main street and relieve flooding at Linden Street. He mentioned the repair of a collapsed culvert at Waverley Oaks near the Girl Scouts; this is now providing storage. HE also mentioned a project on Trapelo Road in Belmont. He suggested that now is the time to consider Met State and other areas for flood storage.

Gabriela Comera suggested invited the Heller School of Brandies University to participate. Ms. Cagle noted that the universities were really engaged. They wrote support letters for the grant application and came to the Workshop.

Someone asked whether Waltham has a local area network for emergencies. Catherine stated that fire and police do have a system that work well.

Public Comment Period

Ms. Cagle noted that public comments will be accepted between February 27, 2019 and March 8, 2019. Comments can be sent to Catherine Cagle.

Email: ccagle@city.waltham.ma.us
Mail: Catherine Cagle
City of Waltham Planning Department
Government Center
119 School Street, Suite 25
Waltham, MA 02451
Phone: (781) 314-3370

Next Steps

Next steps for the project are for the City to prepare a draft Hazard Mitigation and Municipal Vulnerability Plan for public review. The next listening session will be held at Waltham Government Center on March 14, 2019 at 6:00 pm. Ms. Cagle thanked the audience for participating.

welcome

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1

Municipal Vulnerability Preparedness & Hazard Mitigation Planning

Workshop Findings and Priority Recommendations

Waltham, Massachusetts

2

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Waltham Project Team Leadership

Jeannette A. McCarthy, Mayor

MVP/HMP Committee Members

- Planning Director - Catherine Cagle
- Director of Consolidated Public Works - Michael Chiasson
- City Engineer - Steve Casazza
- Inspector of Wires, Superintendent Fire Alarm and Director of Communications - Tim Kelly
- Traffic Engineer - J. Michael Garvin
- Fire Deputy Chief - Richard Grant
- Fire Deputy Chief – Andrew Mullin
- Fire Lieutenant/James Perry
- Police Captain - Jeff Rodley
- Police Lieutenant -Tim Maher

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What MVP and HMP Programs?

Massachusetts: Municipal Vulnerability Preparedness (MVP)

Plan for climate change resiliency and implement priority projects

United States: Hazard Mitigation Planning (HMP)

Reduce loss of life and property by lessening the impact of natural disasters through a long-term mitigation plan

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What MVP/HMP offers Waltham

- Preparedness for natural & climate hazards
- Collaboration with stakeholders
- Education and planning
- Grant funding for priority actions

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MVP Workshop

- Defined natural hazards (hurricanes, tornadoes, winter storms and earthquakes); climate change hazards
- Identified key features
- Determined vulnerabilities and strengths
- Developed and prioritized actions/mitigation strategies
- Next: Implement mitigation strategies

1. Engage Community → 2. Identify Hazards → 3. Assess Vulnerabilities and Strengths → 4. Develop & Prioritize Actions → 5. Take Action!

6

6

Workshop Participants

Municipal Government
- Mayor
- Building Inspector
- Conservation Commission
- Engineering
- Health
- Fire
- Local Emergency Planning Committee
- Planning Board
- Police
- Public Works
- Purchasing
- Traffic
- Wires

Environmental Groups
- Charles River Watershed Association
- Waltham Land Trust

Institutions
- Bentley University
- Brandeis University
- Charles River Museum of Innovation & Industry

Regional
- Metropolitan Area Planning Committee
- City of Cambridge Water Department

State
- MA Emergency Management Agency

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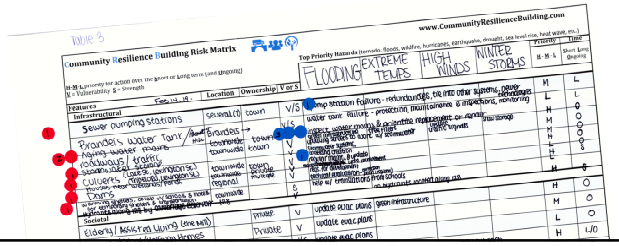
Top Hazards Identified at the Workshop

Flooding | **High Winds** | **Winter Storms** | **Extreme Temperatures (Heat and Cold)**



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Climate Change Impacts

Entire State (including Waltham)		Coastal Communities only (not Waltham)
Higher Temperatures	**More Extreme Precipitation (More droughts, more floods)**	~~**Sea Level Rise & Coastal Surge**~~

Goal: to protect infrastructure, environment, public health & safety, and economy

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Vulnerabilities

Infrastructural
- Stormdrain system
- Culverts
- Power Grid
- Electrical/wires
- Transportation
- Buildings
- Bridges
- Moody Street Dam
- Water supply
- Wastewater services
- Communication network
- Hospitals


(Source: https://www.wcvb.com/article/remnants-of-florence-train-heavy-rain-flooding/23804720)

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- Language barriers
- Homeless population
- Schools/universities & students
- Undocumented population
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Environmental
- Wetlands/Watersheds
- Charles River & Hardy Pond
- Open space/Trees
- Cambridge Reservoir
- Invasive species
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- Air quality

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Strengths and Assets

Infrastructural
- Fire
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- MWRA (water supply, wastewater services)
- Communication network
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- Halfway houses
- Warming centers

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- Wetlands
- Open space
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- Cambridge Reservoir

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High Priority Actions


(Source: https://patch.com/massachusetts/waltham/fd-makes-multiple-flooding-rescues-waltham-0)

- Reduce riverine and stormwater flooding
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  - Improve stormdrains and roads (raised roads, if needed)
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- Improve strategies to reduce impervious surfaces. Create incentives use of green infrastructure.
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Medium Priority Actions

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- Create/rehabilitate parks for cooling and to treat stormwater
- Integrate more trees into the landscape to reduce temperatures
- Continue offering extreme weather-related centers

(Source: https://www.bostoncentral.com/activities/waltham-spray-parks/p2359.php)

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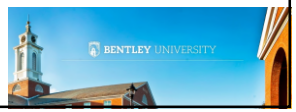
Additional Priority Actions

- Inventory City policies, regulations, and zoning to promote stormwater management, green infrastructure, resilience measures
- Educate property owners about the benefits of green infrastructure
- Continue coordinated communication via Local Emergency Planning Committee
- Enhance access and collaboration between universities and the City during emergencies.
- Determine management and responsibility of electrical wires during emergency response



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Public Comments

- Comments accepted:
  - February 27, 2019 – March 8, 2019
- Send comments to Catherine Cagle
  - Email: ccagle@city.waltham.ma.us
  - Mail: Catherine Cagle
    City of Waltham Planning Department
    Government Center
    119 School Street, Suite 25
    Waltham, MA 02451
  - Phone: 781.314.3370

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Next Steps

- March 14, 2019 Listening Session: Draft Plan
- Finalize Plan
- Send Plan to MEMA/FEMA for review and approval
- Apply for grants

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thank you

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WALTHAM
MASSACHUSETTS
"The Watch City"

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Home

Waltham Planning Department Public Meeting

Event Date: Thursday, March 14, 2019 - 6:00pm

WALTHAM'S DRAFT HAZARD MITIGATION PLAN TO BE PRESENTED AT MARCH 14, 2019 PUBLIC MEETING

A meeting will be held to present an overview of Waltham's Natural Hazards Mitigation Plan and Municipal Vulnerability Preparedness Plan and to solicit public comments.

Who: Waltham residents, business owners, representatives of non-profit organizations and institutions, and others who are interested in preventing and reducing damage from natural hazards and climate change.

What: The Waltham Planning Department will hold a public meeting to present an overview of the draft Waltham Hazard Mitigation Plan Update and Municipal Vulnerability Plan. The plan identifies natural and climate change hazards affecting Waltham such as floods, hurricanes, winter storms, and earthquakes, as well as actions that the City can

take to reduce the impacts of these hazards. When it is finalized, the Plan will be submitted to the Federal Emergency Management Agency (FEMA) for approval.

When: March 14, 2019, 6:00 PM

Where: Auditorium, Waltham Government Center, 119 School Street, Waltham

Contact: Waltham Planning Department at 781-314-3370

march_14_2019_public_meeting_notice.pdf

CALENDAR LISTING / MEDIA ADVISORY

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When: March 14, 2019, 6:00 PM

Where: Auditorium, Waltham Government Center, 119 School Street, Waltham

Contact: Waltham Planning Department at 781-314-3370

City of Waltham
Municipal Vulnerability Preparedness and Hazard Mitigation Planning Grant Project
Public Listening Session
Auditorium, Waltham Government Center, 119 School Street, Waltham, MA
Thursday, March 14, 2019
6:00 pm – 7:30 pm

Agenda

1. **Welcome and Introductions** — 5 minutes
   Catherine Cagle, Project Manager and Planning Director

2. **Overview of Hazard Mitigation Planning** — 30 minutes
   Catherine Cagle, Project Manager and Planning Director
   Kathy Baskin PE, Project Manager, Weston & Sampson

3. **Questions and Answers** — 40 minutes
   All

4. **Public Comment Period** — 10 minutes

5. **Conclusions** — 5 minutes
   Catherine Cagle, Project Manager and Planning Director

welcome

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Public Meeting

Review of Draft Municipal Vulnerability Preparedness & Hazard Mitigation Plan

Waltham, Massachusetts

March 14, 2019

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Definitions

Hazard – potential threat
Sun

Critical Infrastructure – valuable asset
You

Vulnerability – weakness or gap in protection
Being Outdoors

Risk – potential for loss, damage or destruction
Sunburn

Hazard + Critical Infrastructure + Vulnerability = Risk

Mitigation – reduce or eliminate risk
Sunscreen

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What is "Hazard Mitigation"?

Mitigate: reduce or eliminate risk; make less severe or painful - *PREVENTATIVE*

Hazard Mitigation: any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards (*from FEMA*)

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Planning and Outreach Strategy: Three Tiers

1) Planning Team: municipal department leadership
   - *4 Meetings*
2) Stakeholder Outreach: are vulnerable to, or provide strength against, natural hazards or climate change
   - *8-Hour Workshop*
3) Public Outreach: live and work in the City
   - *2 Public Meetings*

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Project Overview

Set Goals for Plan

Risk Assessment

- Data Collection/Analysis
- Hazard Identification
- Hazard Profiles & Mapping
- Inventory of Community Assets
- Vulnerability Assessment
- Findings and Conclusions

(Source: https://patch.com/massachusetts/waltham/fd-makes-multiple-flood-rescues-waltham-0)

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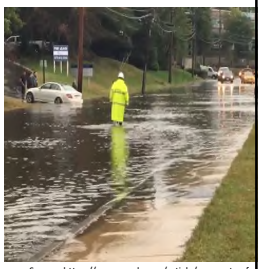
Project Overview

Capabilities Assessment

- Review Existing Capabilities
- Findings and Conclusions

Mitigation Strategy

- Update Goals and Objectives
- Analyze Actions and Projects
- Prepare Mitigation Action Plans
- Complete Action Prioritization



Source: https://www.wcvb.com/article/remnants-of-florence-bring-heavy-rain-flooding/23304720)

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Goals of the Plan

1. Prevent and reduce the loss of life, injury, public health impacts and property damages resulting from all major natural hazards.
2. Identify and seek funding for measures to mitigate or eliminate each known significant flood hazard area
3. Integrate hazard mitigation planning as an integral factor in all relevant municipal departments, committees and boards.
4. Prevent and/or reduce the damage to public infrastructure resulting from natural hazards.
5. Encourage the business community, major institutions and non-profits to work with the City to develop, review and implement the hazard mitigation plan.

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(More) Goals of the Plan

6. Work with surrounding communities, state, regional and federal agencies to ensure regional cooperation and solutions for hazards affecting multiple communities.
7. Ensure that future development meets federal, state and local standards for preventing and reducing the impacts of natural hazards.
8. Take maximum advantage of resources from FEMA and MEMA to educate City staff and the public about hazard mitigation.
9. Consider the impacts of climate change and incorporate climate sustainability, mitigation, and resiliency into hazard mitigation and other City plans and policies.

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Major Natural Hazards in Waltham

Current and Future under Climate Change

Heavy Precipitation/Flooding

Severe Winter/Nor'easter

Other Severe Weather (i.e. Wind)

Hurricane

Erosion

Dam Failure

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More Major Natural Hazards

Current and Future under Climate Change

Rising Temperature/ Extreme Heat

Drought

Wildfires/Brush Fires

Landslides

Tornadoes

Earthquakes

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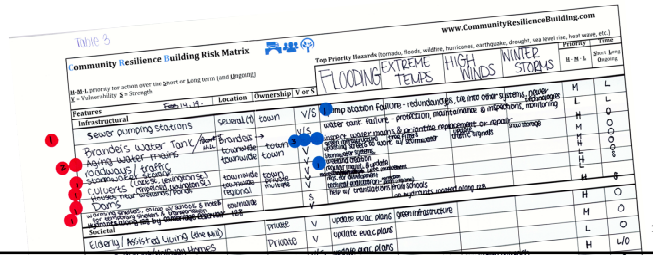
Top Hazards Identified at the Workshop

Flooding

High Winds

Winter Storms

Extreme Temperatures (Heat and Cold)



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Predicted Climate Change

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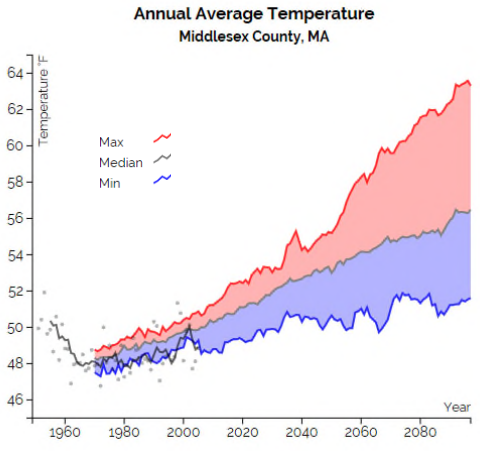
Projected: Annual Average Temperature in Middlesex County



(Source: Northeast Climate Adaption Science Center)

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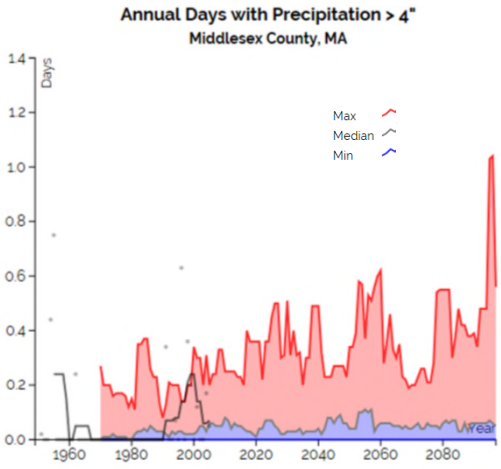
Heavy Precipitation



(Source: Northeast Climate Adaption Science Center)

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Flood Exposure to Buildings by Parcel Type

Parcel Type Category	Number of Buildings	Building Value	Total Value
Commercial - Industrial/Manufacturing/Automotive	165	$118,323,900	$206,531,700
Commercial - Office	176	$1,269,029,400	$1,668,498,800
Commercial - Retail/Entertainment	138	$166,050,300	$254,140,000
Commercial - Unknown	22	$135,020,000	$135,138,200
Industrial - Unknown	1	$298,800	$298,800
Industrial	141	$313,256,700	$492,218,500
Industrial - Utility	8	$3,919,200	$11,553,300
Public Service	280	$578,298,800	$1,621,334,500
Residential - Multifamily	2953	$1,427,080,900	$2,194,560,600
Residential - Other	50	$318,848,600	$371,862,300
Residential - Single Family	8690	$1,691,162,600	$4,114,523,600
Vacant Land (Developable)	58	$0	$60,281,700
Vacant Land (Undevelopable)	25	$0	$3,904,600
Other*	134	$0	$0
Grand Total	12841	$6,021,289,200	$11,134,846,600

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Vulnerabilities

Infrastructural
- Stormdrain system
- Culverts
- Power Grid
- Electrical/wires
- Transportation
- Buildings
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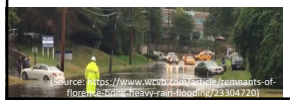
(Source: https://www.wcvb.com/article/remnants-of-florence-spin-heavy-rain-flooding/23304720)

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Strengths and Assets

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Medium Priority Actions

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(Source: https://www.bostoncentral.com/activities/waltham-spray-parks/p2359.php)

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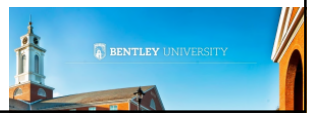

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Next Steps

- March 15-25, 2019 Comment Period
- Finalize Plan
- Send Plan to MEMA
- Send Plan to FEMA for review and approval
- Adoption by Waltham
- Final approval by FEMA
- Implement Plan
- Yearly review
- 5 year update cycle
- Apply for grants

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Comments?

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Public Comments

- Online comments accepted:
  - March 15 - 25, 2019 Draft document with comment portal https://www.city.waltham.ma.us/planning-department/pages/plans-reports
- Email or written comments to Catherine Cagle
  - Email: ccagle@city.waltham.ma.us
  - Mail: Catherine Cagle
    City of Waltham Planning Department
    Government Center
    119 School Street, Suite 25
    Waltham, MA 02451
  - Phone: 781.314.3370

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thank you

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APPENDIX D

Plan Adoption

CITY OF WALTHAM
IN THE CITY COUNCIL

610 Main Street Waltham Massachusetts 02452

Order #34567

Ordered:

That the City Council adopts the June 2019, Hazard Mitigation Plan and Municipal Vulnerability Plan 2019.

Read and Adopted: September 23, 2019

Order #
In the City Council

_____

_____

_____

_____

Read and Adopted: 9/23/19

_____
President Paul J. Brasco

Approved: 9/24/2019

_____
Mayor Jeannette A. McCarthy

RECEIVED
SEP 24 2019
Mayor's Office

CC: _____
_____
_____
_____

CITY OF WALTHAM

MASSACHUSETTS

Resolution

A RESOLUTION OF THE WALTHAM CITY COUNCIL ADOPTING THE *June 2019, Hazard Mitigation Plan and Municipal Vulnerability Preparedness Plan 2019*

WHEREAS the City of Waltham recognizes the threat that natural hazards pose to people and property within the City of Waltham; and

WHEREAS the City of Waltham has prepared a multi-hazard mitigation plan, hereby known as *June 2019, Hazard Mitigation Plan and Municipal Vulnerability Preparedness Plan 2019*, in accordance with the Disaster Mitigation Act of 2000; and

WHEREAS the *June 2019, Hazard Mitigation Plan and Municipal Vulnerability Preparedness Plan 2019*, identifies mitigation goals and actions to reduce or eliminate long-term risk to people and property in City of Waltham from the impacts of future hazards and disasters; and

WHEREAS adoption by the City of Waltham demonstrates their commitment to the hazard mitigation and achieving the goals outlined in the *June 2019, Hazard Mitigation Plan and Municipal Vulnerability Preparedness Plan 2019*.

NOW THEREFORE, BE IT RESOLVED BY THE CITY OF WALTHAM, MASSACHUSETTS, THAT:

The Waltham City Council formally adopts the *June 2019, Hazard Mitigation Plan and Municipal Vulnerability Preparedness Plan 2019*.

Approved: September 23, 2019

Attest: Robert J. Waddick

APPENDIX E

Plan Approval

U.S. Department of Homeland Security
FEMA Region I
99 High Street, Sixth Floor
Boston, MA 02110-2132

FEMA

OCT 0 7 2019

Samantha C. Phillips, Director
Massachusetts Emergency Management Agency
400 Worcester Road
Framingham, Massachusetts 01702-5399

Dear Director Phillips:

The U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA) Region I Mitigation Division has approved the City of Waltham Hazard Mitigation Plan and Municipal Vulnerability Preparedness Plan 2019 effective **October 2, 2019** through **October 1, 2024** in accordance with the planning requirements of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), as amended, the National Flood Insurance Act of 1968, as amended, and Title 44 Code of Federal Regulations (CFR) Part 201.

With this plan approval, the jurisdiction is eligible to apply to the Massachusetts Emergency Management Agency for mitigation grants administered by FEMA. Requests for funding will be evaluated according to the eligibility requirements identified for each of these programs. A specific mitigation activity or project identified in this community's plan may not meet the eligibility requirements for FEMA funding; even eligible mitigation activities or projects are not automatically approved.

The plan must be updated and resubmitted to the FEMA Region I Mitigation Division for approval every five years to remain eligible for FEMA mitigation grant funding.

Thank you for your continued commitment and dedication to risk reduction demonstrated by preparing and adopting a strategy for reducing future disaster losses. Should you have any questions, please contact Melissa Surette at (617) 956-7559 or Melissa.Surette@fema.dhs.gov.

Sincerely,

Captain W. Russ Webster, USCG (Ret.), CEM
Regional Administrator
FEMA Region I

WRW:ms

cc: Sarah White, State Hazard Mitigation Officer, MEMA
Jeffrey Zukowski, Hazard Mitigation Planner, MEMA
Beth Dubrawski, Hazard Mitigation Contract Specialist, MEMA