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## **ACKNOWLEDGEMENTS AND CREDITS**

This plan was prepared for the City of Cambridge by the Metropolitan Area Planning Council (MAPC) under the direction of the Massachusetts Emergency Management Agency (MEMA) and the Massachusetts Department of Conservation and Recreation (DCR). The plan was funded by the Federal Emergency Management Agency's (FEMA) Pre-Disaster Mitigation (PDM) Grant Program.

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## **I. EXECUTIVE SUMMARY**

Hazard Mitigation planning is a proactive effort to identify actions that can be taken to reduce the dangers to life and property from natural hazard events. In the communities of the Boston region of Massachusetts, hazard mitigation planning tends to focus most on flooding, the most likely natural hazard to impact these communities. The Federal Disaster Mitigation Act of 2000 requires all municipalities that wish to be eligible to receive FEMA funding for hazard mitigation grants, to adopt a local multi-hazard mitigation plan and update this plan in five year intervals.

### **PLANNING PROCESS**

Planning for the Cambridge Hazard Mitigation Plan update was led by the Cambridge Local Hazard Mitigation Planning Committee, composed of staff from a number of different City Departments. This committee discussed where the impacts of natural hazards most affect the City, goals for addressing these impacts, and hazard mitigation measures that would benefit the City.

Public participation in this planning process is important for improving awareness of the potential impacts of natural hazards and to build support for the actions the City takes to mitigate them. The City hosted public meetings two times during the process with the two meetings occurring January 9, 2013 and January 10, 2013 and a third meeting that occurred March 18, 2014. The draft plan was then posted on the City's website for public review.

### **RISK ASSESSMENT**

The Cambridge Hazard Mitigation Plan assesses the potential impacts to the City from flooding, high winds, winter storms, brush fire, and geologic hazards. Flooding, driven by hurricanes, northeasters, and other storms, clearly presents the greatest hazard to the City, most especially in locations that are low-lying or where drainage and conveyance systems can be overwhelmed during storm events with significant precipitation.

The Cambridge Local Committee identified those areas where flooding most frequently occurs, comprising 17% of the City's land area, and over 3,100 building structures worth an estimated \$907,000,000.

### **HAZARD MITIGATION GOALS**

1. Goal: Protect the health and safety of the public.
  - Encourage people to be prepared before, during and after a hazard event.
  - Identify at-risk populations and keep up to date list of locations
  - Ensure that services related to public health can function during and after a hazard, e.g., sanitation, water, debris removal, hospitals, and emergency services.

- Ensure that evacuation can happen in an organized and efficient manner.
- Minimize secondary impacts from hazards, such as the release of pollutants.
- 2. Goal: Protect existing properties and structures.
  - Provide resources for residents and businesses to make their buildings and properties more disaster resistant.
  - Educate the public on measures they can take to protect their property.
  - Maintain existing mitigation structures.
  - Ensure that future development / redevelopment does not make existing properties more vulnerable to hazards.
  - Ensure that critical facilities are protected from hazards.
  - Complete separation of combined sewers
- 3. Goal: Ensure that essential services can function during and after a hazard event.
  - Ensure that critical infrastructure is protected from natural hazards.
  - Ensure that people (key service providers and employees) can get into the city to provide services.
  - Build resiliency into the system for faster recovery, e.g., electricity distribution system.
- 4. Goal: Avoid chaos and confusion with good communication.
  - Have an effective communication plan.
  - Perform outreach to non-English speakers and other vulnerable populations before, during and after hazard events
  - Coordinate efforts with the private sector and institutions and with neighboring communities.
- 5. Goal: Work regionally to mitigate impacts from natural hazards and to respond and recover from hazard events.
  - Continue to participate in regional efforts.
  - Cooperate with other agencies, communities, and private entities.
  - Understand priorities and capabilities of other entities to allow for resource-sharing, mutual aid, and entering into memoranda of understanding (MOU).
- 6. Goal: Determine priorities for directing resources for hazard mitigation and response.
  - Prioritize mitigation projects.

- Continue to program mitigation projects in the 5 and 10 year CIP.
- Pursue various funding sources.
- Encourage private property-owners to implement measures to protect their own property.

**7. Protect natural resources**

- Identify mitigation strategies that preserve or restore the function of natural systems.
- Protect indigenous wetland areas, undeveloped floodplains and other natural features that provide mitigation of natural hazards.
- Introduce green infrastructure elements, where possible, to reduce impervious surfaces and introduce natural systems.

**8. Create capacity to monitor existing changes**

- Identify and understand how climate change may alter where and how the City is vulnerable to natural hazards.
- Review and update current mitigation activities to anticipate future changes in vulnerabilities.
- Review and update current emergency preparedness and response activities to anticipate future changes in vulnerabilities.

**HAZARD MITIGATION STRATEGY**

The Cambridge Local Committee identified a number of mitigation measures that would serve to reduce the City's vulnerability to natural hazard events. A primary focus of the measures was maintaining and improving the integrity of the drainage system through addressing maintenance and reconstruction issues. A secondary emphasis is on boosting the general emergency planning capabilities of the City so that both hazard mitigation and emergency management can be handled efficiently and effectively. Lastly, the City has included a set of measures that are aimed at identifying and addressing how vulnerabilities to natural hazards may change due to Climate Change.

Overall, the hazard mitigation strategy recognizes that mitigating hazards for Cambridge will be an ongoing process as our understanding of natural hazards and the steps that can be taken to mitigate their damages changes over time. The Hazard Mitigation Strategy will be incorporated into other related plans and policies.

**PLAN REVIEW AND UPDATE PROCESS****Table 1 Plan Review and Update**

<b>Chapter</b>	<b>Reviews and Updates</b>
III – Public Participation	The Cambridge Local Committee emphasized public participation for the update of the Hazard Mitigation Plan, discussing strategies to enhance participation opportunities at the first local committee meeting. During plan development, the plan was discussed at public meetings hosted by the Local Emergency Planning Committee and the Climate Protection Action Committee. Both meetings were publicized. The plan was also made available on the City’s website for public comment.
IV – Risk Assessment	MAPC gathered the most recently available hazard and land use data and met with City staff to identify changes in local hazard areas and development trends. City staff reviewed critical infrastructure with MAPC staff in order to create an up-to-date list. MAPC also used the most recently available version of HAZUS and assessed the potential impacts of flooding using the latest data.
V - Goals	The Hazard Mitigation Goals were reviewed, updated, and endorsed by the Local Hazard Mitigation Committee.
VI – Existing Mitigation Measures	The list of existing mitigation measures was updated to reflect current mitigation activities in the City.
VII & VIII – Hazard Mitigation Strategy	Mitigation measures from the 2008 plan were reviewed and assessed as to whether they were completed, on-going, or deferred. The Local Committee determined whether to carry forward measures into the 2014 plan or delete them. The 2014 Hazard Mitigation Strategy reflects both new measures and measures carried forward from the 2008 plan. The Committee prioritized the new set of measures based on current conditions.
IX – Plan Adoption & Maintenance	This section of the plan was updated with a new on-going plan implementation review and five year update process that will assist the City in incorporating hazard mitigation issues into other City planning and regulatory review processes and better prepare the City to update the plan in 2016.

As indicated on Table 19, Cambridge has made significant progress on advancing and implementing mitigation measures from the 2008 Hazard Mitigation Plan. Many measures

identified in that plan were completed, such as construction of numerous projects to address drainage issues related to Combined Sewer Overflows, and others have seen major progress, such as having 40% of the city undergo hydraulic modeling. There are measures that still require action and that will require additional capital, equipment, and manpower. Moving forward into the next five year implementation period, there will be many more opportunities to incorporate hazard mitigation into the City's decision making processes, especially as Cambridge completes its Climate Change Vulnerability Assessment and Preparedness Plan.

## **II. INTRODUCTION**

### **PLANNING REQUIREMENTS UNDER THE FEDERAL DISASTER MITIGATION ACT**

The Federal Disaster Mitigation Act, passed in 2000, requires that after November 1 2004, all municipalities that wish to continue to be eligible to receive FEMA funding for hazard mitigation grants, must adopt a local multi-hazard mitigation plan, and update this plan in five year intervals. This planning requirement does not affect disaster assistance funding.

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 Department of Conservation and Recreation (DCR). Massachusetts has taken a regional approach and has encouraged the regional planning agencies to apply for grants to prepare plans for groups of their member communities. The Metropolitan Area Planning Council (MAPC) received a grant from FEMA under the Pre-Disaster Mitigation (PDM) Program to assist the City of Cambridge, and seven other municipalities in the Inner Core region, to update their local Hazard Mitigation Plans, which were first adopted in 2008 as part of a Metro-Boston Multi Hazard Mitigation Plan. These local Hazard Mitigation Plan updates are designed to meet the requirements of the Disaster Mitigation Act for each community.

In order to address multijurisdictional and regional issues, the participating municipalities were afforded the opportunity to meet with their neighboring communities during plan development. A public, regional meeting of the Metro Boston Multiple Hazard Community Planning Team was held April 13, 2012 to re-introduce participating communities to the hazard mitigation planning process and to identify inter-community hazard mitigation issues.

### **WHAT IS A HAZARD MITIGATION PLAN?**

Natural hazard mitigation planning is the process of determining how to systematically reduce or eliminate the loss of life and property damage resulting from natural hazards such as floods, earthquakes, and hurricanes. Hazard mitigation means to permanently reduce or alleviate the losses of life, injuries, and property resulting from natural hazards through long-term strategies. These long-term strategies include planning, policy changes, programs, projects, and other activities.

### **PREVIOUS FEDERAL/STATE DISASTERS**

The City of Cambridge has experienced 16 natural hazards that triggered federal or state disaster declarations since 1991. These are listed in Table 2. The vast majority of these events involved flooding.

**Table 2. Previous Federal/State Disaster Declarations**

<b>Disaster Name \ (Date of Event)</b>	<b>Type of Federal Assistance Provided</b>	<b>Declared Areas in MA</b>
Hurricane Bob (August 1991)	FEMA Public Assistance Project Grants	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (16 projects)
No-Name Storm (October 1991)	FEMA Public Assistance Project Grants	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	FEMA Individual Household Program	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
March Blizzard (March 1993)	FEMA Public Assistance Project Grants	Statewide
January Blizzard (January 1996)	FEMA Public Assistance Project Grants	Statewide
October Flood (October 1996)	FEMA Public Assistance Project Grants	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
	FEMA Individual Household Program	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
	Hazard Mitigation Grant Program	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
(1997)	Community Development Block Grant-HUD	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk

**Table 2. Previous Federal/State Disaster Declarations**

<b>Disaster Name \ (Date of Event)</b>	<b>Type of Federal Assistance Provided</b>	<b>Declared Areas in MA</b>
June Flood (June 1998)	FEMA Individual Household Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	Community Development Block Grant-HUD	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
March Flood (March 2001)	FEMA Individual Household Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester (16 projects)
February Snowstorm (Feb 17-18, 2003)	FEMA Public Assistance Project Grants	Statewide
January Blizzard (January 22-23, 2005)	FEMA Public Assistance Project Grants	Statewide
Hurricane Katrina (August 29, 2005)	FEMA Public Assistance Project Grants	Statewide
May Rainstorm/Flood (May 12-23, 2006)	Hazard Mitigation Grant Program	Statewide
April Nor'easter (April 15-27, 2007)	Hazard Mitigation Grant Program	Statewide
Flooding (March, 2010)	FEMA Public Assistance FEMA Individuals and Households Program SBA Loan	Bristol, Essex, Middlesex, Suffolk, Norfolk, Plymouth, Worcester
	Hazard Mitigation Grant Program	Statewide

**Table 2. Previous Federal/State Disaster Declarations**

<b>Disaster Name \ (Date of Event)</b>	<b>Type of Federal Assistance Provided</b>	<b>Declared Areas in MA</b>
Tropical Storm Irene (August 27-28, 2011)	FEMA Public Assistance	Statewide
Hurricane Sandy (October 27-30, 2012)	FEMA Public Assistance	Statewide

(Source: database provided by MEMA)

## **FEMA FUNDED MITIGATION PROJECTS**

Over the last 20 years the City of Cambridge has not received funding from FEMA for mitigation projects under the Hazard Mitigation Grant Program (HMGP).

## **COMMUNITY PROFILE**

Cambridge borders Watertown, Belmont, Arlington, and Somerville and is separated from Boston by the Charles River. Cambridge was first organized as a City in 1630 and then incorporated as a city in 1846. It is located in Middlesex County and the city has a Council-Manager form of government.

The city's website is at <http://www.cambridgema.gov/index.cfm>.

In 2010, Cambridge had 105,162 residents and 47,291 housing units. The city's land area is 6.5 square miles. Its total area is 7.13 square miles. The city is served by State Routes 2, 2A, 16, and 38, the MBTA's Red Line and Green Line, the commuter rail, and a number of bus routes. Table 3 highlights key community data from the 2010 Census.

Cambridge is home to four colleges/universities: Harvard University (including Radcliffe College), the Massachusetts Institute of Technology (MIT), Lesley College, and Cambridge College. When discussing natural hazards, the presence of the educational institutions is an important consideration. These schools bring in thousands of college or graduate students every year and bring thousands of workers into Cambridge every day (see Table 4 for details). In addition, these institutions often conduct their own hazard planning and emergency preparedness programs.

**Table 3. Cambridge Characteristics, 2010**

Population = 105,162
<ul style="list-style-type: none"><li>• 4.3% are under age 5</li><li>• 9.5% are over age 65</li><li>• 8.1% speak English less than "very well" (over age 5)</li><li>• 32.0% of households have no vehicle</li><li>• 16.3% live in group quarters</li></ul>
Number of Housing Units = 47,291
<ul style="list-style-type: none"><li>• 65.4% are renter-occupied housing units</li><li>• 58.7% of housing units were built prior to 1940</li></ul>

Source: U.S. Census, 2010, American Community Survey 2006-2010

**Table 4. College Students, Workers, and Buildings, 2004**

	Cambridge College	Harvard Univ.	Lesley Univ.	MIT	Total
Total Acres	1	214	16	253	484
Number of Buildings	1	391	59	109	560
Staff & Faculty	210	11,256	532	8,956	20, 954
Total Students in Degree Programs	2,946	17,408	4,571	10,908	35,833
Total Students in Dormitories	0	7,167	856	5,981	14,004
Total Students in Off-Campus Affiliated Housing	0	2,065	0	130	2,195

Source: 2013 Cambridge Town Gown Annual Report.

## II. PLANNING PROCESS AND PUBLIC PARTICIPATION

MAPC employs a six step planning process based on FEMA's hazard mitigation planning guidance focusing on local needs and priorities but maintaining a regional perspective matched to the scale and nature of natural hazard events. Public participation is a central component of this process, providing critical information about the local occurrence of hazards while also serving as a means to build a base of support for hazard mitigation activities. MAPC supports participation by the general public and other plan stakeholders through Regional and Local Hazard Mitigation Planning Committees, two public meetings hosted by the City, posting of the plan to the City's website, and invitations sent to neighboring cities and towns, City boards and commissions, and other local or regional entities to review the plan and provide comment.

### PLANNING PROCESS SUMMARY

The six-step planning process outlined below is based on the guidance provided by FEMA in the Local Multi-Hazard Mitigation Planning Guidance, July 1, 2008. Public participation is a central element of this process, which attempts to focus on local problem areas and identify needed mitigation measures based on where gaps occur in the existing mitigation efforts of the municipality. By working on municipal hazard mitigation plans in groups of neighboring cities and towns, MAPC is able to identify regional opportunities for collaboration and facilitate communication between communities. In plan updates, the process described below allows staff to bring the most recent hazard information into the plan, including new hazard occurrence data, changes to a municipality's existing mitigation measures, and progress made on actions identified in previous plans.



1. Map the Hazards – MAPC relies on data from a number of different federal, state, and local sources in order to map the areas with the potential to experience natural

hazards. This mapping represents a multi-hazard assessment of the municipality and is used as a set of base maps for the remainder of the planning process. A particularly important source of information is the knowledge drawn from local municipal staff on where natural hazard impacts have occurred, which is collected. These maps can be found in Appendix B.

2. Assess the Risks & Potential Damages – Working with local staff, critical facilities, infrastructure, vulnerable populations, and other features are mapped and contrasted with the hazard data from the first step to identify those that might represent particular vulnerabilities to these hazards. Land use data and development trends are also incorporated into this analysis. In addition, MAPC develops estimates of the potential impacts of certain hazard events on the community.
3. Review Existing Mitigation – Municipalities in the Boston Metropolitan Region have an active history in hazard mitigation as many have adopted flood plain zoning districts, wetlands protection programs, and other measures as well as enforcing the State building code, which has strong provisions related to hazard resistant building requirements. All current municipal mitigation measures must be documented.
4. Develop Mitigation Strategies – MAPC works with the local municipal staff to identify new mitigation measures, utilizing information gathered from the hazard identification, vulnerability assessments, and the community's existing mitigation efforts to determine where additional work is necessary to reduce the potential damages from hazard events. Additional information on the development of hazard mitigation strategies can be found in Chapter VII.
5. Plan Approval & Adoption – Once a final draft of the plan is complete it is sent to MEMA for the state level review and, following that, to FEMA for approval. Typically, once FEMA has approved the plan the agency issues a conditional approval with the condition being adoption of the plan by the municipality. More information on plan adoption can be found in Chapter IX and documentation of plan adoption can be found in Appendix D.
6. Implement & Update the Plan – Implementation is the final and most important part of any planning process. Hazard Mitigation Plans must also be updated on a five year basis making preparation for the next plan update an important on-going activity. Chapter IX includes more detailed information on plan implementation.

## **2008 PLAN IMPLEMENTATION AND MAINTENANCE**

The 2008 Cambridge Annex to the Metro Boston Regional Multi-Hazard Mitigation Plan contained a risk assessment of identified hazards for the City and mitigation measures to address the risk and vulnerability from these hazards. Since approval of the plan by FEMA and local adoption, progress has been made on implementation of the measures.

The City has advanced a number of projects for implementation, including maintenance of 225 miles of sewer pipes, provision of back flow preventers to private landowners in targeted areas, design, and completion of numerous sewer and stormwater drainage projects around the City and advancement on the hydraulic model for Cambridge.

The City has advanced these projects in a fiscal environment that is often constrained and where municipal staff is often performing the work in multiple roles. As such, much of the coordination for projects that either directly or indirectly address mitigation measures has occurred through small groups rather than through a regular convening of a local mitigation team. In addition, the City was prepared to engage in the plan update process from the Regional Committee meeting through to the local team and public meetings.

### **CAMBRIDGE'S PARTICIPATION IN THE REGIONAL COMMITTEE**

On February 28, 2010 a letter was sent notifying the communities of the first meeting of the Metro Boston Hazard Mitigation Planning Committee and requesting that the Chief Elected Official designate a minimum of two municipal employees and/or officials to represent the community. The following individuals were appointed to represent Cambridge on the regional committee:

Brian Gover	Local Emergency Planning Committee/ Fire Department
Gerard Mahoney	Emergency Planning and Coordination / Fire Department

The regional committee serves as an opportunity for neighboring communities to discuss hazard mitigation issues of shared concern. The Metro Boston Regional Committee met on April 13, 2010 and was attended by representatives from the neighboring municipalities of Brookline, Cambridge, Chelsea, Everett, Malden, Medford, Melrose, and Somerville. At that meeting, the communities began the process of reviewing and revising their 2008 Natural Hazard Mitigation Plans and were re-introduced to the following items:

- The Massachusetts State Hazard Mitigation Plan and the FEMA hazard mitigation planning and grant process;
- The concept of each community engaging staff and the public to update its current Natural Hazard Mitigation Plan;
- FEMA plan overview and requirements and plan eligibility;
- Review of the overall scope of work and plan revision schedule
- Question and of Discussion of local issues, inter-community and Metro Boston Region hazard mitigation issues and how to address.
- Re-introduction to identifying and mapping municipal Critical Facilities, municipal Areas of Concern, Inter-Community Areas of Concern, and Regional Shared areas of Concern.

- Municipal representatives were also briefed on the importance of trying to create a diversified presence on the local Multiple Hazard Community Planning Team in advance of local team meetings, being asked to contact major employers, business owners, schools, and non-profit organizations to participate in the process.

In addition, as the same group of MAPC staff is working on each community's plan, these issues of shared concern, and other issues that may arise between neighboring communities, are discussed in greater detail in local committee meetings and resulting actions are reflected in the identified mitigation measures, as noted in Chapter VI.

### **THE LOCAL HAZARD MITIGATION PLANNING TEAM**

The Local Hazard Mitigation Planning Team is central to the planning process as it is the primary body tasked with developing a mitigation strategy for the community. Given this role, it is important that this committee include a diverse representation of community stakeholders and knowledgeable municipal staff.

Given the Cambridge's large number of stakeholders and staff whose participation in this process was desirable, it was decided that a local committee would be given oversight of the planning process. The committee was tasked with setting plan goals and providing information on the impacts of hazards on the City and existing mitigation measures, and helping to develop new mitigation measures that would then be made available for review. The steering committee membership can be found in the table below. The steering committee met on: October 25, 2012; November 21, 2012; June 13, 2013; and October 16, 2013.

**Table 5. Cambridge Hazard Mitigation Plan Steering Committee**

<i>Name</i>	<i>Representing</i>
Brian Gover	Local Emergency Planning Committee/ Fire Department
Gerard Mahoney	Emergency Planning and Coordination / Fire Department
Joseph Wilson	Police Department
Owen O'Riordan	Department of Public Works
John Nardone	Department of Public Works
Lisa Peterson	Manager's Office
John Bolduc	Community Development Department
Sam Corda	Cambridge Water Department
Mike Nicolero	Inspectional Services Department
Jennifer LeTourneau	Conservation Commission
Bill Van Schalkwyk	Massachusetts Institute of Technology

**Table 5. Cambridge Hazard Mitigation Plan Steering Committee**

<i>Name</i>	<i>Representing</i>
Nick Hambridge	Harvard University
Sam Lipson	Public Health Department
Lynn Schoeff	Public Health Department
Steve Lenkauskas	Electrical Department

**PUBLIC MEETINGS**

Public participation in the hazard mitigation planning process is important, both for plan development and for later implementation of the plan. Residents, business owners, and other community members are an excellent source for information on the historic and potential impacts of natural hazard events and particular vulnerabilities the community may face from these hazards. Their participation in this planning process also builds understanding of the concept of hazard mitigation, potentially creating support for mitigation actions taken in the future to implement the plan. To gather this information and educate residents on hazard mitigation, the City hosted three public meetings, two during the planning process and one after a complete draft plan was available for review.

Natural hazard mitigation plans unfortunately rarely attract much public involvement in the Boston region, unless there has been a recent hazard event. One of the best strategies for overcoming this challenge is to include discussion of the hazard mitigation plan on the agenda of an existing board or commission. With this strategy, the meeting receives widespread advertising and a guaranteed audience of the board or commission members plus those who attend the meeting. These board and commission members represent an engaged audience that is informed and up to date on many of the issues that relate to hazard mitigation planning in the locality and will likely be involved in plan implementation, making them an important audience with which to build support for hazard mitigation measures. In addition, these meetings frequently receive press coverage and are televised, expanding the audience that has the opportunity to hear the presentation and provide comment by phoning or emailing local staff.

The public had an opportunity to provide input to the Cambridge hazard mitigation planning process during a meeting of the Local Emergency Planning Committee (LEPC) on January 9, 2013 held in the W.R. Grace Building in Cambridge and on January 10, 2013 at the Climate Protection Action Committee (CPAC) in the City Hall Annex. The final draft of the plan was presented at Public Meeting held on March 18, 2014. This meeting was held in the public meeting room at the Department of Public Works.

The first two meetings were publicized as a regular meeting of the two committees. The presentation of the final draft was publicized as a standalone public meeting. The attendance list for each meeting can be found in Table 6.

**Table 6. Attendance at Public Meetings**

<b>Name</b>	<b>Organization or Neighborhood</b>
<b><i>Public Meeting – LEPC - January 9, 2013</i></b>	
Joe Wilson	Cambridge Police
James Defrancesco	Cambridge Police
Demetra Borlas	Amgen
Tamanah Anuard	Ironwood
Stefan Wawzyricki	Infinity
Tom Diamond	Pfizer
David Loh	MA Dept of Fire Services
Buchoul Yam	CPD
George Fosque	Cams. ECD
Joseph F. Gafun	MIT
Bill Van Schalkwyk	MIT
Jeff Richards	Shire
Nick Hambridge	Harvard
Gerry Mahoney	CFD
Sam Corda	Cambridge Water
Brian Gover	CFD
Bill Donovan	Whitehead Inst.
Mike Hughes	CFD
Kristin Garlund	Safety Partners
Alex Wong Bermier	Ironwood
Sarah Avgood	Safety Parties / Agios
Xi Biarth	TEI
Dave Degou	CHA
D. Carlson	MIT Pb
Bob Najjar	Draper
Jeff Trask	MIT
Norman Collings	Mount Auburn Hospital

**Table 6. Attendance at Public Meetings**

<b>Name</b>	<b>Organization or Neighborhood</b>
Eli Gifford	Harvard
Patrick J. Sullivan	Somerville Fire Department
Dana Haagensen	MA DFS
Kim Parker	Sanofi
Mary Lucot	Sanofi
Heidi Fon	Novartis
Dick Aichelmann	Ironwood
Skip Botelho	Cambridge 911
Stacia Joyce	CFD
Laura Piecewicz	WR Grace
Kathleen Woodward	Biogen Idec
Judith Tilden	Vertex Pharm
Lou DiBerardinis	MIT
PM Bochnat	MIT
Bob Beniot	Mt Auburn Hospital
David M. Barber	MIT
Lynn Schoeff	CPHD
Heather Tece	MEMA
<b><i>Public Meeting – CPAC - January 10, 2013</i></b>	
Milton Bevington	Resident
Peter Crawley	Resident
Janet Curtis	Resident
Lyn Huckabee	Resident
Ted Live	Resident
Lauren Miller	Resident
David Rabkin	Resident
Marguerite Reynolds	Resident
Keren Schlomy	Resident

**Table 6. Attendance at Public Meetings**

<b>Name</b>	<b>Organization or Neighborhood</b>
Scott Wood	Resident
Quinton Zondervan	Resident
Malcolm Bliss	Resident
Kurt Trampusch	Resident
Paula Phipps	Resident
John Pitkin	Resident
Dorothea von Herder	Resident
Steve Lanou	MIT
Carri Boisselle	Novartis
Terrence Smith	Chamber of Commerce
Kyle Greaves	Urban Ecology Institute
Robyn Tsukayama	Harvard
Barry Hilts	Cambridge Health Alliance
Susanne Rasmussen	Community Development Department
John Bolduc	Community Development Department
Kristen von Hoffmann	School Department
<b><i>Public Meeting – March 18, 2014</i></b>	
Carol Weinhaus	Resident
Jim Newman	Resident
Sam Seidel	Resident/Planner
Craig Kelley	City Councillor
Brian Gover	Fire Department/LEPC
Jim Wilcox	Engineering

**OTHER OPPORTUNITIES FOR PUBLIC INVOLVEMENT****Review by Community Organizations**

Notice was sent to the following organizations and neighboring municipalities inviting them to review the Cambridge Hazard Mitigation Plan and submit their comments to the City.

City of Cambridge Boards and Commissions  
City of Boston  
City of Somerville  
City of Medford  
City of Everett  
City of Arlington

**Website**

Draft copies of the Cambridge Hazard Mitigation Plan update were posted on the City's website and updated regularly over the course of the planning process. Members of the public could access the draft document and submit comments or questions.

## IV. RISK ASSESSMENT

The risk assessment analyzes the potential natural hazards that could occur within the City of Cambridge as well as the relationship between those hazards and current land uses, potential future development, and critical infrastructure. This section also includes a vulnerability assessment that estimates the potential damages that could result from certain large scale natural hazard events.

### UPDATE PROCESS

In order to update Cambridge's risk assessment, MAPC gathered the most recently available hazard and land use data and met with City staff to identify changes in local hazard areas and development trends. MAPC also used the most recently available version of HAZUS (described below).

### Overview of Hazards and Impacts

The Massachusetts Hazard Mitigation Plan 2010 (state plan) provides an in-depth overview of natural hazards in Massachusetts. The state plan indicates that Massachusetts is subject to the following natural hazards (listed in order of frequency); floods, heavy rainstorms, nor'easters or winter storms, coastal erosion, hurricanes, tornadoes, wildfires, drought and earthquakes. Previous state and federal disaster declarations since 1991 are summarized in Table 2.

The following table summarizes the hazard risks for Cambridge. This evaluation takes into account the frequency of the hazard, historical records, and variations in land use. This analysis is based on the vulnerability assessment in the Commonwealth of Massachusetts State Hazard Mitigation Plan, 2010. The statewide assessment was modified to reflect local conditions in Cambridge using the definitions for hazard frequency and severity listed below Table 7.

**Table 7. Hazard Risks Summary**

Hazard	Frequency		Severity	
	Massachusetts	Cambridge	Massachusetts	Cambridge
Flooding	High	High	Serious	Serious
Dam failures	Very Low	Medium	Serious	Serious
Coastal Hazards	High	Very Low	Serious	Serious
Winter storms	High	High	Minor	Minor
Hurricanes	Medium	Medium	Serious	Serious
Tornadoes	Medium	Very Low	Serious	Serious
Brush fires	Medium	Medium	Minor	Minor

**Table 7. Hazard Risks Summary**

<b>Hazard</b>	<b>Frequency</b>		<b>Severity</b>	
Earthquakes	Very Low	Very Low	Extensive	Serious
Landslides	Low	Very Low	Minor	Minor

**Definitions used in the Commonwealth of Massachusetts State Hazard Mitigation Plan**

Frequency

Very low frequency: events that occur less frequently than once in 1,000 years (less than 0.1% per year)

Low frequency: events that occur from once in 100 years to once in 1,000 years (0.1% to 1% per year);

Medium frequency: events that occur from once in 10 years to once in 100 years (1% to 10% per year);

High frequency: events that occur more frequently than once in 10 years (greater than 10% per year).

Severity

Minor: Limited and scattered property damage; no damage to public infrastructure (roads, bridges, trains, airports, public parks, etc.); contained geographic area (i.e., one or two communities); essential services (utilities, hospitals, schools, etc) not interrupted; no injuries or fatalities.

Serious: Scattered major property damage (more than 50% destroyed); some minor infrastructure damage; wider geographic area (several communities); essential services are briefly interrupted; some injuries and/or fatalities.

Extensive: Consistent major property damage; major damage to public infrastructure (up to several days for repairs); essential services are interrupted from several hours to several days; many injuries and fatalities.

Catastrophic: Property and public infrastructure destroyed; essential services stopped, thousands of injuries and fatalities.

**FLOOD RELATED HAZARDS**

Flooding was the most prevalent serious natural hazard identified by local officials in Cambridge. Flooding is generally the rising or overflowing of water onto normally dry land and can be caused by hurricanes, nor'easters, severe rainstorms, and thunderstorms among other causes. Global climate change has the potential to increase the frequency and severity of rainstorms and snowstorms, which would be a continuation of trend observed over the past several decades.

**Regionally Significant Floods**

There have been a number of major floods that have affected the Metro Boston region over the last fifty years. Significant historic flood events in Cambridge have included:

- March 1968
- The blizzard of 1978
- January 1979
- April 1987
- October 1991 ("The Perfect Storm")
- October 1996
- June 1998
- March 2001
- April 2004
- May 2006
- April 2007
- March 2010

**Overview of City-Wide Flooding**

The City of Cambridge is subject to inland flooding in the forms of riverine flooding and urban flooding. Riverine flooding occurs when the rate of precipitation and/or amount of stormwater runoff overwhelms the capacity of natural or structured drainage systems causing overflows; urban flooding occurs when precipitation causes the water table to rise and leads to flooding of low-lying areas such as streets and underpasses. These types of flooding are often combined as storm events lead to large amounts of draining stormwater, which can be blocked by elements of the built environment and can be backed up when drainage conveyance systems (storm drains, pipes, etc.) and/or locations (ponds, streams, etc.) are at or above capacity.

The city straddles two watersheds, the Charles River watershed to the south and east, and the Alewife Brook (tributary to the Mystic River) watershed to the northwest. Stream piping and development have severely altered the natural flow of water in Cambridge. Stormwater drainage from developed areas occurs primarily through the manmade system of storm drains.

Outside of inland flooding, Cambridge has limited exposure to coastal flooding and flooding is relatively infrequent due to the Charles River Dam, which controls water levels

for the Charles River and limits tidal changes within the Charles River Basin. However, if sea levels are to rise and storm events to become more intense, there is the potential for the dam to be overtopped and Cambridge to become susceptible to coastal flooding.

### **Overview of Drainage System**

The majority of Cambridge's flooding problems are associated with insufficient capacity in the drainage system, topography, and the City's location in the Concord-Alewife flood plains. As a result, Cambridge faces challenges in terms of mitigation planning for flooding hazards.

There are a variety of issues that affect the drainage system in the City. In some cases, the system is served by older infrastructure that has been impacted by increased development and does not have the necessary capacity to accommodate the resulting higher volume of runoff. In addition, there are many older conveyance systems that need updated to meet new standards and changes in precipitation events. Some of these issues are exacerbated by the fact that drainage from many surrounding cities and towns flow through Cambridge to the Charles River.

Information on flood hazard areas was taken from two sources. The first was the National Flood Insurance Rate Maps (FIRM). The FIRM flood zones are shown on Map 3 in Appendix B and defined below.

#### Flood Insurance Rate Map Zone Definitions

- Zones A1-30 and AE: Special Flood Hazard Areas subject to inundation by the 1-percent-annual-chance flood event determined by detailed methods. Base Flood Elevations are shown within these zones.
- Zone A (Also known as Unnumbered A Zones): Special Flood Hazard Areas subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations or depths are shown.
- Zone AO: Special Flood Hazard Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between one and three feet. Average flood depths derived from detailed hydraulic analyses are shown in this zone.
- Zone B and X (shaded): Zones where the land elevation has been determined to be above the Base Flood Elevation, but below the 500 year flood elevation. These zones are not Special Flood Hazard Areas.
- Zones C and X (unshaded): Zones where the land elevation has been determined to be above both the Base Flood Elevation and the 500 year flood elevation. These zones are not Special Flood Hazard Areas

The second source of flooding information was discussions with local officials. The Locally Identified Areas of Flooding below were identified by City staff as areas where flooding is known to occur or could occur if certain infrastructure failed. These areas do not necessarily coincide with the flood zones from the FIRM maps. They may be areas that flood due to inadequate drainage systems or other local conditions rather than location within a flood zone. The numbers correspond to the numbers on Map 8, “Locally Identified Hazard Areas”.

1. Fresh Pond Reservation (A, B, C) – This is the location of low lying areas adjacent to Fresh Pond that experience overland flooding during significant rainfall events. Flooding occurs primarily on undeveloped land but can block trails and walking paths around the pond.
2. Alewife Watershed - This area adjacent to Alewife Brook suffers from flooding during events in excess of the 5-10 year storm. The flooding has resulted in lanes closures on the nearby roadway. The causes of flooding in the area are multiple, including lack of capacity in the Alewife Brook, lack of flood storage capacity on land within the flood plain or adjacent to the Alewife Brook, backwater from the Mystic River and restrictions to conveyance caused by the various bridges over the Brook.
3. New Street - The area around New Street experience surface flooding during the 10-year storm events and can contribute to nearby CSO discharges.
4. Bellis Circle - Flooding in this area is generally caused by the inability of the conveyance system to carry water into the Alewife Brook since longer duration events raise the brook’s water level and prohibit the pipe systems from discharging into the brook. The system can then back up and flood the low lying areas around Bellis Circle.
5. Vassal Lane/Tobin School – This area is subject to flooding during events equal to or in excess of a 10-year storm. Flooding is due to the limited capacity of the drainage system, including the MWRA’s collection system. Impacts include basement flooding, CSO discharges, and surface flooding.
6. Concord Avenue and Fern Street - Flooding in this area is due to the limited capacity of the drainage system, including the MWRA’s collection system. Impacts include CSO discharges and surface flooding.
7. Porter Square at Somerville Avenue - The Somerville Avenue area in the Porter Square is an area that has traditionally suffered from poor drainage. The drainage issues are caused primarily by a poor collection and conveyance system in this area.
8. Harvard Square - The area surrounding Harvard Square has been subject to significant flooding and backups due to the poor conveyance capacity of the municipal system and the MWRA system.
9. Cambridge Cemetery –Area with pockets of low-lying land and poor drainage that experiences surface flooding during storms events with significant precipitation.
10. Agassiz Community – This area includes an existing CSO that has overflowed during

intense storm events and resulted in surface flooding.

11. Myrtle Street and Magnolia Avenue - During significant rain events ponding occurs in this area. The primary reason for flooding in these areas is their relative low lying nature and the inadequacy of the conveyance system.
12. Cambridge Highlands – CSOs in this area have resulted in backups during intense storm events leading to surface flooding. The CSOs in this area have substantial limitations in capacity.
13. Area 4 - A location that has poor conveyance systems and that tends to flood in short duration intense events and flood to a significant extent during the longer duration events.
14. Hancock Street and Kinnaird Street – Low lying area that has been impacted by poor drainage which results in surface flooding.
15. Green Street at Kennedy Biscuit Lofts – Area with CSOs that have capacity limitations and that have contributed to flooding in the areas as a result of heavy precipitation.
16. Cardinal Medeiros Avenue - Corridor with poor conveyance systems that tend to surcharge and flood in short duration intense events and flood to a significant rainfall events.
17. East Cambridge – Area with CSO constraints that has led to back up issues and surface flooding. The drainage system in the area has constraints relative to the CSO system and capacity of existing pipes.
18. Corcoran Way and May Street – Area that has historically experienced flooded. During significant rain events, surface flooding has occurred as well as flooding within nearby buildings.

## **Dam Failure**

Dam failure can occur as a result of structural failure, independent of a hazard event, or as the result of the impacts of a hazard event such as flooding associated with storms or an earthquake. In the event of a dam failure, the energy of the water stored behind even a small dam can cause loss of life and property damage if there are people or buildings downstream. The number of fatalities from a dam failure depends on the amount of warning provided to the population and the number of people in the area in the path of the dam's floodwaters. Dam failure in general is infrequent but has the potential for severe impacts. An issue for dams in Massachusetts is that many were built in the 19<sup>th</sup> century without the benefits of modern engineering or construction oversight.

A review with City staff and information available from the Division of Conservation and Recreation (DCR) was used to identify dams in Cambridge. DCR assesses the dams are using the three hazard classifications below:

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

Although the City of Cambridge does not own or operate any dam, the Charles River Dam does impact the City. The dam, which is owned and operated by the Department of Conservation and Recreation (DCR), is located along the Charles River and Basin, which borders the City to the south and east (separating Cambridge and the City of Boston). The Charles River Dam is classified as an urban flood control structure and has been identified as a Significant Hazard according to the DCR Hazard Potential Classification.

Another significant dam that is proximate to Cambridge is the Amelia Earhart Dam. Located in the City of Medford, this dam is associated with the Mystic River and is owned, maintained, and operated by DCR. The Amelia Earhart Dam is listed as a low hazard, but is estimated to need \$5 million dollars in repairs, such as repairs to the current third pump and the possible installation of a fourth pump. The dam separates the tidal and the non-tidal parts of the Mystic River, and is currently able to pump 4,000 cubic feet per second of flow from the Mystic and Malden Rivers against high tide into Boston Harbor. The pump improvements would increase the rate that flood water can travel out of the cities and towns along the Mystic River.

### **Repetitive Loss Structures**

There are 2 current repetitive loss structures in Cambridge, an increase from the one (1) structure identified in the 2008 plan. As defined by the Community Rating System (CRS) of the National Flood Insurance Program (NFIP), a repetitive loss property is any property which the NFIP has paid two or more flood claims of \$1,000 or more in any given 10-year period since 1978. For more information on repetitive losses see <http://www.fema.gov/business/nfip/replps.shtm>.

The following table shows the breakdown of structure type by number of claims and amount of losses.

**Table 8. Repetitive Loss Properties Summary**

	<b>Number of Claims</b>	<b>Building Losses</b>	<b>Contents Losses</b>	<b>Total Losses</b>
Single Family	0	0	0	0
2-4 Family	3	\$9,484.68	\$629.23	\$10,113.91
Condo	0	0	0	0
Other Residential	0	0	0	0
Non-Residential	2	\$75,882.82	\$82,425.00	\$158,307.82
<b>TOTAL</b>	<b>5</b>	<b>\$85,367.5</b>	<b>\$83,054.23</b>	<b>\$168,421.73</b>

Source: Federal Emergency Management Agency, National Flood Insurance Program

### Conclusions

Based on these factors, there is potential for significant flooding events but these have occurred infrequently and property damage or endangerment is not a frequent occurrence in the City. However, areas that are impacted or where property damage has occurred do not necessarily correspond to recognized flood plain areas.

### **WIND RELATED HAZARDS**

Wind-related hazards include hurricanes and tornadoes as well as high winds during severe rainstorms and thunderstorms. The typical wind speed in the Cambridge area ranges from around 11 miles per hour to 14 over the course of the year, but independent of storm events, gusts of up to 40 mph can occur. As with many cities and towns, falling trees that result in downed power lines and power outages are an issue in Cambridge. Information on wind related hazards can be found on Map 5 in Appendix B

### **Hurricanes**

Between 1858 and 2013, Massachusetts has experienced approximately 35 tropical storms, eleven Category 1 hurricanes, five Category 2 hurricanes, and one Category 3 hurricane. This equates to a frequency of approximately once every four years. A hurricane or storm track is the line that delineates the path of the eye of a hurricane or tropical storm. There has been one recorded storm track through Cambridge, a Category 1 Hurricane in 1944. The storm passed roughly through the central part of the City (just west of Harvard Square), traveling from Boston and through to Somerville and Medford. The City experiences the impacts of the wind and rain of hurricanes and tropical storms regardless of whether the storm track passed through the City. The hazard mapping indicates that the 100 year wind speed is 110 miles per hour.

Hurricanes typically have regional impacts beyond their immediate tracks, and numerous hurricanes have affected the communities of eastern Massachusetts (Table 9). A hurricane

or tropical storm track is the line that delineates the path of the eye of the hurricane or storm. Falling trees and branches are a significant problem because they can result in power outages when they fall on power lines or block traffic and emergency routes.

**Table 9. Hurricane Records for Massachusetts**

<b>Hurricane Event</b>	<b>Date</b>
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

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

Hurricane intensity is measured according to the Saffir/Simpson scale, which categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure, and storm surge potential. These are combined to estimate potential damage. The following gives an overview of the wind speeds, surges, and range of damage caused by different hurricane categories:

Scale No. (Category)	Winds(mph) Storm	Surge (ft)	Potential Damage
1	74 – 95	4 - 5	Minimal
2	96 – 110	6 - 8	Moderate
3	111 – 130	9 - 12	Extensive
4	131 – 155	13 - 18	Extreme
5	> 155	>18	Catastrophic

Source: NOAA

## **Tornados**

On average, there are six tornadoes that touchdown somewhere in the northeast region every year. Tornadoes are most common in the summer, June through August and most

form in the afternoon or evening. Tornadoes are associated with strong thunderstorms. The strongest tornado in Massachusetts history was the Worcester Tornado in 1953 (NESEC). The most recent tornado event in Massachusetts caused significant damage in the Springfield area and resulted in 4 deaths in June of 2011. There have been no recorded tornadoes within the limits of the City of Cambridge.

### **Nor'easters**

Featuring strong northeasterly winds blowing in from the ocean over coastal areas, nor'easters are relatively common in the winter months in New England occurring one to two times a year and frequently lead to coastal flooding and erosion. The storm radius of a nor'easter can be as much as 1,000 miles and these storms feature sustained winds of 10 to 40 mph with gusts of up to 70 mph. These storms are accompanied by heavy rains or snows, depending on temperatures.

Many of the historic flood events identified in the previous section were precipitated by nor'easters, including the "Perfect Storm" event in 1991. More recently, blizzards in December 2010, October 2011, and February 2013 were both large nor'easters that caused significant snowfall amounts.

### **Severe Thunderstorms**

While less severe than the other types of storms discussed, thunderstorms can lead to localized damage and represent a hazard risk for communities. Generally defined as a storm that includes thunder, which always accompanies lightning, a thunderstorm is a storm event featuring lightning, strong winds, and rain and/or hail. Thunderstorms sometime give rise to tornadoes. On average, these storms are only around 15 miles in diameter and last for about 30 minutes. A severe thunderstorm can include winds of close to 60 mph and rain sufficient to produce flooding.

### **WINTER STORMS**

Winter storms are the most common and most familiar of the region's hazards that affect large geographic areas. The majority of blizzards and ice storms in the region cause more inconvenience than they do serious property damage, injuries, or deaths. However, periodically, a storm will occur which is a true disaster and necessitates intense large-scale emergency response. Occasionally winter storms can also hinder the tidal exchange in tidally restricted watersheds and result in localized flooding within these areas. Ice build-up at gate structures can also damage tide gates and increase the hazard potential as a result of malfunctioning tide gates. Coastal storms also cause flooding because of tidal surges. The average annual snowfall for the western portion of the City is between 48-72 inches (4-6 feet, while the eastern part of the City has an average snowfall is 36-48 inches (3-4 feet).

The Northeast Snowfall Impact Scale (NESIS) developed by Paul Koki of The Weather Channel and Louis Cellini of the National Weather Service (Koki and Cellini, 2004)

characterizes and ranks high impact northeast snowstorms. These storms have large areas of 10 inch snowfall accumulations and greater. NESIS has five categories: Extreme, Crippling, Major, Significant, and Notable. 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 largest NESIS values result from storms producing heavy snowfall over large areas that include major metropolitan centers. The NESIS categories are summarized below:

Category	NESIS	Value Description
1	1–2.499	Notable
2	2.5–3.99	Significant
3	4–5.99	Major
4	6–9.99	Crippling
5	10.0+	Extreme

Source: Massachusetts State Hazard Mitigation Plan, 2010

Since 1958 Massachusetts has experienced two Category 5 Extreme snow storms, nine Category 4 (Crippling) storms, and 13 Category 3 (Major) snow storms. The most significant winter storm in recent history was the “Blizzard of 1978,” which resulted in over 3 feet of snowfall and multiple day closures of roadways, businesses, and schools. Historically, severe winter storms have occurred in the following years:

**Table 10. Severe Winter Storm Records for Massachusetts**

Blizzard of 1978	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
Blizzard of 2013	February 2013

Source: National Oceanic and Atmospheric Administration

Because a major feature of winter storms is heavy precipitation, the same mitigation measures in place for flooding are all important for mitigating the impacts of winter storms. However, the rapid melting of snow after major storms, combined with rainfall, is a more common flooding threat.

## **GEOLOGIC HAZARDS**

Geologic hazards include earthquakes, landslides, sinkhole, subsidence, and unstable soils such as fill, peat, and clay. Although new construction under the most recent building codes generally will be built to seismic standards, there are still many structures which pre-date

the most recent building code. Information on geologic hazards can be found on Map 4 in Appendix B.

### **Earthquakes**

Damage in an earthquake stems from ground motion, surface faulting, and ground failure in which weak or unstable soils, such as those composed primarily of saturated sand or silts, liquefy. The effects of an earthquake are mitigated by distance and ground materials between the epicenter and a given location. An earthquake in New England affects a much wider area than a similar earthquake in California due to New England's solid bedrock geology (NESEC).

Earthquakes are a hazard with multiple impacts beyond the obvious building collapse. Buildings may suffer structural damage which may or may not be readily apparent. Earthquakes can cause major damage to roadways, making emergency response difficult. Water lines and gas lines can break, causing flooding and fires. Another potential vulnerability is equipment within structures. For example, a hospital may be structurally engineered to withstand an earthquake, but if the equipment inside the building is not properly secured, the operations at the hospital could be severely impacted during an earthquake. Earthquakes can also trigger landslides.

According to the State Hazard Mitigation Plan, New England experiences an average of five earthquakes per year. From 1668 to 2007, 355 earthquakes were recorded in Massachusetts (NESEC) and a sample of these is included in Table 11 below.

**Table 11. Historical Earthquakes in Massachusetts or Surrounding Area, 1727-2013**

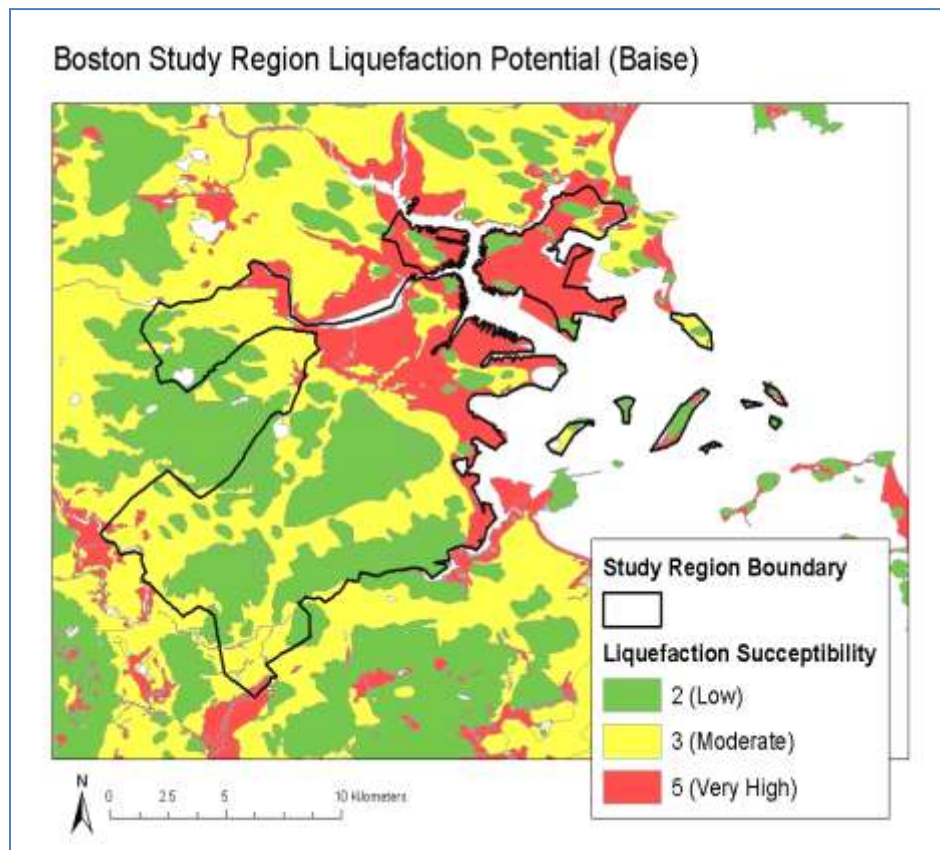
Location	Date	Magnitude*
MA - Cape Ann	11/10/1727	5
MA - Cape Ann	12/29/1727	NA
MA – Cape Ann	2/10/1728	NA
MA – Cape Ann	3/30/1729	NA
MA – Cape Ann	12/9/1729	NA
MA – Cape Ann	2/20/1730	NA
MA – Cape Ann	3/9/1730	NA
MA - Boston	6/24/1741	NA
MA - Cape Ann	6/14/1744	4.7
MA - Salem	7/1/1744	NA
MA - Off Cape Ann	11/18/1755	6

**Table 11. Historical Earthquakes in Massachusetts or Surrounding Area, 1727-2013**

Location	Date	Magnitude*
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

There have been no recorded earthquake epicenters within Cambridge.

*Liquefaction* - One additional impact that is of particular concern in the Boston metropolitan area is liquefaction (see figure below). This is due to the prevalence of filled land. Liquefaction means that loosely packed, water-logged sediments lose strength and therefore move in large masses or lose bearing strength. Soil units susceptible to liquefaction include: non-engineered artificial fill, alluvial deposits, beach deposits, fluvial deposits, and flood plain deposits. Non-engineered artificial fill is what is typically known locally as filled land. An earthquake with a magnitude of 5.5 or greater can trigger liquefaction. In the Boston region, these areas of filled land are densely developed with structures that pre-date the seismic provisions of the current Massachusetts State Building Code.

**Boston Study Region Liquefaction Potential**

Source: Baise, Laurie G., Rebecca B. Higgins ; and Charles M. Brankman, Tufts University

**Landslides**

Landslides can result from human activities that destabilize an area or can occur as a secondary impact from another natural hazard such as flooding. In addition to structural damage to buildings and the blockage of transportation corridors, landslides can lead to sedimentation of water bodies.

According to State data, the City is classified as having areas with a low risk for landslides as well having areas with a moderate risk (Appendix B - Map 4). The western portion of the city has a low risk for landslides whereas the eastern portion has a moderate risk for landslides.

**OTHER NATURAL HAZARDS****Brush Fires**

For the purposes of this plan, a brush fire is an uncontrolled fire occurring in a forested or grassland area. In the Boston Metro region these fires rarely grow to the size of a wildfire as seen more typically in the western U.S. As their name implies, these fires typically burn no more than the underbrush of a forested area. These fires present a hazard where there

is the potential for them to spread into developed or inhabited areas, particularly residential areas where sufficient fuel materials might exist to allow the fire the spread into homes.

The Fire Department responds to a limited number of brush fires of varying sizes annually. Within the past year, there were no brush fires that resulted in significant property damage.

The incidence of brush fires is distributed throughout the City with wetland areas and railroad rights-of-way having a higher risk. The Fire Department does not need any additional equipment to deal with brush fires.

Two areas of City were identified as having the highest potential for brush fires based on past experiences are wetlands areas where there can be concentrations of dry vegetation. The areas are identified below and the numbers correspond to the numbers on Map 8, "Hazard Areas"

19. Bullfinch/Alewife Reservation

20. Marsh Post/Greenough Boulevard

## **LAND USE AND DEVELOPMENT TRENDS**

### **Existing Land Use**

The most recent land use statistics available from the state are from aerial photography done in 2005. Table 12 shows the acreage and percentage of land in 10 categories. If the three residential categories are aggregated, residential uses make up over 37% of the area of the City (1,654 acres). Commercial and industrial uses comprise over 20% of land use in of Cambridge, and undeveloped land and wetlands account for just over 14%.

**Table 12. 2005 Land Use**

<b>Land Use Type</b>	<b>Acres</b>	<b>Percent</b>
High Density Residential	1 585.59	34.95%
Medium Density Residential	63.12	1.39%
Low Density Residential	5.92	1.31%
Non-Residential, Developed	1 176.87	25.94%
Commercial	594.53	13.12%
Industrial	340.47	7.51%
Transportation	1 14.90	2.53%
Agriculture	4.14	0.09%
Undeveloped	158.09	3.48%
Undeveloped Wetland	492.78	10.86%
<b>Total</b>	<b>4,536.42</b>	<b>100%</b>

Source: MassDEP 2205 Land Use

**Economic Elements**

Cambridge has economic centers located in multiple areas of the City. Significant centers of economic development include Kendall Square, Harvard Square, Central Square, and Porter Square. These areas are complimented by commercial corridors along Massachusetts Avenue and in the Concord Alewife section of the City. There are also many smaller commercial centers and corridors located in various neighborhoods through the Cambridge.

These centers and corridors consist of historic structures and businesses as well as more recent developments that include retail, office, and residential uses.

**Historic, Cultural, and Natural Resource Areas**

There are several locations and areas of historical and cultural importance to Cambridge, some of which are listed on the State and National historic registers and many which are included in local historic districts. In addition, the City has designated Neighborhood Conservation Districts to protect and preserve areas and buildings that important in Cambridge's history. Included are the:

- Old Cambridge Historic District
- Fort Washington Historic District
- Avon Hill Neighborhood Conservation District
- Harvard Square Conservation District

- Mid Cambridge Neighborhood Conservation District
- Half Crown -Marsh Neighborhood Conservation District

The districts are primarily located in the central portion of the City, in and to the east and west of Harvard Square.

The City has a limited number of larger open spaces and conserved lands, especially along the existing waterways, and is actively adding more natural elements to its built environment. The open space system in the City comes mostly from land reclaimed from other uses and these public parks and plazas are complimented by privately owned open spaces that typically offer some level of public access. The city values its current set of street trees and is working to plant more trees each year. The City is also participating in efforts to address water quality issues related to the Mystic River and Alewife Brook through open space preservation and enhancement. More information about open space planning can be found in the City's 2009-2016 Open Space and Recreation Plan.

### **Development Trends**

Under current zoning, the City of Cambridge is largely built out. Much of the land area is occupied by existing residential neighborhoods, commercial corridor and districts, open space and recreational spaces, and conservation land and undevelopable wetlands. The development that is occurring in the City is largely infill development and redevelopment.

### **Potential Future Development**

MAPC consulted with City staff to determine areas that are likely to be developed in the future, defined for the purposes of this plan as a ten year time horizon. In some cases the types of future development are known, but in many cases the areas have been identified as a location that has been planned for and shown likelihood for future growth.

The potential future development areas are shown on Map 2, "Developable Land" and are described below. The letter for each site corresponds to the letters on Map 2.

- A. Kendall Square - The 27-acre area is owned by MIT and leased to Forest City Enterprises. Most of the project has been built with the last two buildings under construction. The area includes roughly 2.3 million square feet of residences (almost 700 units), biotechnology uses, a dormitory, and a hotel. This 9.8-acre area, which lies along the Board Canal, is being developed as a Planned Unit Development (PUD) and is currently owned by Lyme Properties. The area will include roughly 1.5 million square feet of a variety of uses, including biotechnology, research and development and residences. The area was a brownfield.
- B. Main Street/Massachusetts Avenue – Area also known as Osborne Triangle that is the location for new development and redevelopment that is proposed to include a mixture of residential, neighborhood business, office, and institutional uses. This area serves as a link between Kendall Square and Central Square.

- C. North Point - Jones Lange LaSalle is the developer for North Point. Construction will be phased over 15 to 20 years. Five million square feet is planned, with roughly 2 million square feet of residences (over 2,000 units), 3 million square feet of commercial uses, and 10 acres of open space. The area totals 43.7 acres.
- D. Concord-Alewif Area - The planning process for this underdeveloped area is at early stages. The city has formulated a vision and new zoning was recently adopted. The vision entails mixed uses throughout the area including housing; allowing development rights to be transferred away from Cambridge Highlands to the area around Alewife Station, and the use of overlay districts to address open space and stormwater issues including the use of Low Impact Development techniques. Much of the 180-acre area is in the 500 year floodplain. Additional approaches to addressing flooding concerns are discussed under potential mitigation for flooding, later.
- E. Discovery Park - This area will be redeveloped for commercial uses. The project proposed for this site would increase the amount of office and research space from 416,000 square feet to 820,000 square feet. The project also entails removing parking areas along the Little River Area and providing flood storage capacity.
- F. Whittemore Avenue - Harvey Street – Area located on the eastern edge of the Concord-Alewif development district with potential for future redevelopment. Current location of light industrial and technology uses.

## **VULNERABILITY ASSESSMENT**

The purpose of the vulnerability assessment is to estimate the extent of potential damages from natural hazards of varying types and intensities.

### **Future Development in Hazard Areas**

Table 13 shows the relationship of these parcels to two of the mapped hazards. This information is provided so that planners can ensure that development proposals comply with flood plain zoning and that careful attention is paid to drainage issues.

<b>Table 13. Relationship of Potential Development to Hazard Areas</b>			
<b>Area</b>	<b>Landslide risk</b>	<b>Flood Zone</b>	<b>Brush Fire</b>
North Point	Moderate Susceptibility	No	No
Kendall Square	Moderate Susceptibility	3.2% in AE	No
Main Street/Massachusetts Avenue	Moderate Susceptibility	No	No
Concord-Alewif Area	Low	31.8% in AE	No
Discovery Park	Low	98.5% in AE	Yes
Whitmore Avenue - Harvey Street	Low	42.8493% in AE	No

Critical Infrastructure in Hazard Areas

Critical infrastructure includes facilities that are important for disaster response and evacuation (such as emergency operations centers, fire stations, water pump stations, etc.) and facilities where additional assistance might be needed during an emergency (such as nursing homes, elderly housing, day care centers, etc.). These facilities are listed in Table 14 and are shown on all of the maps in Appendix B.

The purpose of mapping the natural hazards and critical infrastructure is to present an overview of hazards in the community and how they relate to critical infrastructure, to better understand which facilities may be vulnerable to particular natural hazards.

### Explanation of Columns in Table 14

**Column 1: ID #:** The first column in Table 14 is an ID number which appears on the maps that are part of this plan. See Appendix B.

**Column 2: Name:** The second column is the name of the site. If no name appears in this column, this information was not provided to MAPC by the community.

**Column 3: Type:** The third column indicates what type of site it is.

**Column 4: Landslide Risk:** The fourth column indicates the degree of landslide risk for that site. This information came from NESEC. The landslide information shows areas with either a low susceptibility or a moderate susceptibility to landslides based on mapping of geological formations. This mapping is highly general in nature. For more information on how landslide susceptibility was mapped, refer to <http://pubs.usgs.gov/pp/p1183/pp1183.html>.

**Column 5: FEMA Flood Zone:** The fifth 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 A** (1% annual chance) - Zone A is the flood insurance rate zone that corresponds to the 100-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 (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.

**Zones X500** (.2% annual chance) - Zone X500 is the flood insurance rate zone that correspond 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 (base flood elevations) or depths are shown within this zone.

**Zone VE** (1% annual chance) - Zone VE is the flood insurance rate zone that corresponds to the 100-year coastal floodplains that have additional hazards associated with storm waves. BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply

**Column 6: Locally-Identified Flood Area:** The locally identified areas of flooding were identified by City staff as areas where flooding occurs. These areas do not necessarily coincide with the flood zones from the FIRM maps. They may be areas that flood due to inadequate drainage systems or other local conditions rather than location within a flood zone. The numbers correspond to the numbers on Map 8, "Hazard Areas".

**Column 7: Hurricane Surge Category:** The seventh column indicates whether or not the site is located within a hurricane surge area and the category of hurricane estimated to be necessary to cause inundation of the area. The following explanation of hurricane surge areas was taken from the US Army Corps of Engineers web site:

"Hurricane storm surge is an abnormal rise in sea level accompanying a hurricane or other intense storm. Along a coastline a hurricane will cause waves on top of the surge. Hurricane Surge is estimated with the use of a computer model called SLOSH. SLOSH stands for Sea Lake and Overland Surge from Hurricanes. The SLOSH models are created and run by the National Hurricane Center.

The SLOSH model results are merged with ground elevation data to determine areas that will be subject to flooding from various categories of hurricanes. Hurricane categories are defined by the Saffir-Simpson Scale." See <http://www.sam.usace.army.mil/hesdata/General/hestasks.htm>

According to the Saffir-Simpson Scale, the least damaging storm is a Category 1 (winds of 74-95 miles per hour) and the most damaging storm is a Category 5 (winds greater than 155 miles per hour).

**Column 8: Brushfire Risk (Not shown):** The fourth column indicates whether the site falls within an area identified by municipal staff as posing a brushfire risk. This column is not included in the Cambridge Plan as no CIs were located in an area identified as having a brushfire risk.

**Table 14. Relationship of Critical Infrastructure to Hazard Areas<sup>1</sup>**  
*(Partial list excluding critical public safety facilities)*

<b>ID</b>	<b>NAME</b>	<b>Type</b>	<b>Landslide Risk</b>	<b>FEMA Flood Zone</b>	<b>Locally-Identified Flood Area</b>	<b>Hurricane Surge Category</b>
2	Lesley University Washburn Hall	Lesley University Cafeteria	Low Susceptibility	No	No	0
3	Cambridge Montessori School	School Grades 1-7 (85 students)	Low Susceptibility	No	Bellis Circle	4
5	Cambridge Montessori School	School Grades Pre K-K (121 students)	Low Susceptibility	No	No	0
6	Buckingham Middle School	School Grades 7-8 (140 students)	Low Susceptibility	No	No	0
7	Buckingham Elementary School	School Grades K-6 (400 students)	Low Susceptibility	No	No	0
8	Cambridge Montessori School	School Grades Middle School Grade 8 (25 students)	Low Susceptibility	No	No	2
9	Buckingham Browne and Nichols High School	School Grades 9-12 (550 students)	Low Susceptibility	No	No	2
10	Saint Peter's Elementary School	School Grades K-8 (235 students)	Low Susceptibility	No	No	0
11	Porter Square MBTA Station	Transportation Facility	Low Susceptibility	No	No	High

<sup>1</sup> This brushfire risk column is not included in the Cambridge Plan as no CIs were located in an area identified as having a brushfire risk.

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*(Partial list excluding critical public safety facilities)*

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12	Mt Auburn Hospital Clark Building	Hospital	Low Susceptibility	No	No	0
16	Agassiz Community Center (91 children)	Day Care (Municipal)	Low Susceptibility	No	Agassiz Community	0
17	Vassal Lane Upper School	Municipal School Grades 6-8 (296 students)	Low Susceptibility	0.2 Pct Annual Chance Flood Hazard	Vassal Lane/Tobin School	2
18	Boston Archdiocesan Choir School	School Grades 4-8 (53 students)	Moderate Susceptibility	No	No	0
19	Tobin Montessori School	Municipal School Grades Pre K-5 (277 students)	Low Susceptibility	0.2 Pct Annual Chance Flood Hazard	Vassal Lane/Tobin School	2
20	CRLS Auto Shop	Municipal School Grades 9-12	Moderate Susceptibility	No	No	0
21	Cambridge Rindge and Latin High School (CRLS)	Municipal School Grades 9-12 (1700 students)	Moderate Susceptibility	No	No	0
24	Haggerty School	Municipal School Grades K-5 (242 students)	Low Susceptibility	No	Corcoran Way and May Street	0
25	Harvard University Cabot Hall, Cabot House	Harvard University Dining Hall	Low Susceptibility	No	No	0
26	Mt Auburn Hospital South Building	Hospital	Low Susceptibility	No	No	0

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27	Cambridge Water Dept	Municipal Emergency Operations Center (Primary)	Low Susceptibility	0.2 Pct Annual Chance Flood Hazard	No	2
28	Mt Auburn Hospital Stanton Bldg	Hospital	Low Susceptibility	No	No	0
29	Lesley University White Hall	Lesley University Cafeteria	Low Susceptibility	No	No	0
30	Graham and Parks Alternative School	Municipal School Grades K-5 (363 students)	Low Susceptibility	No	No	0
31	Cambridge Ellis School (86 children)	Day Care	Moderate Susceptibility	No	No	0
32	Mt Auburn Hospital Nuclear Medicine Bldg	Hospital	Low Susceptibility	No	No	0
33	Harvard Place (3 stories) (21 units)	Housing Elderly	Moderate Susceptibility	No	No	0
34	Mt Auburn Hospital Medical Office Building	Hospital	Low Susceptibility	No	No	0
35	45 Linnaean St (4 stories, 24 units)	Housing Elderly CHA	Low Susceptibility	No	No	0
36	Mt Auburn Hospital Needham Building	Hospital	Low Susceptibility	No	No	0
37	Children's Village (77 children)	Day Care	Low Susceptibility	0.2 Pct Annual Chance	Concord Avenue and Fern Street	1

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*(Partial list excluding critical public safety facilities)*

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				Flood Hazard		
38	Harvard Vanguard Medical Associates	Medical	Moderate Susceptibility	No	No	0
39	Cambridge Rehabilitation and Nursing Center	Medical	Moderate Susceptibility	No	No	0
40	Baldwin School	Municipal School Grades K-5 (321 students)	Low Susceptibility	No	Agassiz Community	0
41	Cambridge Cemetery Garage	Municipal	Low Susceptibility	No	Cambridge Cemetery	0
42	Cambridge Police Station Reporting for North/West Cambridge	Municipal	Low Susceptibility	0.2 Pct Annual Chance Flood Hazard	No	1
43	Dragonfly After School Program (39 children)	Day Care (Municipal)	Low Susceptibility	No	No	0
44	Cambridge Cemetery Fuel Pumps	Municipal	Low Susceptibility	No	Cambridge Cemetery	0
45	Cambridge Cemetery Office	Municipal	Low Susceptibility	No	Cambridge Cemetery	0
46	Radcliffe Child Care Center (60 children)	Day Care	Low Susceptibility	No	No	0
47	Sacramento Street	Day Care	Low	No	No	0

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	Preschool/Aggasiz Kindergarten Afterschool (39 children)		Susceptibility			
48	West Cambridge Recreation Youth Center	Municipal	Low Susceptibility	No	No	0
49	Evergreen Day School (64 children)	Day Care	Low Susceptibility	No	No	0
50	Fire Apparatus Repair Garage	Municipal	Low Susceptibility	0.2 Pct Annual Chance Flood Hazard	No	1
51	Fire Station Engine 9	Municipal	Low Susceptibility	No	No	0
52	Mt Auburn Hospital Wyman Building	Hospital	Low Susceptibility	No	No	0
53	Newtowne Parent Coop (65 children)	Day Care	Low Susceptibility	No	No	0
55	Harvard University Adams House	Harvard University Dining Hall	Low Susceptibility	No	No	0
56	Harvard University Botanic Children's Center (59 children)	Harvard University Daycare	Low Susceptibility	No	No	0
57	Fayerweather Street School	School Grades Pre K-8 (200 students)	Low Susceptibility	No	No	0

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58	Fire Station Engine 8	Municipal	Low Susceptibility	No	No	0
59	Harvard University Eliot House	Harvard University Dining Hall	Low Susceptibility	No	No	2
61	Cambridge Health Alliance Family Health - Teen Health Center	Medical	Moderate Susceptibility	No	No	0
62	Main Public Library	Municipal	Moderate Susceptibility	No	No	0
64	Harvard University Currier House	Harvard University Dining Hall	Low Susceptibility	No	No	0
65	Harvard University Harvard Yard Child Care Center (68 children)	Harvard University Daycare	Moderate Susceptibility	No	No	0
67	Harvard University Malkin Athletic Center	Harvard University Emergency Shelter	Low Susceptibility	No	No	0
68	Harvard University Kirkland House	Harvard University Dining Hall	Low Susceptibility	No	No	2
69	Sancta Maria Nursing Facility (150 patients)	Medical	Low Susceptibility	No	No	0
70	Harvard University	Harvard University Dining	Moderate	No	No	0

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	Mather House	Hall	Susceptibility			
71	Harvard University Memorial Hall	Harvard University Dining Hall	Low Susceptibility	No	No	0
72	Harvard University Oxford Street Daycare Co-op (40 children)	Harvard University Daycare	Moderate Susceptibility	No	No	0
73	Putnam Sq Apartments (11 stories, 94 units, 103 residents)	Housing Elderly	Moderate Susceptibility	No	No	0
75	Harvard University Leverett House	Harvard University Dining Hall	Low Susceptibility	No	No	2
76	Harvard University Quadrangle Athletic Center	Harvard University Emergency Shelter	Low Susceptibility	No	No	0
78	Harvard University Radcliffe Gymnasium	Harvard University Emergency Shelter	Low Susceptibility	No	No	0
79	Harvard University Rosovsky Hall	Harvard University Dining Hall	Low Susceptibility	No	No	2
80	Harvard University Holyoke Center	Harvard University Medical/Incident Support	Low Susceptibility	No	No	0

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		Team/Emergency Mgmt. Center				
82	Harvard University Radcliffe Child Care Centers, Inc.	Harvard University Daycare	Low Susceptibility	No	No	0
83	Bay State Pools	Hazardous Materials	Low Susceptibility	0.2 Pct Annual Chance Flood Hazard	No	1
85	Harvard University Massachusetts Hall	Harvard University Crisis Mgmt. Team/Emergency Mgmt. Center	Low Susceptibility	No	No	0
86	Harvard University Police Station	Harvard University Police Station	Moderate Susceptibility	No	No	0
87	Harvard University Dunster House	Harvard University Dining Hall	Moderate Susceptibility	No	No	2
88	Fire Station Engine 1	Municipal	Low Susceptibility	No	No	0
89	St Paul's Residence (4 floors, 21 units)	Housing CHA	Low Susceptibility	No	No	0
90	Harvard University Peabody Terrace Children's Center (83 children)	Harvard University Daycare	Moderate Susceptibility	No	No	2

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91	Cambridge Homes Assisted Living (4 stories, 44 units)	Medical	Low Susceptibility	No	No	0
92	Neville Place Assisted Living (73 patients)	Medical	Low Susceptibility	0.2 Pct Annual Chance Flood Hazard	No	2
96	Harvard University Pound Hall	Harvard University Medical	Low Susceptibility	No	No	0
97	Neville Center at Fresh Pond (112 patients)	Medical	Low Susceptibility	0.2 Pct Annual Chance Flood Hazard	No	4
98	Professional Ambulance Co.	Ambulance Company	Low Susceptibility	0.2 Pct Annual Chance Flood Hazard	No	1
99	Shady Hill School	School Grades Pre K-8 (520 students)	Low Susceptibility	No	No	0
100	Cambridgeport Children's Center - Tot Lot (35 children)	Day Care	Moderate Susceptibility	No	No	0
101	Cambridge Community Center (117 children)	Day Care	Moderate Susceptibility	No	No	2

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102	Fresh Pond Golf Course Maintenance Building	Hazardous Materials (Municipal)	Low Susceptibility	No	No	0
104	Margaret Fuller House (48 children)	Day Care	Moderate Susceptibility	No	Harvard Street (Canard) and Hancock Street	2
105	Technology Children's Center (82 children)	Day Care	Moderate Susceptibility	No	No	2
107	Dr. Martin Luther King Preschool (34 children)	Day Care (Municipal)	Moderate Susceptibility	No	No	0
108	Cambridge Hospital (Birthing Center)	Hospital	Moderate Susceptibility	No	No	0
109	Cambridge Hospital (Macht Building)	Hospital	Moderate Susceptibility	No	No	0
110	CAAS Head Start - Frisoli Center (39 children)	Day Care (Municipal)	Moderate Susceptibility	No	No	2
111	Cambridge Hospital (Office)	Hospital	Moderate Susceptibility	No	No	0
112	Harvard University Wasserstein Hall	Harvard University Emergency Shelter	Low Susceptibility	No	No	0
113	Johnson Apts (12 stories, 180 units)	Housing Elderly CHA	Moderate Susceptibility	No	No	0

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114	Kennedy Apts (8 stories, 69 units)	Housing Elderly CHA	Moderate Susceptibility	No	No	4
115	Malik Academy / Al Bustan Preschool (52 children)	Day Care	Moderate Susceptibility	No	No	2
116	Roosevelt Towers midrise (8 floors, 75 units)	Housing Elderly CHA	Moderate Susceptibility	No	No	4
117	Manning Apts (19 stories, 199 units)	Housing Elderly CHA	Moderate Susceptibility	No	No	0
118	Cambridge Family YMCA - A Child's Place (82 children)	Day Care	Moderate Susceptibility	No	No	0
119	Cambridge Health Alliance Family Health - Windsor St	Medical	Moderate Susceptibility	No	Harvard Street (Canard) and Hancock Street	2
120	Cambridge Health Alliance Family Health - Inman Square	Medical	Moderate Susceptibility	No	No	0
121	Multi-Service/Community Learning Center	Human Services	Moderate Susceptibility	No	No	2
122	Cambridge Health Alliance Administration Offices	Medical	Moderate Susceptibility	No	Harvard Street (Canard) and Hancock Street	2

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*(Partial list excluding critical public safety facilities)*

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123	Cambridge Hospital (Main Building)	Hospital	Moderate Susceptibility	No	No	0
124	Cambridge Hospital (Cahill Building)	Hospital	Moderate Susceptibility	No	No	0
126	Spaulding Rehabilitation Hospital	Medical	Moderate Susceptibility	No	No	0
127	Our Place - Salvation Army (46 children)	Day Care	Moderate Susceptibility	No	No	2
128	MIT Johnson Athletic Center (W34)	MIT Athletic Center	Moderate Susceptibility	No	No	2
129	Pine Village Preschool (43 children)	Day Care	Low Susceptibility	No	No	0
130	Youville Assisted Living (8 Floors, 95 Apts)	Medical	Moderate Susceptibility	No	No	0
132	MIT Rockwell Cage (W33)	MIT Athletic Facility	Moderate Susceptibility	No	No	2
133	MIT EHS and SEMO Office (N52)	MIT Public Safety	Moderate Susceptibility	No	No	2
134	MIT Zesiger Sports and Fitness (W35)	MIT Athletic Facility	Moderate Susceptibility	No	No	2
135	MIT Police Station (W89)	MIT Public Safety	Moderate Susceptibility	No	No	4
136	MIT Stata Center (32)	MIT Cafeteria	Moderate Susceptibility	No	No	2

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137	Cambridge Senior Center	Medical	Moderate Susceptibility	No	No	0
138	City Hall (Coffon Building)	Municipal	Moderate Susceptibility	No	No	0
139	MIT Koch Building (76)	MIT Cafeteria	Moderate Susceptibility	No	No	2
140	DPW Administration Building	Municipal	Moderate Susceptibility	No	No	2
141	City Hall Annex	Municipal	Moderate Susceptibility	No	No	0
142	DPW Fuel Pumps	Municipal	Moderate Susceptibility	No	No	2
143	DPW Carpentry Shop	Municipal	Moderate Susceptibility	No	No	2
144	DPW Main Garage	Municipal	Moderate Susceptibility	No	No	2
145	Fire Station Engine 6	Municipal	Moderate Susceptibility	No	No	0
146	DPW Emergency Operations Center	Municipal Emergency Operations Center (Back-up)	Moderate Susceptibility	No	No	2
147	MIT Kresge Auditorium (W16)	MIT Assembly Area	Moderate Susceptibility	No	No	2
148	Frisoli Youth Recreation Center	Municipal	Moderate Susceptibility	No	No	2
149	MIT Stratton Student Center (W20)	MIT Student Activity	Moderate Susceptibility	No	No	2

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		Center/Cafeteria				
150	Moore Youth recreation Center	Municipal	Moderate Susceptibility	No	No	2
151	Fire Station Engine 5	Municipal	Moderate Susceptibility	No	No	0
152	Area IV Youth Recreation Center	Municipal	Moderate Susceptibility	No	No	0
153	Cambridgeport School	Municipal School Grades Pre K-5 (300 students)	Moderate Susceptibility	No	No	2
154	Future site of Cambridge Housing Authority, Community Learning Center and Multi-Service Center	Municipal	Moderate Susceptibility	No	No	0
155	Central Square Multi-Level Above Ground Parking Garage	Municipal	Moderate Susceptibility	No	No	0
156	City Hall (Lombardi Building)	Municipal	Moderate Susceptibility	No	No	0
157	Morse School	Municipal School Grades K-5 (students)	Moderate Susceptibility	No	No	2
158	Fire Station Engine 2	Municipal	Moderate Susceptibility	No	No	2
159	Fletcher-Maynard Academy	Municipal School Grades K-5	Moderate Susceptibility	No	Harvard Street	2

**Table 14. Relationship of Critical Infrastructure to Hazard Areas<sup>1</sup>**  
*(Partial list excluding critical public safety facilities)*

<b>ID</b>	<b>NAME</b>	<b>Type</b>	<b>Landslide Risk</b>	<b>FEMA Flood Zone</b>	<b>Locally-Identified Flood Area</b>	<b>Hurricane Surge Category</b>
		(222 students)			(Canard) and Hancock Street	
160	City Hall (Primary)	Municipal	Moderate Susceptibility	No	No	0
161	Dr. Martin Luther King Jr. School (Presently under construction)	Municipal School Grades 6-8	Moderate Susceptibility	No	No	0
162	Amigos School	Municipal School Grades K-8 (335 students)	Moderate Susceptibility	No	No	0
163	King-Open School	Municipal School Grades K-5 (350 students)	Moderate Susceptibility	No	No	2
164	(CRLS) High School Extension Program	Municipal School Grades 9-12 (60 students)	Moderate Susceptibility	No	No	0
165	Dr Martin Luther King, Jr. School (Presently under construction)	Municipal School Grades Pre K-5	Moderate Susceptibility	No	No	0
166	Prospect Hill Academy High School	School Grades 9-12 (300 students)	Moderate Susceptibility	No	No	4
167	Prospect Hill Academy Middle School	School Grades 7-8 (200 students)	Moderate Susceptibility	No	No	4
168	Dr Martin Luther	Municipal School Grades K-5	Moderate	No	No	0

**Table 14. Relationship of Critical Infrastructure to Hazard Areas<sup>1</sup>**  
*(Partial list excluding critical public safety facilities)*

<b>ID</b>	<b>NAME</b>	<b>Type</b>	<b>Landslide Risk</b>	<b>FEMA Flood Zone</b>	<b>Locally-Identified Flood Area</b>	<b>Hurricane Surge Category</b>
	King. Jr School	(250 students)	Susceptibility			
169	Henry Buckner School	School Grades Pre K-1 (70 students)	Moderate Susceptibility	No	No	0
170	Cambridge YWCA (105 residents)	Shelter (Transitional)	Moderate Susceptibility	No	No	0
171	240 Albany St Shelter (107 residents)	Shelter (Homeless)	Moderate Susceptibility	No	No	2
173	Farr Academy	School Grades 7-12 (27 students)	Moderate Susceptibility	No	No	0
176	Afterworks (39 children)	Day Care	Moderate Susceptibility	No	No	0
177	Alef-Bet Child Care Center (40 children)	Day Care	Moderate Susceptibility	No	No	0
179	Bright Horizons Children's Center-OKS (97 children)	Day Care	Moderate Susceptibility	No	No	2
180	Area IV Youth Center (52 children)	Day Care (Municipal)	Moderate Susceptibility	No	No	0
182	Cambridge Street Upper School	Municipal School Grades 6-8 (280 students)	Moderate Susceptibility	No	No	2
183	Benjamin Banneker School	School K-6 (350 students)	Low Susceptibility	No	No	0
184	Bright Horizons Children's Center @ University Park (61	Day Care	Moderate Susceptibility	No	Area 4	2

**Table 14. Relationship of Critical Infrastructure to Hazard Areas<sup>1</sup>**  
*(Partial list excluding critical public safety facilities)*

<b>ID</b>	<b>NAME</b>	<b>Type</b>	<b>Landslide Risk</b>	<b>FEMA Flood Zone</b>	<b>Locally-Identified Flood Area</b>	<b>Hurricane Surge Category</b>
	children)					
186	Associated Early Care and Education/Children's of Cambridge (68 children)	Day Care (Municipal)	Moderate Susceptibility	No	No	0
187	CAAS Head Start - Windsor Center (38 children)	Day Care	Moderate Susceptibility	No	Harvard Street (Canard) and Hancock Street	2
189	Cambridge Nursery School (30 children)	Day Care	Low Susceptibility	No	No	0
190	Cambridge YMCA (128 residents)	Shelter (Transitional)	Moderate Susceptibility	No	No	0
191	CAPI (39 children)	Day Care (Municipal)	Moderate Susceptibility	No	No	2
192	Cambridge Health Alliance Family Health - Porter Square	Medical	Low Susceptibility	No	No	0
193	Salvation Army (200 residents)	Shelter (Homeless)	Moderate Susceptibility	No	No	2
194	North Cambridge Senior Center	Medical	Low Susceptibility	No	No	0
195	International School of Boston	School Grades 1-12 (425 students)	Low Susceptibility	No	No	0
196	Matignon High	School Grades 9-	Low	No	No	0

**Table 14. Relationship of Critical Infrastructure to Hazard Areas<sup>1</sup>**  
*(Partial list excluding critical public safety facilities)*

<b>ID</b>	<b>NAME</b>	<b>Type</b>	<b>Landslide Risk</b>	<b>FEMA Flood Zone</b>	<b>Locally-Identified Flood Area</b>	<b>Hurricane Surge Category</b>
	School	12 (461 students)	Susceptibility			
197	Burns Apartments (6 stories, 198 units)	Housing Elderly CHA	Low Susceptibility	No	No	2
198	DPW Snow Salt Storage Shed	Municipal	Low Susceptibility	No	No	2
199	Weaver Apts (3 floors, 20 units)	Housing CHA	Low Susceptibility	0.2 Pct Annual Chance Flood Hazard	No	2
200	Peabody School	Municipal School Grades K-5 (312 students)	Low Susceptibility	No	No	0
201	Cadbury Commons Assisted Living (3 stories, 74 units)	Medical	Low Susceptibility	No	No	4
203	Sunrise Learning Academy (98 children)	Day Care	Low Susceptibility	AE	No	1
204	Cambridge Friends School	School Grades K-8 (200 students)	Low Susceptibility	No	No	0
205	Rindge Ave Upper School	Municipal School Grades 6-8 (300 students)	Low Susceptibility	No	No	0
206	Aggasiz Preschool, Inc. (47 children)	Day Care	Low Susceptibility	No	No	0
207	Fire Station Engine 4	Municipal	Low Susceptibility	No	No	0

**Table 14. Relationship of Critical Infrastructure to Hazard Areas<sup>1</sup>**  
*(Partial list excluding critical public safety facilities)*

<b>ID</b>	<b>NAME</b>	<b>Type</b>	<b>Landslide Risk</b>	<b>FEMA Flood Zone</b>	<b>Locally-Identified Flood Area</b>	<b>Hurricane Surge Category</b>
208	North Cambridge Children's Center (50 children)	Day Care	Low Susceptibility	No	No	2
210	Head Start / Jefferson Park (36 children)	Day Care	Low Susceptibility	No	No	0
216	Gately Youth Recreation Center	Municipal	Low Susceptibility	No	No	0
218	Community Charter School of Cambridge	School Grades 7-12 (370 students)	Moderate Susceptibility	No	East Cambridge	2
219	Russell Apts (6 floors, 51 units)	Housing Elderly CHA	Low Susceptibility	No	No	0
220	Putnam School (5 stories, 36 units)	Housing Elderly CHA	Moderate Susceptibility	No	East Cambridge	0
221	Millers River Apts (19 stories, 301 units)	Housing Elderly CHA	Moderate Susceptibility	No	No	2
223	Truman Apts (8 floors, 60 units)	Housing Elderly CHA	Moderate Susceptibility	No	East Cambridge	2
224	East End House Inc. (106 students)	Day Care	Moderate Susceptibility	No	East Cambridge	0
225	Kennedy-Longfellow School	Municipal School Grades K-5 (300 students)	Moderate Susceptibility	No	East Cambridge	2
226	Public School Administration Building	Municipal	Moderate Susceptibility	No	East Cambridge	0

**Table 14. Relationship of Critical Infrastructure to Hazard Areas<sup>1</sup>**  
*(Partial list excluding critical public safety facilities)*

<b>ID</b>	<b>NAME</b>	<b>Type</b>	<b>Landslide Risk</b>	<b>FEMA Flood Zone</b>	<b>Locally-Identified Flood Area</b>	<b>Hurricane Surge Category</b>
227	East Cambridge Multi-Level Above Ground Parking Garage	Municipal	Moderate Susceptibility	No	East Cambridge	1
228	Middlesex County Jail	Corrections	Moderate Susceptibility	No	East Cambridge	0
229	Two Little Owls School House (42 children)	Day Care	Moderate Susceptibility	No	East Cambridge	0
230	Putnam Ave Upper School	Municipal School Grades 6-8 (259 students)	Moderate Susceptibility	No	East Cambridge	2
231	Frisoli Youth Center (65 children)	Day Care (Municipal)	Moderate Susceptibility	No	No	2
233	Emergency Communications Center	Municipal Emergency Operations Center (Back-up)	Moderate Susceptibility	No	East Cambridge	2
234	Cambridge Health Alliance Family Health - East Cambridge	Medical	Moderate Susceptibility	No	No	0
235	Fire Station Engine 3	Municipal	Moderate Susceptibility	No	East Cambridge	0
236	Technology Children's Center - Eastgate(43 children)	Day Care	Moderate Susceptibility	No	No	2
237	MIT Medical (E23)	MIT Medical	Moderate	No	No	2

**Table 14. Relationship of Critical Infrastructure to Hazard Areas<sup>1</sup>**  
*(Partial list excluding critical public safety facilities)*

<b>ID</b>	<b>NAME</b>	<b>Type</b>	<b>Landslide Risk</b>	<b>FEMA Flood Zone</b>	<b>Locally-Identified Flood Area</b>	<b>Hurricane Surge Category</b>
		Facility	Susceptibility			
238	Gen On Energy	Hazardous Materials	Moderate Susceptibility	No	No	2
239	Bright Horizons @ One Rogers Street (62 children)	Day Care	Moderate Susceptibility	No	East Cambridge	2
241	MIT Sloan School (E62)	MIT Cafeteria	Moderate Susceptibility	No	No	2
242	Cambridge Police Vehicle Maintenance Garage	Municipal	Low Susceptibility	0.2 Pct Annual Chance Flood Hazard	Alewife Watershed	2
243	Cambridge Police Headquarters	Municipal	Moderate Susceptibility	No	East Cambridge	2
245	TSC Tot Child Care Center (56 children)	Day Care	Moderate Susceptibility	No	No	2
246	MIT Facilities Operations/Repair and Maintenance (E19)	MIT Facilities/Grounds	Moderate Susceptibility	No	No	2
247	116 Norfolk St (5 stories, 37 units)	Housing Elderly CHA	Moderate Susceptibility	No	No	0
259	Alewife MBTA Station	Transportation Facility	Low Susceptibility	0.2 Pct Annual Chance Flood Hazard	Alewife Watershed	High
260	Harvard Square MBTA Station	Transportation Facility	Low Susceptibility	No	Harvard Square	High

**Table 14. Relationship of Critical Infrastructure to Hazard Areas<sup>1</sup>**  
*(Partial list excluding critical public safety facilities)*

<b>ID</b>	<b>NAME</b>	<b>Type</b>	<b>Landslide Risk</b>	<b>FEMA Flood Zone</b>	<b>Locally-Identified Flood Area</b>	<b>Hurricane Surge Category</b>
261	Central Square MBTA Station	Transportation Facility	Moderate Susceptability	No	No	Low
262	Kendall Square MBTA Station	Transportation Facility	Moderate Susceptability	No	No	Low
263	Lechemere MBTA Station	Transportation Facility	Moderate Susceptability	No	East Cambridge	Low

### Damage Assessments

An estimation of damages was performed for hurricanes, earthquakes, and flooding. The methodology used for hurricanes and earthquakes was the HAZUS-MH software. The methodology for flooding was developed specifically to address the issue in many of the communities where flooding was not solely related to location within a floodplain.

#### *Introduction to HAZUS-MH*

HAZUS- MH (multiple-hazards) is a computer program developed by FEMA to estimate losses due to a variety of natural hazards. The following overview of HAZUS-MH is taken from the FEMA website. For more information on the HAZUS-MH software, go to <http://www.fema.gov/plan/prevent/hazus/index.shtm>

“HAZUS-MH is a nationally applicable standardized methodology and software program that contains models for estimating potential losses from earthquakes, floods, and hurricane winds. HAZUS-MH was developed by the Federal Emergency Management Agency (FEMA) under contract with the National Institute of Building Sciences (NIBS). Loss estimates produced by HAZUS-MH are based on current scientific and engineering knowledge of the effects of hurricane winds, floods, and earthquakes. Estimating losses is essential to decision-making at all levels of government, providing a basis for developing and evaluating mitigation plans and policies as well as emergency preparedness, response and recovery planning.

HAZUS-MH uses state-of-the-art geographic information system (GIS) software to map and display hazard data and the results of damage and economic loss estimates for buildings and infrastructure. It also allows users to estimate the impacts of hurricane winds, floods, and earthquakes on populations.”

There are three modules included with the HAZUS-MH software: hurricane wind, flooding, and earthquakes. There are also three levels at which HAZUS-MH can be run. Level 1 uses national baseline data and is the quickest way to begin the risk assessment process. The analysis that follows was completed using Level 1 data.

Level 1 relies upon default data on building types, utilities, transportation, etc. from national databases as well as census data. While the databases include a wealth of information on the City of Cambridge, it does not capture all relevant information. In fact, the HAZUS training manual notes that the default data is “subject to a great deal of uncertainty.”

However, for the purposes of this plan, the analysis is useful. This plan is attempting to only generally indicate the possible extent of damages due to certain types of natural disasters and to allow for a comparison between different types of disasters. Therefore, this analysis should be considered to be a starting point for understanding potential

damages from the hazards. If interested, communities can build a more accurate database and further test disaster scenarios.

#### *Estimated Damages from Hurricanes*

The HAZUS software was used to model potential damages to the community from a 100 year and 500 year hurricane event; storms that are .01% and .005% likely to happen in a given year and roughly equivalent to a Category 2 and Category 4 hurricane. The damages caused by these hypothetical storms were modeled as if the storm track passed directly through the City, bringing the strongest winds and greatest damage potential.

Though there are no recorded instances of a hurricane equivalent to a 500 year storm passing through Massachusetts, this model was included. The model was used in order to present a reasonable “worst case scenario” that would help planners and emergency personnel evaluate the impacts of storms that might be more likely in the future, as we enter into a period of more intense and frequent storms.

**Table 15. Estimated Damages from Hurricanes**

	<b>100 Year</b>	<b>500 Year</b>
<b>Building Characteristics</b>		
Estimated total number of buildings	18,571	18,571
Estimated total building replacement value (Year 2006 \$) (Millions of Dollars)	10,659	10,659
<b>Building Damages</b>		
# of buildings sustaining minor damage	2,081	5,799
# of buildings sustaining moderate damage	591	3,727
# of buildings sustaining severe damage	24	494
# of buildings destroyed	2	76
<b>Population Needs</b>		
# of households displaced	380	2,626
# of people seeking public shelter	96	668
<b>Debris</b>		
Building debris generated (tons)	23,151.57	93,204.9
Tree debris generated (tons)	3,459.43	10,356.1
# of truckloads to clear building debris	922	3750
<b>Value of Damages (Thousands of dollars)</b>		
Total property damage	127,495.59	789,150.28
Total losses due to business interruption	20,149.60	124,429.45

*Estimated Damages from Earthquakes*

The HAZUS earthquake module allows users to define an earthquake magnitude and model the potential damages caused by that earthquake as if its epicenter had been at the geographic center of the study area. For the purposes of this plan, two earthquakes were selected: magnitude 5.0 and a magnitude 7.0. Historically, major earthquakes are rare in New England, though a magnitude 5 event occurred in 1963.

**Table 16. Estimated Damages from Earthquakes**

	<b>Magnitude 5.0</b>	<b>Magnitude 7.0</b>
<b>Building Characteristics</b>		
Estimated total number of buildings	18,571	18,571
Estimated total building replacement value (Year 2006 \$)(Millions of dollars)	10,659	10,659
<b>Building Damages</b>		
# of buildings sustaining slight damage	3,029	1,266
# of buildings sustaining moderate damage	1,202	4,762
# of buildings sustaining extensive damage	231	4,998
# of buildings completely damaged	32	7,376
<b>Population Needs</b>		
# of households displaced	581	24,877
# of people seeking public shelter	355	15,259
<b>Debris</b>		
Building debris generated (tons)	0.100 million	3.350 million
# of truckloads to clear building debris	4,120	134,080
<b>Value of Damages (Millions of dollars)</b>		
Total property damage	597.09	8,864.99
Total losses due to business interruption	69.76	1,835.89

*Estimated Damages from Flooding*

MAPC did not use HAZUS-MH to estimate flood damages in Cambridge. In addition to technical difficulties with the software, the riverine module is not a reliable indicator of flooding in areas where inadequate drainage systems contribute to flooding even when

those structures are not within a mapped flood zone. In lieu of using HAZUS, MAPC developed a methodology to give a rough approximation of flood damages.

Cambridge is 7.13 square miles or 4,563.2 acres. Approximately 774 acres have been identified by local officials as areas of flooding. This amounts to 17% of the land area in the City. The number of structures in each flood area was estimated by applying the percentage of the total land area to the number of structures (18,571) in Cambridge; the same number of structures used by HAZUS for the hurricane and earthquake calculations. HAZUS uses a value of approximately \$573,959 per structure for the building replacement value. This was used to calculate the total building replacement value in each of the flood areas. The calculations were done for a low estimate of 10% building damages and a high estimate of 50% as suggested in the FEMA September 2002 publication, "State and Local Mitigation Planning how-to guides" (Page 4-13). The range of estimates for flood damages is \$181,453,055 (*low*) - \$907,265,277 (*high*). These calculations are not based solely on location within the floodplain or a particular type of storm (i.e. 100 year flood).

**Table 17. Estimated Damages from Flooding**

<b>ID</b>	<b>Flood Hazard Area</b>	<b>Approximate Area (acres)</b>	<b>% of Total Land Area</b>	<b>Estimated Number of Structures</b>	<b>Replacement Value</b>	<b>Low Estimate of Damages</b>	<b>High Estimate of Damages</b>
1a	Fresh Pond Reservation	8.88	0.20	36	\$20,816,846	\$2,081,685	\$10,408,423
1b	Fresh Pond Reservation	4.87	0.11	20	\$11,419,095	\$1,141,909	\$5,709,547
1c	Fresh Pond Reservation	13.79	0.30	56	\$32,316,602	\$3,231,660	\$16,158,301
2	Alewife Watershed	214.38	4.71	876	\$502,547,029	\$50,254,703	\$251,273,514
3	New Street	11.76	0.26	48	\$27,557,844	\$2,755,784	\$13,778,922
4	Bellis Circle	11.21	0.25	46	\$26,282,433	\$2,628,243	\$13,141,216
5	Vassal Lane/Tobin School	13.77	0.30	56	\$32,271,738	\$3,227,174	\$16,135,869
6	Concord Avenue and Fern Street	9.10	0.20	37	\$21,323,388	\$2,132,339	\$10,661,694
7	Porter Square at Somerville Ave	18.17	0.40	74	\$42,600,623	\$4,260,062	\$21,300,311
8	Harvard Square	9.07	0.20	37	\$21,261,157	\$2,126,116	\$10,630,578
9	Cambridge Cemetery	75.23	1.65	307	\$176,357,120	\$17,635,712	\$88,178,560
10	Agassiz Community	28.78	0.63	118	\$67,470,821	\$6,747,082	\$33,735,411
11	Myrtle Street and Magnolia Avenue	15.06	0.33	62	\$35,302,312	\$3,530,231	\$17,651,156

**Table 17. Estimated Damages from Flooding**

<b>ID</b>	<b>Flood Hazard Area</b>	<b>Approximate Area (acres)</b>	<b>% of Total Land Area</b>	<b>Estimated Number of Structures</b>	<b>Replacement Value</b>	<b>Low Estimate of Damages</b>	<b>High Estimate of Damages</b>
12	Cambridge Highlands	21.70	0.48	89	\$50,861,058	\$5,086,106	\$25,430,529
13	Area 4	22.67	0.50	93	\$53,139,519	\$5,313,952	\$26,569,760
14	Hancock Street and Kinnaird Street	9.17	0.20	37	\$21,498,417	\$2,149,842	\$10,749,208
15	Green Street at Kennedy Biscuit Lofts	6.84	0.15	28	\$16,030,635	\$1,603,063	\$8,015,317
16	Cardinal Medeiros Ave	20.12	0.44	82	\$47,174,906	\$4,717,491	\$23,587,453
17	East Cambridge	240.36	5.29	982	\$563,448,543	\$56,344,854	\$281,724,272
18	Corcoran Way and May Street	19.13	0.42	78	\$44,850,469	\$4,485,047	\$22,425,235
<i>Totals</i>			<i>17.02</i>	<i>3161</i>	<i>\$1,814,530,554</i>	<i>\$181,453,055</i>	<i>\$907,265,277</i>

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### V. HAZARD MITIGATION GOALS

The Cambridge Hazard Mitigation Plan Steering Committee met on June 12, 2013. At that meeting, the team reviewed and discussed the goals from the 2008 Hazard Mitigation Plan for the City of Cambridge. After some discussion, the existing goals were updated to reflect the City's objectives with regard to addressing hazard mitigation in the community.

The following 7 goals, with supporting objectives, were endorsed by the Committee for the 2014 update of the Cambridge Hazard Mitigation Plan:

1. Goal: Protect the health and safety of the public.
  - *Encourage people to be prepared before, during and after a hazard event.*
  - *Identify at-risk populations and keep up to date list of locations*
  - *Ensure that services related to public health can function during and after a hazard, e.g., sanitation, water, debris removal, hospitals, and emergency services.*
  - *Ensure that evacuation can happen in an organized and efficient manner.*
  - *Minimize secondary impacts from hazards, such as the release of pollutants.*
2. Goal: Protect existing properties and structures.
  - *Provide resources for residents and businesses to make their buildings and properties more disaster resistant.*
  - *Educate the public on measures they can take to protect their property.*
  - *Maintain existing mitigation structures.*
  - *Ensure that future development / redevelopment does not make existing properties more vulnerable to hazards.*
  - *Ensure that critical facilities are protected from hazards.*
  - *Complete separation of combined sewers*
3. Goal: Ensure that essential services can function during and after a hazard event.
  - *Ensure that critical infrastructure is protected from natural hazards.*
  - *Ensure that people (key service providers and employees) can get into the city to provide services.*
  - *Build resiliency into the system for faster recovery, e.g., electricity distribution system.*
4. Goal: Avoid chaos and confusion with good communication.

- *Have an effective communication plan.*
  - *Perform outreach to non-English speakers and other vulnerable populations before, during and after hazard events*
  - *Coordinate efforts with the private sector and institutions and with neighboring communities.*
5. Goal: Work regionally to mitigate impacts from natural hazards and to respond and recover from hazard events.
- *Continue to participate in regional efforts.*
  - *Cooperate with other agencies, communities, and private entities.*
  - *Understand priorities and capabilities of other entities to allow for resource-sharing, mutual aid, and entering into memoranda of understanding (MOU).*
6. Goal: Determine priorities for directing resources for hazard mitigation and response.
- *Prioritize mitigation projects.*
  - *Continue to program mitigation projects in the 5 and 10 year CIP.*
  - *Pursue various funding sources.*
  - *Encourage private property-owners to implement measures to protect their own property.*
7. Protect natural resources
- *Identify mitigation strategies that preserve or restore the function of natural systems.*
  - *Protect indigenous wetland areas, undeveloped floodplains and other natural features that provide mitigation of natural hazards.*
  - *Introduce green infrastructure elements, where possible, to reduce impervious surfaces and introduce natural systems.*
8. Create capacity to monitor existing changes
- *Identify and understand how climate change may alter where and how the City is vulnerable to natural hazards.*
  - *Review and update current mitigation activities to anticipate future changes in vulnerabilities.*
  - *Review and update current emergency preparedness and response activities to anticipate future changes in vulnerabilities.*

## **VI. HAZARD MITIGATION STRATEGY**

The central component of a hazard mitigation plan is the strategy for reducing the community's vulnerabilities to natural hazard events. Responding to the analysis of risk, vulnerabilities, potential impacts, and anticipated future development, the process for developing this strategy is one of setting goals, understanding what actions the community is already taking that contribute to mitigating the effects of natural hazards and assessing where more action is needed to complement or modify existing measures. The following sections include descriptions of existing mitigation measures, a status update on mitigation measures identified in previous plans, and descriptions of proposed new mitigation measures. All mitigation measures are evaluated by their benefits and potential costs to arrive at a prioritized list of action items.

### **WHAT IS HAZARD MITIGATION?**

Hazard mitigation means to permanently reduce or alleviate the losses of life, injuries, and property resulting from natural hazards through long-term strategies. These long-term strategies include planning, policy changes, education programs, infrastructure projects, and other activities. FEMA currently has three mitigation grant programs: the Hazards Mitigation Grant Program (HGMP), the Pre-Disaster Mitigation program (PDM), and the Flood Mitigation Assistance (FMA) program. The three links below provide additional information on these programs.

<http://www.fema.gov/government/grant/hmmp/index.shtm>

<http://www.fema.gov/government/grant/pdm/index.shtm>

<http://www.fema.gov/government/grant/fma/index.shtm>

Hazard Mitigation Measures can generally be sorted into the following groups:

- **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.

(Source: FEMA Local Multi-Hazard Mitigation Planning Guidance)

## **EXISTING MITIGATION MEASURES**

### **Existing Multi-Hazard Mitigation Measures**

*City Of Cambridge Emergency Preparedness* - Includes the City performing as an emergency preparedness entity and preparation of comprehensive emergency management plan (CEMP) in both hard copy and electronic versions. The City leads the Local Emergency Planning Committee (LEPC), which is comprised of city officials, private sector representatives, and college and university representatives.

The city uses a reverse 911 flexible communications systems to send alerts and other communications related to emergency preparedness and response. The city also maintains an emergency management website to provide the public with information and resources related to emergency preparedness and response.

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

*City of Cambridge Fire Department (CFD)* – The CFD Hazmat Unit that is continuously trained to respond to and manage hazmat incidents. Fire Department also responds to all threats and hazards (e.g. fire, explosions, chemical spills, CBRNE incidents).

*City of Cambridge Public Health Department (CPHD)* – The CPHD works with other local and regional agencies to enhance public preparedness to major hazards. CPHD operates a Medical Reserve Corps, serve as co-lead (with CFD) in response to biological threats, coordinates the regional public health preparedness region (4B), and participates in citywide tabletop exercises.

*Massachusetts Institute of Technology (MIT) Emergency Preparedness* - Includes MIT acting as an emergency preparedness entity and includes: testing and analyzing various disaster scenarios, performing exercises to improve disaster response and a full-time emergency coordinator that is a liaison to city.

*Harvard University Emergency Preparedness* - Includes the University acting as an emergency preparedness entity and administering an incident management committee, trainings, and individual plans for specific events.

### **Existing Flood Hazard Mitigation Measures**

*Catch basin cleaning, maintenance and repairs* - Catch basins are normally cleaned on the same day street sweeping occurs on a particular street. Crews typically clean over 50% of catch basins per year in the city. The city responds to requests to clean basins during storms; typically those requests are for a basin already on a repair list or a basin with a lateral connection defect. There are approximately 4,300 catch basins in Cambridge.

*Street cleaning and litter pick-up* -The Street Cleaning Division is responsible for maintaining clean public ways through a contractual street sweeping operation (currently Millennium Sweeping Services) which runs from April through December each year. Cleaning through the end of December ensures the cleanliness of Cambridge streets through the early winter months. Vacuum sweeping occurs in combination with mechanical street sweeping.

One contractor with two sweepers is used to clean both residential streets and major city squares. In the major squares (e.g., Harvard, Porter, Central, etc.) cleaning occurs 7 days a week. City also maintains Fresh Pond Parkway, which is a DCR facility.

*Zoning: Flood Plain Overlay District, Article 19 review, & Permeable Open Space Requirements* - This district applies to the 100 year flood plain and requires a special permit from the Planning Board for any structure or building that is constructed, expanded, etc., or for dumping, filling, excavation, etc., within the flood plain.

Two sections (Articles 5.22 and 19) require a minimum amount of permeable open space. Between these two provisions, this requirement applies to virtually all new development, except non-residential development below 25,000 square feet in size. Zoning in the City is administered by the Community Development Department (CDD).

*Development Runoff Controls* – The City requires that developments store the difference in volume between 2 year 24 hour storm event pre-development runoff & post-development 25 year 24 hour storm event runoff hydrograph through its stormwater policy.

*Capital Infrastructure Programming* – The City develops and maintains 5- and 10-year capital infrastructure program objectives for municipal storm sewer infrastructure.

*Massachusetts Water Resources Authority (MWRA) Review* - The MWRA reviews large developments (through State MEPA process) to reduce potential impacts, including system flooding

*Public education: Floodplain Information* – The City holds meetings and develops brochures to provide the public with information about flood hazard maps and related resources.

*Storm Sewer and Drainage Infrastructure Regular Maintenance* – The City performs remedial reconstruction of storm sewer and drainage infrastructure, a cleaning program for combined sewer overflows (CSOs) and televised reviews to check on physical condition of structures.

*Mapping of Catch Basins and Outfalls: Cambridge-* Cambridge uses GPS to map its catch basins and stormwater outfalls.

*Mapping of Catch Basins and Outfalls: Division of Conservation and Recreation (DCR)* - DCR uses GPS to map its catch basins and stormwater outfalls.

*Regular Catch Basin Cleaning and Street Sweeping: DCR* -DCR performs catch basin cleaning and street sweeping for DCR property and roadways in Cambridge, with the exception of Fresh Pond Parkway

*Cambridge Water Department (CWD) activities in water supply watershed communities* - The CWD reviews proposed development projects in watershed communities; visits construction sites and meets with developers; and with USGS jointly collects technical information, including real-time stream information; and review/repair to hurricane gates.

*Participation in the National Flood Insurance Program* - FEMA maintains a database on flood insurance policies and claims. This database can be found on the FEMA website at <http://www.fema.gov/business/nfip/statistics/pcstat.shtm>. The reporting period covers January 1, 1978 through June 30, 2013. The following information is provided for the City of Cambridge.

Flood insurance policies in force (as of October 31, 2013)	255
Coverage amount of flood insurance policies	\$72,308,800
Premiums paid	\$246,941
Total losses (all losses submitted regardless of the status)	53
Closed losses (Losses that have been paid)	36
Open losses (Losses that have not been paid in full)	2
CWOP losses ( Losses that have been closed without payment)	15

Total payments (Total amount paid on losses)	\$1,932,973.59
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**Existing Dam Hazard Mitigation Measures**

*Dam Inspections* - Dams are inspected every 2 years by CWD staff. The CWD staff are also trained to anticipate large storms so that control gates can release water appropriately.

*Review of Regional Dams* - Through the Vulnerability Assessment, the city is assessing the risk of overtopping or bypass for the Amelia Earhart and Charles River dams under climate change scenarios and evaluating the potential impacts.

**Existing Wind Hazard Mitigation Measures**

*GIS layer of trees* - The city has created a geographic information system (GIS) layer of trees in the public right of way, which is updated at least on an annual basis through crews working in the field. The city is also completing a tree canopy study to compliment the street tree data.

*Management of damaged trees* - The Urban Forestry Division is well trained to handle downed limbs and response time has been very good. Currently the city is equipped with several vehicles to deal with any tree issue including bucket and crane trucks, chippers, and stump grinders. The crew mobilizes for major emergencies.

The city has contracts in place to support the forestry division. These contracts include dealing with debris, which specifically addresses wood products, and regular pruning of street trees. The city also has working relationship with NStar to determine where structural pruning is needed in relation to overhead utilities.

*Preventative tree maintenance: pruning, treating, planting, protecting trees* - The city's Urban Forestry Division provides high quality tree care along city rights-of-way, in parks, and around public buildings. The staff is dedicated to pruning, treating, planting, and protecting trees using the most current arboricultural and safety standards. The staff is led by the City Arborist, who directs two crews, each with a Tree Climber and Forestry Worker (on-ground). These personnel handle the acute hazards, routine pruning requests made by the public, and respond to storm events.

*Public education* - The city has created a brochure, "Residential Street Tree Planting and Care," as well as additional materials to inform residents about tree maintenance.

*Building code* - The building code provides structural protections from high winds.

*Inspection of construction sites prior to forecasted storms* - To minimize damage at construction sites, the city communicates and coordinates with active construction sites prior to forecast storms and recommends measures for contractors to take to minimize potential damage.

### **Existing Winter Hazard Weather Mitigation Measures**

*Routine snow operations* - The city has operations in place for clearing snow, salting, etc. DPW goals to chemically treat all major arteries within 3 hours of start of snow (prioritizing most traveled roads), plow main arteries throughout storm, clear all streets and sidewalks bordering city property once snow has stopped.

The City uses salt & calcium chloride instead of sand on roads in winter. The city previously used sand on roads during snow storms, but the sand tended to clog catch basins and caused sedimentation. The city has stopped using sand and now relies on salt and calcium chloride.

*Snow emergency plan: Cambridge* - The city implements emergency parking bans prior to predicted major snow storms. The ban is communicated via electronic and social media, and maps for the parking ban locations are available on the city's website.

*Storm Management Plan: DCR* - DCR has a Storm Management Plan, with plans and schedules for snow removal. DCR partnered with the Massachusetts Department of Transportation (MassDOT) to share snow removal responsibility with the City.

*Public education* - The city has created "Snow: Our Winter Challenge" brochure to inform the public about preparing for and responding to winter storms.

*Council on Aging Outreach* – The Council on Aging can provide residents with contact information for students for hire for snow shoveling.

### **Existing Extreme Temperature Hazard Mitigation Measures**

*Local Coordination and Protocols: Extreme Heat and Cold* - Various entities cooperate to address vulnerable populations during extreme cold and a protocol is in place to delineate efforts and responsibilities. Heat vulnerability is being assessed under the climate change vulnerability assessment.

*Shelter Protocols: Extreme Heat* - The city has a cool shelter for elderly residents.

*Public Outreach: Extreme Heat* - The City conducts public outreach during heat emergencies along with other entities such as Professional Ambulance.

### **Existing Geological Hazard Mitigation Measures**

*Building code* - New construction, as well as construction that includes significant upgrades, must abide by the state building code seismic requirements.

### **Existing Brush Fire Hazard Mitigation Measures**

*Outdoor Burning Ban* - The city does not allow outdoor burning.

### **Existing Mosquito-borne Disease Hazard Mitigation Measures**

*Cambridge West Nile Response Plan* – Cambridge (through the CPHD, DPW and Inspectional Services Department [ISD]), in partnership with Eastern Middlesex Mosquito Control Project (EMMCP), created a West Nile Response Plan. The city and EEMCP collect dead birds and send them to the State for testing. The Department of Public Health (DPH) reviews site plans for certain development proposals. The city Inspectional Services Department responds to habitat concerns on construction sites. EMMCP at the city's direction treats land and right-of-ways for mosquito control.

*Public Education* - The city (through the CPHD, DPW, CDD, and ISD) provides public education through brochures, community events, informal phone inquiries, signage in parks, and trained city staff. The city also uses the web and social media to communicate information about reducing the risks for mosquito-borne diseases.

### **Existing Climate Change Hazard Mitigation Measures**

*Climate Protection network* - The city is part of the ICLEI Cities for Climate Protection network.

*Climate Protection plans* - The City has developed new climate protection goals and objectives and is engaged in a climate change vulnerability assessment and preparedness plan project.

*Climate Protection Action Committee* - This advisory committee helps the city carry out its climate protection plan and meet the city's goal of reducing greenhouse gas emissions and advancing preparedness recommendations.

*Climate Change Vulnerability Assessment* - The city is undertaking a climate change vulnerability assessment, which will serve as the foundation for a climate change resilience and adaptation plan.

**Table 18. Cambridge Existing Mitigation Measures**

Type of Existing Mitigation Measures	Area Covered	Effectiveness/ Enforcement	Improvements/ Changes Needed
<b>EXISTING MULTI-HAZARD MITIGATION MEASURES</b>			
City Of Cambridge Emergency Preparedness	City-wide	Effective. <i>Emphasis is on emergency preparedness and response.</i>	None
City of Cambridge Fire Department (CFD)	City-wide	Effective. <i>Emphasis is on emergency preparedness and response.</i>	None
City of Cambridge Public Health Department (CPHD)	City-wide	Effective. <i>Emphasis is on emergency preparedness and response.</i>	None
Massachusetts State Building Code	City-wide.	Effective for new construction. Many buildings in the City pre-date the most recent, more stringent requirements.	None.
Massachusetts Institute of Technology (MIT) Emergency Preparedness	MIT Campus	Effective. <i>Emphasis is on emergency preparedness and response.</i>	None
Harvard University Emergency Preparedness	Harvard Campus	Effective. <i>Emphasis is on emergency preparedness and response.</i>	None
<b>EXISTING FLOOD HAZARD MITIGATION MEASURES</b>			
Catch basin cleaning, maintenance and repairs	City-wide	Effective. <i>Emphasis is on prevention.</i>	None

**Table 18. Cambridge Existing Mitigation Measures**

<b>Type of Existing Mitigation Measures</b>	<b>Area Covered</b>	<b>Effectiveness/ Enforcement</b>	<b>Improvements/ Changes Needed</b>
Street cleaning and litter pick-up	City-wide	Effective. <i>Emphasis is on prevention.</i>	None
Zoning: Flood Plain Overlay District, Article 19 review, and Permeable Open Space Requirements	City-wide	Effective. <i>Emphasis is on prevention.</i>	Revised FEMA FIRMs adopted in 2010.
Development Runoff Controls	City-wide	Effective. <i>Emphasis is on prevention.</i>	None
Capital Infrastructure Programming	City-wide	Effective. <i>Emphasis is on structural projects.</i>	None
Massachusetts Water Resources Authority (MWRA) Review	City-wide	Effective. <i>Emphasis is on prevention.</i>	None
Public education: Floodplain Information	City-wide	Effective. <i>Emphasis is on public education and awareness.</i>	None
Storm Sewer and Drainage Infrastructure Regular Maintenance	City-wide	Effective. <i>Emphasis is on prevention.</i>	None
Mapping of Catch Basins and Outfalls: Cambridge	City-wide	Effective. <i>Emphasis is on prevention.</i>	None
Mapping of Catch Basins and Outfalls: Division of Conservation and Recreation (DCR)	DCR facilities and properties	Effective. <i>Emphasis is on prevention.</i>	None
Regular Catch Basin Cleaning and Street Sweeping: DCR	DCR facilities and properties	Effective. <i>Emphasis is on prevention.</i>	None
Cambridge Water Department (CWD) activities in water supply watershed communities	Regional	Effective. <i>Emphasis is on prevention.</i>	None

**Table 18. Cambridge Existing Mitigation Measures**

<b>Type of Existing Mitigation Measures</b>	<b>Area Covered</b>	<b>Effectiveness/ Enforcement</b>	<b>Improvements/ Changes Needed</b>
Participation in the National Flood Insurance Program	City-wide	Effective. <i>Emphasis is on prevention.</i>	None
<b>EXISTING DAM-RELATED HAZARD MITIGATION MEASURES</b>			
Water supply watershed communities	Regional	Effective. <i>Emphasis is on prevention.</i>	None
Review of regional dams	Regional; Area potentially inundated by dam breach	Effective. <i>Emphasis is on prevention.</i>	None
<b>EXISTING WIND-RELATED HAZARD MITIGATION MEASURES</b>			
GIS layer of trees	City-wide	Effective. <i>Emphasis is on prevention.</i>	None
Management of damaged trees	City-wide	Effective. <i>Emphasis is on prevention.</i>	None
Preventative tree maintenance: pruning, treating, planting, protecting trees	City-wide	Effective. <i>Emphasis is on prevention.</i>	None
Public education	City-wide	Effective. <i>Emphasis is on public education and awareness.</i>	None
Building code	City-wide	Effective. <i>Emphasis is on prevention.</i>	None
Inspection of construction sites prior to forecasted storms	City-wide	Effective. <i>Emphasis is on prevention.</i>	None

**Table 18. Cambridge Existing Mitigation Measures**

Type of Existing Mitigation Measures	Area Covered	Effectiveness/ Enforcement	Improvements/ Changes Needed
<b>EXISTING WINTER-RELATED HAZARD MITIGATION MEASURES</b>			
Routine snow operations	City-wide	Effective. <i>Emphasis is on prevention.</i>	None
Snow emergency plan: Cambridge	City-wide	Effective. <i>Emphasis is on emergency response.</i>	None
Storm Management Plan: DCR	City-wide, DCR properties and facilities	Effective. <i>Emphasis is on emergency response.</i>	None
Public education	City-wide	Effective. <i>Emphasis is on public education and awareness.</i>	None
Council on Aging Outreach	City-wide	Effective. <i>Emphasis is on public education and awareness.</i>	None
<b>EXISTING EXTREME TEMPERATURE-RELATED HAZARD MITIGATION MEASURES</b>			
Local Coordination and Protocols: Extreme Heat and Cold	City-wide	Effective. <i>Emphasis is on emergency response.</i>	None
Shelter Protocols: Extreme Heat	City-wide	Effective. <i>Emphasis is on emergency response.</i>	None
Public Outreach: Extreme Heat	City-wide	Effective. <i>Emphasis is on public education and awareness.</i>	None

**Table 18. Cambridge Existing Mitigation Measures**

Type of Existing Mitigation Measures	Area Covered	Effectiveness/ Enforcement	Improvements/ Changes Needed
<b>EXISTING GEOLOGICAL HAZARD MITIGATION MEASURES</b>			
Building code	City-wide	Effective. <i>Emphasis is on prevention.</i>	None
<b>EXISTING BRUSH FIRE HAZARD MITIGATION MEASURES</b>			
Outdoor Burning Ban	City-wide	Effective. <i>Emphasis is on public education and awareness.</i>	None
<b>EXISTING MOSQUITO-BORNE DISEASE-RELATED HAZARD MITIGATION MEASURES</b>			
Cambridge West Nile Response Plan	City-wide	Effective. <i>Emphasis is on prevention.</i>	<i>Difficult to change regulations for the treatment of catch basins. Looking to push toward contractors and potential relax regulations.</i>
Public Education	City-wide	Effective. <i>Emphasis is on public education and awareness.</i>	None
<b>EXISTING CLIMATE CHANGE-RELATED HAZARD MITIGATION MEASURES</b>			
Climate Protection network	City-wide	Effective. <i>Emphasis is on prevention.</i>	None
Climate Protection plans	City-wide	Effective. <i>Emphasis is on prevention.</i>	None

**Table 18. Cambridge Existing Mitigation Measures**

Type of Existing Mitigation Measures	Area Covered	Effectiveness/ Enforcement	Improvements/ Changes Needed
Climate Protection Action Committee	City-wide	Effective. <i>Emphasis is on prevention.</i>	None
Climate Change Vulnerability Assessment	City-wide	Effective. <i>Emphasis is on prevention.</i>	None

**Implementation Progress on Previous Plans**

At a meeting of the Cambridge Hazard Mitigation Steering Committee, City staff reviewed the mitigation measures identified in the 2008 Metro Boston Regional Pre-Disaster Mitigation Plan Cambridge Annex and determined whether measures identified in the plan had been implemented or deferred. For implemented projects, they were categorized as either complete or ongoing, with the latter referring to projects were still under development or had begun but not yet completed. If measures had been deferred, the committee evaluated whether the measure should be deleted or carried forward into the 2014 Cambridge Hazard Mitigation 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 19. Mitigation Measures from the 2008 Plan**

Mitigation Measures	Priority	Implementation Responsibility	2012 Status
Complete hydraulic modeling for city	High	DPW	Ongoing  <i>Substantial portions of the city are already modeled. Approximately 40% has a detailed model and work is continuing to include the remainder of the city.</i>
Complete new stormwater regulations & update guidelines	High	DPW	Complete

**Table 19. Mitigation Measures from the 2008 Plan**

<b>Mitigation Measures</b>	<b>Priority</b>	<b>Implementation Responsibility</b>	<b>2012 Status</b>
Continue to program flood mitigation & sewer separation projects in CIP.	High	DPW	Ongoing <i>Projects continue through engineering and design, and the city is seeking funding for construction.</i>
Continue remedial reconstruction city-wide/Upgrade aging infrastructure	High	DPW	Ongoing <i>225 miles of sewer pipe have been addressed. Improvements being constructed as part of 5 year plan which priorities changes based on condition of street and infrastructure.</i>
Help private landowners install back flow preventers in targeted areas.	Medium	DPW	Ongoing/Complete <i>Received grant and provided private landowners with one-on-one technical assistance and produced brochure.</i>
Install SCADA system at Fresh Pond to allow remote monitoring & control of elevations at Little Fresh Pond	High	DPW	Ongoing <i>Improvement under construction and in the future there may be an expansion to other water systems in city.</i>
Sewer separations and stormwater management: - East of Fresh Pond Pkwy (area #6) - Between Concord Ave. rotaries & New St. (area #5)	High	DPW	Ongoing <i>Under design with separations to be completed by 2016.</i>

**Table 19. Mitigation Measures from the 2008 Plan**

<b>Mitigation Measures</b>	<b>Priority</b>	<b>Implementation Responsibility</b>	<b>2012 Status</b>
Complete stormwater infrastructure at golf course	High	DPW/CWD	Complete
Sewer separation (CAM 002 CSO area), Porter Square	High	DPW	Ongoing <i>Project under development with separation to occur in the future following other separation projects in city</i>
Improve collection & conveyance system east of 2nd St & north of Charles St. (area #27)	High	DPW	Ongoing <i>Project under development with separation to occur in the future following other separation projects in city.</i>
Implement additional stormwater management measures, School, Pine, Cherry Streets, Windsor (area #26)	High	DPW	Ongoing <i>Planned improvements delayed due to additional design work.</i>
Implement CAM017 Stormwater Management Program near Tremont & Norfolk Sts (area #25)	High	DPW	Complete
Complete Cambridgeport / CAM017 stormwater management program, Newton, Green, Franklin & Sydney streets (area #28)	High	DPW	Ongoing <i>Planned improvements part of 15 year stormwater system improvement plan.</i>

**Table 19. Mitigation Measures from the 2008 Plan**

<b>Mitigation Measures</b>	<b>Priority</b>	<b>Implementation Responsibility</b>	<b>2012 Status</b>
Complete CAM011 sewer separation & stormwater management program - Irving, Bryant, Crescent, Carver, Sacramento (areas 16, 17) - Kirkland, Myrtle, Magnolia, Cambridge (areas #18, 19) - Ellery St. & Broadway (area # 24)	High	DPW	Complete/Ongoing <i>Improvements completed with exception of Kirkland, Myrtle, Magnolia, and Cambridge, which will complete in the near future.</i>
Investigate potential hazardous releases due to any/all natural hazard	High	DPH/Fire Dept.	Complete
Pursue a more aggressive program to replace older water mains (minimize bursts in cold weather)	High	CWD	Ongoing <i>CWD has an ongoing program to replace older water infrastructure through the City.</i>
Emergency & evacuation plan that spells out roles. Include options for residents without cars	High	EMD	Complete
Develop comprehensive communications plan. Include communication with non-English speakers	High	EMD	Complete

**Table 19. Mitigation Measures from the 2008 Plan**

<b>Mitigation Measures</b>	<b>Priority</b>	<b>Implementation Responsibility</b>	<b>2012 Status</b>
Assess risks to infrastructure including electric, gas, & steam distribution & MBTA subway system	High	DPW	Ongoing <i>Work to assess risks occurring as part of ongoing Climate Change Vulnerability Assessment.</i>
Have a power-loss plan for major power outages	High	Electrical Dept.	Ongoing <i>City communicates with N-Star to evaluate outage impact and restoral time.</i>
Develop MOU between cities, universities, etc., that provides shared access to resources	High	Various	Ongoing <i>City and universities have informal agreement for sharing resources, such as access to equipment and sheltering locations.</i>
Ensure public ROWs are properly maintained & accessible so essential services and deliveries can continue	High	DPW	Ongoing <i>City performs regular maintenance of public ways, and additional work is performed prior to storm events to make sure ways are clear of debris and accessible.</i>
Provide facility for parents to bring infants during heat emergency	Medium	DHSP, EMD	Ongoing <i>Services primarily focused on seniors but discussion continues about including other vulnerable population groups.</i>

**Table 19. Mitigation Measures from the 2008 Plan**

<b>Mitigation Measures</b>	<b>Priority</b>	<b>Implementation Responsibility</b>	<b>2012 Status</b>
Improve communications between City Departments & between universities & the City	Medium	Various	Ongoing <i>City and universities, as well as private sector businesses, communicate regularly through the LEPC as well as in relation to specific public events in the city.</i>
Provide opportunities for “knowledge exchanges” between city agencies & private interests, such as universities on issues relating to hazards	Medium	EMD	Ongoing <i>See above, and the City, Universities, and private interests hold joint table top event response exercises during each year.</i>
Establish funding program for residential structural improvements / flood proofing	Medium	DPW	Ongoing <i>The City has not pursued development of a funding program but continues to review the option and distributes information about structural improvements / flood proofing to residents.</i>
Maintain, protect, & exercise connection between City’s water system & MWRA to ensure operability during emergencies	Medium	CWD	Complete/Ongoing <i>This activity has been performed and the City and the Water Department continue to review and exercise the connections on a regular basis.</i>
Locate critical shut-off’s for gas, electricity, etc. so they can be located under snow	Medium	DPW	Ongoing <i>N-Star has been installing remote switching for electrical system reliability.</i>

**Table 19. Mitigation Measures from the 2008 Plan**

<b>Mitigation Measures</b>	<b>Priority</b>	<b>Implementation Responsibility</b>	<b>2012 Status</b>
Identify measures to adapt state dams to withstand storm surge of major hurricanes	Medium	DCR/ State	Ongoing <i>Work to assess risks occurring as part of ongoing Climate Change Vulnerability Assessment</i>
Determine vulnerability of roadways and utilities to earthquakes in the high liquefaction areas	Medium	EMD	Ongoing <i>Issue still under consideration by Inspectional Services and DPW</i>
Provide generator at cool shelter or provide back-up shelter	Medium	Electrical Dept.	Ongoing <i>The City at this time does not have a mobile generator.</i>
Ensure public facilities have back-up generators & staff are trained to use & maintain generators	Medium	Electrical Dept.	Complete <i>Performed in coordination with updating of Critical Infrastructure list.</i>
Ensure generators are located in areas protected from hazards	Medium	Electrical Dept., DPW	Ongoing <i>Work to assess risks occurring as part of ongoing Climate Change Vulnerability Assessment</i>
Improve response time by private utilities, especially electrical due to live wire hazards	Medium	Private utilities	Ongoing <i>Cambridge Electrical Department regularly meets with utilities to discuss response time and strategies, including meetings in advance of predicted storms.</i>
Complete SCADA & encourage other depts. to use	Medium	DPW	Ongoing <i>DPW in the process of implementing system for public infrastructure in city.</i>

**Table 19. Mitigation Measures from the 2008 Plan**

<b>Mitigation Measures</b>	<b>Priority</b>	<b>Implementation Responsibility</b>	<b>2012 Status</b>
Develop staffing plan for sustained winter events	Medium	DPW	Ongoing <i>Draft plan under development</i>
Improve energy efficiency of buildings & facilities to address climate change	High	DPW/ CDD	Complete/Ongoing <i>The city was designated a Green Community by the state in 2010 and work continues to improve energy efficiency in municipal buildings and programs.</i>
Encourage purchase of fleet & private vehicles with higher fuel economy. Use biodiesel for all city owned diesel vehicles & equipment. Utilize improved vehicle emission technology. (climate change)	High	DPW/ CWD/ CDD	Complete/Ongoing <i>The city has a 'green fleet' policy and procedures in place for purchasing of new municipal vehicles.</i>
Improve communication so city is aware when levels at the Charles River Dam change	Medium	DPW	Ongoing <i>The city is in ongoing conversations with DCR and other agencies involved and potentially impacted by the dam.</i>
Reduce impervious area through pavement replacement, green roofs, & use of low impact development (LID) techniques	Medium	CDD/ DPW	Ongoing <i>The city has ordinances and policies in place to encourage reduction of impervious areas and encourage LID practices.</i>

**Table 19. Mitigation Measures from the 2008 Plan**

<b>Mitigation Measures</b>	<b>Priority</b>	<b>Implementation Responsibility</b>	<b>2012 Status</b>
Expand City catch basin cleaning & repairs with more equipment & more staff	Medium	DPW	Complete/Ongoing <i>The city has increased the frequency of cleaning and evaluating catch basins, and is continuing to do so.</i>
Public education on post-flooding risks. E.g., mold issues, structural impacts due to dampness or flooding, etc.	Medium	DPH	Ongoing <i>The city provides materials on these topics to residents and businesses.</i>
Hurricane surge zone modeling is based on topography. Need research based on actual drainage issues to see if surge zone is different than this model.	Medium	DPW	Ongoing <i>City is currently reviewing updated draft surge zone and evacuation maps and preparing comments about proposed map modifications and related information.</i>
Improve snow-fighting equipment	Medium	DPW	Ongoing <i>City is currently reviewing options related to snow disposal, especially in cases of large snowfall events.</i>

The City of Cambridge's staff continually demonstrates commitment and a high level of professionalism with regard to addressing natural hazard mitigation needs in order to prevent impact from natural hazard events and protect the lives and property of the residents and businesses located in the City. As has been previously stated, flooding represents the greatest hazard for the community and staff diligently maintains drainage structures and enforces the regulations that contribute to minimizing the potential impacts of this hazard, within the resources available. The action items identified above represented a wish list of activities that would further reduce hazard risks, but the ability to implement improvements, especially capital investments, was highly dependent on the availability of greater resources.

## **2013 HAZARD MITIGATION STRATEGY**

### What is Hazard Mitigation?

Hazard mitigation means to permanently reduce or alleviate the losses of life, injuries, and property resulting from natural hazards through long-term strategies. These long-term strategies include planning, policy changes, education programs, infrastructure projects, and other activities. FEMA currently has three mitigation grant programs: the Hazards Mitigation Grant Program (HGMP), the Pre-Disaster Mitigation program (PDM), and the Flood Mitigation Assistance (FMA) program. The three links below provide additional information on these programs.

<http://www.fema.gov/government/grant/hmmp/index.shtm>

<http://www.fema.gov/government/grant/pdm/index.shtm>

<http://www.fema.gov/government/grant/fma/index.shtm>

Hazard Mitigation Measures can generally be sorted into the following groups:

- **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.

(Source: FEMA Local Multi-Hazard Mitigation Planning Guidance)

## **Proposed Hazard Mitigation Measures**

### Flood Hazard Mitigation Measures

- A) Complete hydraulic modeling for city
- B) Complete sewer separation and stormwater management program for Kirkland Street, Myrtle Street, Magnolia Street and Cambridge Street (CAM<sup>2</sup> 011, areas #18 and 19)
- C) Complete sewer separation and stormwater management program for areas east of Fresh Pond Pkwy (area #6) and between Concord Avenue rotaries and New Street (area #5)
- D) Complete sewer separation at Porter Square (CAM 002 CSO area)
- E) Improve collection and conveyance system at area east of 2nd Street and north of Charles Street (area #27)
- F) Implement additional stormwater management measures: School, Pine, Cherry and Windsor Streets (area #26)
- G) Complete Cambridgeport stormwater management program: Newton, Green, Franklin and Sidney Streets (CAM 017, area #28)
- H) Complete sewer separation and stormwater management program for Irving, Bryant, Crescent, Carver and Sacramento Streets (CAM011, areas #16 and 17)
- I) Complete sewer separation and stormwater management program for Ellery Street and Broadway (CAM011, area #24)
- J) Establish funding program for residential structural improvements and flood proofing to support flood prevention for homes in the City

### *Measures to Ensure Compliance with NFIP*

- K) Floodplain Management - Continue to enforce the relevant zoning (Flood Plain Overlay District, Article 19 review and Permeable Open Space Requirements) and associated building regulations for floodplain areas. Update this district to remain consistent with FEMA guidelines and floodplain mapping.
- L) Floodplain Mapping - Maintain up to date maps of local FEMA identified floodplains.

### Winter Storm Hazard Mitigation Measures

- M) Expand program to clear snow and maintain public ROWs (e.g., travel ways for non-vehicular mobility and access for vulnerable populations)

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<sup>2</sup> CAM = Outfall designation (with associated ID number)

Geologic Hazard Mitigation Measures

- N) Determine vulnerability of roadways and utilities to earthquakes in the high liquefaction areas

Extreme Temperature Mitigation Measures

- O) Provide facility for additional vulnerable populations (such as disabled populations and in addition to senior residents) during extreme temperature event

Wind Mitigation Measures

- P) Increase public education on the benefits and proper care of trees on private property

Climate Change Mitigation Measures

- Q) Complete Climate Change Vulnerability Assessment
- R) Complete Climate Change Adaptation Plan
- S) Encourage installation of solar photovoltaic systems, cogeneration, and other energy supplies to improve energy reliability and resilience
- T) Encourage energy efficiency in buildings through zoning requirements for new development and community outreach for existing buildings.

Other Hazard Mitigation Measures

- U) Review evacuation protocols to identify any potential changes that may be needed for communications, preparedness and response protocols
- V) Develop program for enhanced staffing for disaster recovery (e.g., flexing of municipal staff for short-term duty in emergency preparedness and response events)
- W) Ensure generators are located in areas protected from hazards (e.g., elevated above potential flood levels).
- X) Conduct maintenance activities to monitor and reduce brushfire risks

**Prioritization of Mitigation Activities**

The last step in developing the City's mitigation strategy is to assign a level of priority to each mitigation measure so as to guide the focus of the City's limited resources towards those actions with the greatest potential benefit. At this stage in the process, the Hazard Mitigation Committee has limited access to detailed analyses of the cost and benefits of any given measure, so prioritization is based on the committee member's knowledge of the existing and potential hazard impacts and an approximate sense of the costs associated with pursuing any given measure.

Prioritization occurred through discussion at the third and fourth meetings of the committee and through subsequent review by committee members and public comment. Priority setting was based on local knowledge of the hazard areas, including impacts of hazard events and the extent of the area impacted and the relation of a given mitigation measure to the City's identified goals. In addition, through the discussion, the local committee also took into consideration factors such as the number of homes and businesses affected, whether or not road closures occurred and what impact closures had on delivery of emergency services and the local economy, anticipated project costs, whether the City currently had the technical and administrative capability to carry out the mitigation measures, whether any environmental constraints existed, and whether the City would be able to justify the costs relative to the anticipated benefits.

Table 20 (on the following page) below demonstrates the prioritization. For each mitigation measure, the geographic extent of the potential benefiting area is identified as is an estimate of the overall benefit and cost of the measures. The benefits and costs were evaluated in terms of:

**Benefits**

High	Action will result in a significant reduction of hazard risk to people and/or property from a hazard event
Medium	Action will likely result in a moderate reduction of hazard risk to people and/or property from a hazard event
Low	Action will result in a low reduction of hazard risk to people and/or property from a hazard event

**Costs**

High	Estimated costs greater than \$50,000
Medium	Estimated costs between \$10,000 to \$50,000
Low	Estimated costs less than \$10,000 or staff time

With this assessment, an approximate timeframe has been identified in which the municipality would attempt to achieve the mitigation measure.

**Table 20. Mitigation Measure Prioritization**

<b>Mitigation Action</b>	<b>Geographic Coverage</b>	<b>Benefit</b>	<b>Estimated Cost</b>	<b>Priority</b>	<b>Time Frame</b>
<b>Flood Hazard Mitigation Measures</b>					
A) Complete hydraulic modeling for city	City-Wide	High	High	High	2014–2018
B) Complete sewer separation and stormwater management program for Kirkland Street, Myrtle Street, Magnolia Street and Cambridge Street (CAM #011, areas 18 and 19)	Area specific	High	High	High	2014–2018
C) Complete sewer separation and stormwater management program for areas east of Fresh Pond Pkwy (area #6) and between Concord Avenue rotaries and New Street (area #5)	Area specific	High	High	High	2014–2016
D) Complete sewer separation at Porter Square (CAM 002 CSO area)	Area specific	High	High	High	2014–2018
E) Improve collection and conveyance system at area east of 2nd Street and north of Charles Street (area #27)	Area specific	High	High	High	2014–2018
F) Implement additional stormwater management measures: School, Pine, Cherry and Windsor Streets (area #26)	Area specific	High	High	High	2014–2018
G) Complete Cambridgeport stormwater management program: Newton, Green, Franklin and Sidney Streets	Area specific	High	High	High	2014–2018

**Table 20. Mitigation Measure Prioritization**

<b>Mitigation Action</b>	<b>Geographic Coverage</b>	<b>Benefit</b>	<b>Estimated Cost</b>	<b>Priority</b>	<b>Time Frame</b>
(CAM 017, area #28)					
H) Complete sewer separation and stormwater management program for Irving, Bryant, Crescent, Carver and Sacramento Streets (CAM011, areas #16 and 17)	Area specific	High	High	High	2014–2017
I) Complete sewer separation and stormwater management program for Ellery Street and Broadway (CAM011, area #24)	Area specific	High	High	High	2014–2017
J) Establish funding program for residential structural improvements and flood proofing	City-Wide	Medium	High	Medium	2016–2018
K) Floodplain Management	City-Wide	Low	Low	Low	2014–2018
L) Floodplain Mapping	City-Wide	Low	Low	Low	2014–2018
<b>Winter Storm Hazard Mitigation Measures</b>					
M) Expand program to clear snow and maintain public ROWs (e.g., travel ways for non- vehicular mobility and access for vulnerable populations)	City-Wide	High	Medium	Medium	2014–2018
<b>Geologic Hazard Mitigation Measures</b>					
N) Determine vulnerability of roadways and utilities to earthquakes in the high liquefaction areas	City-Wide	Low	Medium	Medium	2016–2018
<b>Extreme Temperature Mitigation Measures</b>					

**Table 20. Mitigation Measure Prioritization**

<b>Mitigation Action</b>	<b>Geographic Coverage</b>	<b>Benefit</b>	<b>Estimated Cost</b>	<b>Priority</b>	<b>Time Frame</b>
O) Provide facility for additional vulnerable populations during extreme temperature event	City-Wide	Medium	Medium	Medium	2014-2016
<b>Wind Mitigation Measures</b>					
P) Increase public education on the benefits and proper care of trees on private property	City-Wide	Medium	Low	Low	2015-2017
<b>Climate Change Mitigation Measures</b>					
Q) Complete Climate Change Vulnerability Assessment	City-Wide	High	High	High	2014
R) Complete Climate Change Adaptation Plan	City-Wide	High	High	High	2014-2015
S) Encourage installation of solar photovoltaic systems, cogeneration, and other energy supplies	City-Wide	Low	Low	Low	2014-2017
T) Encourage energy efficiency in buildings through zoning requirements and community outreach	City-Wide	Low	Low	Low	2014-2017
<b>Other Hazard Mitigation Measures</b>					
U) Evacuation Protocol Review	City-Wide	High	Low	High	2015-2016
V) Develop program for enhanced staffing for disaster recovery	City-Wide	High	Low	Medium	2014-2016
W) Ensure generators are located in areas protected from hazards	City-Wide	Medium	Medium	Medium	2015-2017
X) Conduct maintenance activities to monitor and reduce	Area Specific	Low	Low	Low	2014-2018

**Table 20. Mitigation Measure Prioritization**

<b>Mitigation Action</b>	<b>Geographic Coverage</b>	<b>Benefit</b>	<b>Estimated Cost</b>	<b>Priority</b>	<b>Time Frame</b>
brushfire risks					

## **INTRODUCTION TO POTENTIAL MITIGATION MEASURES (TABLE 21)**

Description of the Mitigation Measure – The description of each mitigation measure is brief and cost information is given only if cost data were already available from the community. The cost data represent a point in time and would need to be adjusted for inflation and for any changes or refinements in the design of a particular mitigation measure.

Measure Type – Each measure was categorized as one of the following mitigation categories: Prevention, Property Protection, Public Education & Awareness, Natural Resource Protection, Structural Projects, and Emergency Services Protection.

Implementation Responsibility – The designation of implementation responsibility was done by MAPC based on a general knowledge of each municipal department's responsibility. It is likely that most mitigation measures will require that several departments work together and assigning staff is the sole responsibility of the governing body of each community.

Priority – The designation of high, medium, or low priority was done at the meeting of the Local Multiple Hazard Community Planning Team meeting. The designations reflect discussion and a general consensus developed at the meeting but could change as conditions in the community change. In determining project priorities, the local team considered potential benefits and project costs.

Time Frame – The time frame was based on a combination of the priority for that measure, the complexity of the measure and whether or not the measure is conceptual, in design, or already designed and awaiting funding. 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 a likely time frame is not meant to constrain a community from taking advantage of funding opportunities as they arise.

Potential Funding Sources – This column attempts to identify the most likely sources of funding for a specific measure. The information on potential funding sources in this table is preliminary and varies depending on a number of factors. These factors include whether or not a mitigation measure has been studied, evaluated, or designed, or if it is still in the conceptual stages. MEMA and DCR assisted MAPC in reviewing the potential eligibility for hazard mitigation funding. Each grant program and agency has specific eligibility requirements that would need to be taken into consideration. In most instances, the measure will require a number of different funding sources. Identification of a potential funding source in this table does not guarantee that a project will be eligible for, or selected for funding. Upon adoption of this plan, the local committee responsible for its implementation should begin to explore the funding sources in more detail.

Additional information on funding sources – The best way to determine eligibility for a particular funding source is to review the project with a staff person at the funding agency. The following websites provide an overview of programs and funding sources.

- Army Corps of Engineers (ACOE) – The website for the North Atlantic district office is <http://www.nae.usace.army.mil/>. The ACOE provides assistance in a number of types of projects including shoreline/streambank protection, flood damage reduction, flood plain management services and planning services.
- Massachusetts Emergency Management Agency (MEMA) – The grants page <http://www.mass.gov/dem/programs/mitigate/grants.htm> has a useful table that compares eligible projects for the Hazard Mitigation Grant Program and the Flood Mitigation Assistance Program.
- United States Department of Agriculture – The USDA has programs by which communities can get grants for firefighting needs. Please use this link for some example: <http://www.rurdev.usda.gov/rd/newsroom/2002/cfg.html>

**Abbreviations Used in Table 21**

FEMA Mitigation Grants includes:

FMA = Flood Mitigation Assistance Program.

HMGP = Hazard Mitigation Grant Program.

PDM = Pre-Disaster Mitigation Program

ACOE = Army Corps of Engineers.

DHS/EOPS = Department of Homeland Security/Emergency Operations

EPA/DEP (SRF) = Environmental Protection Agency/Department of Environmental Protection (State Revolving Fund)

USDA = United States Department of Agriculture

Mass DOT = Massachusetts Department of Transportation

MBTA = Massachusetts Bay Transportation Authority

DCR = MA Department of Conservation and Recreation

DHCD = MA Department of Housing and Community Development

# CITY OF CAMBRIDGE HAZARD MITIGATION PLAN

**Table 21. Cambridge Potential Mitigation Measures**

Mitigation Action	Measure Type	Implementation Responsibility	Priority	Time Frame	Potential Funding Sources
<b>Flood Hazard Mitigation Measures</b>					
A) Complete hydraulic modeling for the city	Prevention	DPW	High	2014–2018	City of Cambridge
B) Complete sewer separation and stormwater management program for Kirkland Street, Myrtle Street, Magnolia Street and Cambridge Street (CAM #011, areas 18 and 19)	Structural Projects	DPW	High	2014-2016	City of Cambridge
C) Complete sewer separation and stormwater management program for areas east of Fresh Pond Pkwy (area #6) and between Concord Avenue rotaries and New Street (area #5)	Structural Projects	DPW	High	2014-2016	City of Cambridge
D) Complete sewer separation at Porter Square (CAM 002 CSO area)	Structural Projects	DPW	High	2014–2018	City of Cambridge
E) Improve collection and conveyance system at area east of 2nd Street and north of Charles Street (area #27)	Structural Projects	DPW	High	2014–2018	City of Cambridge
F) Implement additional stormwater management measures: School, Pine, Cherry and Windsor Streets (area #26)	Structural Projects	DPW	High	2014–2018	City of Cambridge
G) Complete Cambridgeport stormwater management program: Newton, Green, Franklin and Sidney Streets (CAM 017, area #28)	Structural Projects	DPW	High	2014–2018	City of Cambridge

**Table 21. Cambridge Potential Mitigation Measures**

<b>Mitigation Action</b>	<b>Measure Type</b>	<b>Implementation Responsibility</b>	<b>Priority</b>	<b>Time Frame</b>	<b>Potential Funding Sources</b>
H) Complete sewer separation and stormwater management program for Irving, Bryant, Crescent, Carver and Sacramento Streets (CAM011, areas #16 and 17)	Structural Projects	DPW	High	2014–2017	City of Cambridge
I) Complete sewer separation and stormwater management program for Ellery Street and Broadway (CAM011, area #24)	Structural Projects	DPW	High	2014–2017	City of Cambridge
J) Establish funding program for residential structural improvements and flood proofing	Prevention/Property Protection	CDD, DPW	Medium	2016-2018	City of Cambridge, FEMA
K) Floodplain Management	Prevention	Conservation Commission	Low	2014-2018	City of Cambridge
L) Floodplain Mapping	Prevention	CDD, Conservation Commission	Low	2014-2018	City of Cambridge
<b>Winter Storm Hazard Mitigation Measures</b>					
M) Expand program to clear snow and maintain public ROWs (e.g., travel ways for non-vehicular mobility and access for vulnerable populations)	Prevention	DPW	Medium	2014-2018	City of Cambridge, DCR, MassDOT
<b>Geologic Hazard Mitigation Measures</b>					
N) Determine vulnerability of roadways and utilities to earthquakes in the high liquefaction areas	Prevention	EMD, DPW, Inspectional Services	Medium	2016-2018	City of Cambridge

**Table 21. Cambridge Potential Mitigation Measures**

<b>Mitigation Action</b>	<b>Measure Type</b>	<b>Implementation Responsibility</b>	<b>Priority</b>	<b>Time Frame</b>	<b>Potential Funding Sources</b>
<b>Extreme Temperature Mitigation Measures</b>					
O) Provide facility for additional vulnerable populations during extreme temperature event	Prevention/ Public Education & Awareness	DHSP, EMD	Medium	2014-2016	City of Cambridge
<b>Wind Mitigation Measures</b>					
P) Increase public education on the benefits and proper care of trees on private property	Public Education & Awareness	Inspectional Services, EMD	Low	2015-2017	City of Cambridge, MEMA
<b>Climate Change Mitigation Measures</b>					
Q) Complete Climate Change Vulnerability Assessment	Prevention	CDD	High	2014	City of Cambridge
R) Complete Climate Change Adaptation Plan	Prevention	CDD	High	2014-2015	City of Cambridge, EOEEA
S) Encourage installation of solar photovoltaic systems, cogeneration, and other energy supplies	Prevention	CDD	Low	2014-2017	City of Cambridge
T) Encourage energy efficiency in buildings through zoning requirements and community outreach	Prevention	CDD	Low	2014-2017	City of Cambridge
<b>Other Hazard Mitigation Measures</b>					
U) Evacuation Protocol Review	Emergency Services Protection	EMD	High	2015-2016	City of Cambridge
V) Develop program for enhanced staffing for disaster recovery	Prevention/ Emergency Services Protection	Inspectional Services, CPHD	Medium	2014-2016	City of Cambridge

**Table 21. Cambridge Potential Mitigation Measures**

<b>Mitigation Action</b>	<b>Measure Type</b>	<b>Implementation Responsibility</b>	<b>Priority</b>	<b>Time Frame</b>	<b>Potential Funding Sources</b>
W) Ensure generators are located in areas protected from hazards	Emergency Services Protection	Electrical Dept., DPW	Medium	2015-2017	City of Cambridge
X) Conduct maintenance activities to monitor and reduce brushfire risks	Prevention/ Natural Resource Protection	Fire	Low	2014-2018	City of Cambridge

## CITY OF CAMBRIDGE HAZARD MITIGATION PLAN

### REGIONAL AND INTER-COMMUNITY CONSIDERATIONS

#### Regional Issues

Some hazard mitigation issues are strictly local. The problem originates primarily within the municipality and can be solved at the municipal level (e.g., capacity issues in local drainage system). Other issues are inter-community issues that involve cooperation between two or more municipalities (e.g., upstream issues related to upstream flooding on the Mystic River or on Alewife Brook). There is a third level of mitigation which is regional; involving a state, regional, or federal agency or an issue that involves three or more municipalities (e.g., any potential issues related to the Amelia Earhart Dam, which is owned by the DCR).

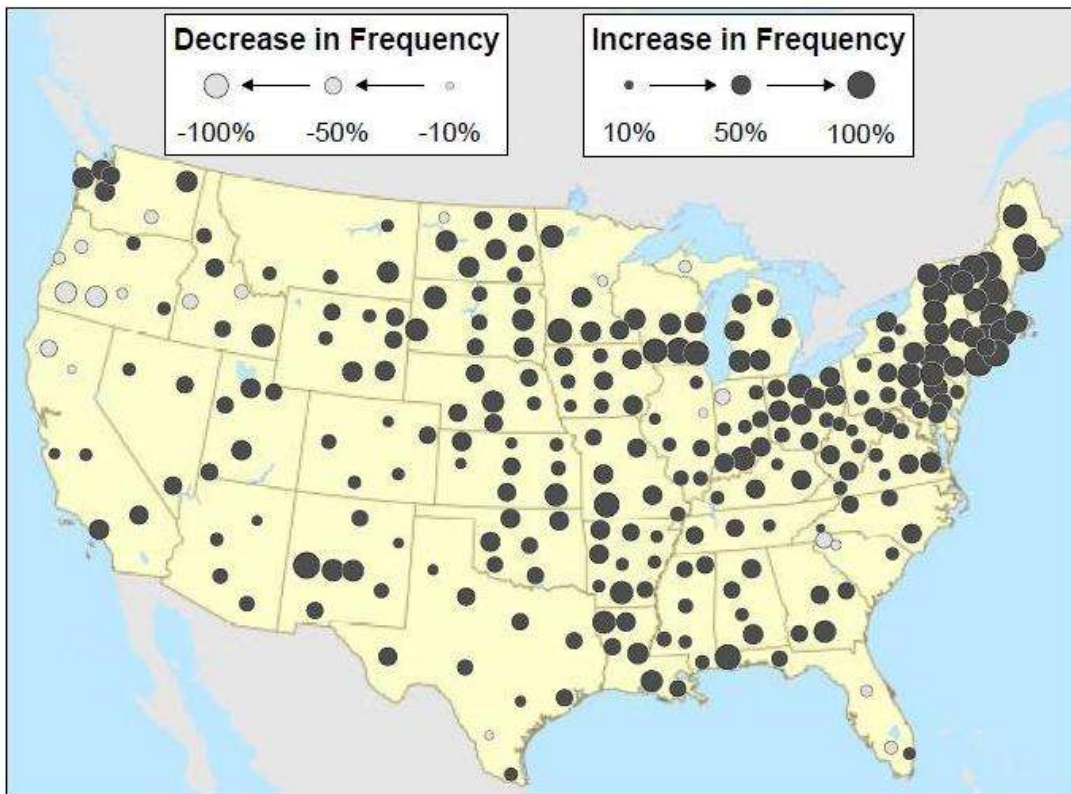
#### Regional Partners and Hazard Mitigation Coordination

In the densely developed communities of the study area, mitigating natural hazards, particularly flooding, is more than a local issue. The drainage systems that serve these communities are a complex system of storm drains, roadway drainage structures, pump stations and other facilities owned and operated by a wide array of agencies. These include but not limited to the City of Cambridge, the Department of Conservation and Recreation (DCR), the Massachusetts Water Resources Authority (MWRA), Massachusetts Department of Transportation (MassDOT), and the Massachusetts Bay Transportation Authority (MBTA).

The planning, construction, operations, and maintenance of these structures are integral to the flood hazard mitigation efforts of communities. These agencies must be considered the communities regional partners in hazard mitigation. These agencies also operate under the same constraints as communities do including budgetary and staffing constraints and numerous competing priorities. The following is a list of recommendations from the 2008 plan that had planned to be undertaken in coordination with or by regional agencies.

### CLIMATE CHANGE

The entirety of Massachusetts, and in particular the Commonwealth's cities and towns on or proximate to the coast, faces potential risk from Climate Change. Many of the natural hazards that cities like Cambridge have historically experienced are likely to be exacerbated by climate change in future years. This is particularly true for flooding caused by extreme precipitation, flooding, and extreme heat. For example, according to the 2012 report *When It Rains It Pours – Global Warming and the Increase in Extreme Precipitation from 1948 to 2011*, intense rainstorms and snowstorms have become more frequent and more severe over the last half century in the northeastern United States. Extreme downpours are now happening 30 percent more often nationwide than in 1948. In other words, large rain or snow storms that happened once every 12 months, on average, in the middle of the 20th century, now happen every nine months.



Source: When It Rains It Pours – Global Warming and the Increase in Extreme Precipitation, Environment America Research and Policy Center, July 2012

Attempts to mitigate climate change or adapt to its potential impacts are largely outside the scope of this Hazard Mitigation Plan, which relies primarily on historic trends to assess risk and vulnerability. However, the City of Cambridge has already embarked on assessing how these hazards may change the city's vulnerability and is thinking about how best to adapt to these changes.

Currently, the City is taking steps to make Cambridge more prepared and resilient to climate change. Building from its 2002 Climate Protection plan, the City is currently conducting a Climate Change Vulnerability Assessment. Coordinated by an inter-departmental steering committee consisting of the Public Works, Public Health, and Community Development Departments, the assessment will identify how Cambridge is vulnerable or resilient to a changing climate in terms of impacts to people, infrastructure, public health, and the economy. When complete, the assessment will serve as the basis for a climate change preparedness plan that will provide recommendations on how to maximize the city's inherent resiliency and to adapt to potential new risks from natural hazard risks due to climate change. Information and the current status of the Climate Change Vulnerability Assessment can be found here:

<http://www.cambridgema.gov/CDD/Projects/Climate/climatechangeresilienceandadaptation.aspx>.

The City also continues to be supported by the Climate Protection Action Committee (CPAC), which is an advisory committee assisting in the implementation of the City's Climate Protection Plan. The Committee develops recommendations to the City Manager and is active participant in climate change vulnerability and adaptation initiatives. For more information on the CPAC and the City's broader set of climate and energy initiatives please visit <http://www.cambridgema.gov/CDD/climateandenergy.aspx>.

In addition to understanding how physical infrastructure will be impacted by the changing characteristics of natural hazards, it is important to identify how vulnerable populations may suffer impacts under future climate change scenarios. Vulnerable populations could include the elderly, the very young, low-income groups, immigrants and the homeless, among others, and could disproportionately suffer the effects of extreme events, like flooding and heat waves, be least-equipped to adapt. Here, too, the City is already taking action by providing shelter for seniors during extreme weather events and identifying mitigation measures to encompass and provide support for other vulnerable populations. The continuation of these efforts will make the City more prepared for potential impacts to vulnerable populations and offer more opportunities to coordinate among the involved departments and divisions like CPHD, CDD, the Human Rights Commission, the Commission for Persons with Disabilities, and the Council on Aging.

## **VII. PLAN ADOPTION AND MAINTENANCE**

### **PLAN ADOPTION**

The City of Cambridge Hazard Mitigation Plan was adopted by the City Council on [ADD DATE]. See Appendix D for documentation. The plan was approved by FEMA on [ADD DATE] for a five-year period that will expire on [ADD DATE].

### **PLAN MAINTENANCE**

MAPC worked with the Cambridge Hazard Mitigation Planning Team to prepare this plan. This group will continue to meet on an as-needed basis to function as the Local Hazard Mitigation Implementation Group, with one City official designated as the coordinator. Additional members could be added to the local implementation group from businesses, non-profits, and institutions.

### **IMPLEMENTATION SCHEDULE**

Bi-Annual Survey on Progress— The coordinator of the Hazard Mitigation Implementation Team will prepare and distribute a biannual survey in years two and four of the plan. The survey will be distributed to all of the local implementation group members and other interested local stakeholders. The survey will poll the members on any changes or revisions to the plan that may be needed, progress and accomplishments for implementation, and any new hazards or problem areas that have been identified.

This information will be used to prepare a report or addendum to the local hazard mitigation plan. The Hazard Mitigation Implementation Team will have primary responsibility for tracking progress and updating the plan.

Develop a Year Four Update— During the fourth year after initial plan adoption, the coordinator of the Hazard Mitigation Implementation Team will convene the team to begin to prepare for an update of the plan, which will be required by the end of year five in order to maintain approved plan status with FEMA. The team will use the information from the year four biannual review to identify the needs and priorities for the plan update.

Prepare and Adopt an Updated Local Hazard Mitigation Plan— FEMA's approval of this plan is valid for five years, by which time an updated plan must be approved by FEMA in order to maintain the City's approved plan status and its eligibility for FEMA mitigation grants. Because of the time required to secure a planning grant, prepare an updated plan, and complete the approval and adoption of an updated plan, the local Hazard Mitigation Planning Team should begin the process by the end of Year 3. This will help the City avoid a lapse in its approved plan status and grant eligibility when the current plan expires.

At this point, the Hazard Mitigation Implementation Team may decide to undertake the update themselves, contract with the Metropolitan Area Planning Council to update the plan or to hire another consultant. However the Hazard Mitigation Implementation Team decides to update the plan, the group will need to review the current FEMA hazard mitigation plan guidelines for any changes. The update of the Cambridge Hazard Mitigation Plan will be forwarded to MEMA and DCR for review and to FEMA for approval.

### **INTEGRATION OF THE PLANS WITH OTHER PLANNING INITIATIVES**

Upon approval of the Cambridge Hazard Mitigation Plan by FEMA, the coordinator of the Hazard Mitigation Implementation Team with support from other members of the team will provide all interested parties and implementing departments with a copy of the plan and will initiate a discussion regarding how the plan can be integrated into that department's ongoing work.

At a minimum, the plan will be reviewed and discussed with the following departments during the first six (6) months following plan adoption:

- Fire / Emergency Management
- Police
- Public Works
- Engineering
- Community Development Department
- Conservation
- Health
- Inspectional Services

Other groups that will be coordinated with include large institutions, Chambers of Commerce, land conservation organizations, and watershed groups. The plans will also be posted on a community's website with the caveat that local team coordinator will review the plan for sensitive information that would be inappropriate for public posting. The posting of the plan on a web site will include a mechanism for citizen feedback such as an e-mail address to send comments.

## **VIII. LIST OF REFERENCES**

In addition to the specific reports listed below, much of the technical information for this plan came from meetings with City department heads and staff.

City of Cambridge Zoning Ordinance.

City of Cambridge Open Space and Recreation Plan, 2009-2016.

City of Cambridge Master Plan and Growth Policy (and Related Initiatives):

<https://www.cambridgema.gov/CDD/planud/masterplan.aspx>.

Historic Districts and Neighborhood Conservation Districts in Cambridge, MA:

<http://www2.cambridgema.gov/historic/districts.html>.

2013 Town Gown Report Summary.

Metro-Boston Multi-Hazard Mitigation Plan, Cambridge Annex, 2008.

Metropolitan Area Planning Council, Geographic Information Systems data.

Metropolitan Area Planning Council, Regional Plans, and Data.

Commonwealth of Massachusetts State Hazard Mitigation Plan, 2010.

FEMA, Local Multi-Hazard Mitigation Planning Guidance, 2008.

FEMA, Flood Insurance Rate Maps for Cambridge, MA, 2010.

New England Seismic Network, Boston College Weston Observatory, website:

<http://aki.bc.edu/index.htm>

Northeast States Emergency Consortium, website

<http://www.nesec.org/>

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## **APPENDIX A**

### **MEETING AGENDAS**



Don Boyce  
DIRECTOR



Edward M. Lambert Jr.  
COMMISSIONER



Marc D. Draisen  
EXECUTIVE DIRECTOR

## THE COMMONWEALTH OF MASSACHUSETTS

*Deval Patrick, Governor*

### MASSACHUSETTS EMERGENCY MANAGEMENT AGENCY

400 WORCESTER ROAD, FRAMINGHAM, MA 01702-5399 508-820-2000 FAX 508-820-1404

### DEPARTMENT OF CONSERVATION AND RECREATION

251 CAUSEWAY STREET, SUITE 600-900, BOSTON, MA 02114-2104 617-626-1250 FAX 617-626-1351

### METROPOLITAN AREA PLANNING COUNCIL

60 TEMPLE PLACE, 6<sup>TH</sup> FLOOR, BOSTON, MA 02111 617-451-2770 FAX 617-482-7185

## Metro Boston Hazard Mitigation Planning Team

### First Meeting

**Wednesday, April 13, 10:00 AM**

Everett City Hall, Keverian Room (3<sup>rd</sup> floor)  
484 Broadway (Route 99), Everett

### AGENDA

#### METRO BOSTON HAZARD MITIGATION PLANNING TEAM

Boston  
Brookline  
Cambridge  
Chelsea  
Everett  
Malden  
Medford  
Somerville

#### 10:00 WELCOME & INTRODUCTIONS

#### 10:10 OVERVIEW OF HAZARD MITIGATION PLANNING & GRANTS

- State Hazard Mitigation Plan & FEMA Grants—Sarah White, MEMA
- FEMA Hazard Mitigation Program and Grants – Nan Johnson, FEMA
- Regional & Local Mitigation Plans - Martin Pillsbury, MAPC

#### 10:30 UPDATING THE METRO BOSTON HAZARD MITIGATION PLAN

- FEMA Requirements & Grant Eligibility
- Review of Scope of Work & Schedule –MAPC
- Questions & Discussion – Local issues & Priorities

#### 11:00 GETTING STARTED: MAPPING AND CRITICAL FACILITIES DATABASE FOR THE METRO BOSTON PLAN UPDATE

- Susan Brunton, GIS Analyst, MAPC

#### 11:20 NEXT STEPS

#### 11:30 ADJOURN

If you have any questions please contact Martin Pillsbury at MAPC:  
617-451-2770, ext. 2012 or [mpillsbury@mapc.org](mailto:mpillsbury@mapc.org)

**Local Team Meeting #1 Agenda  
Local Natural Hazard Plan Update  
City of Cambridge**

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- |  |         |
|--|---------|
| 1) Welcome and Introductions   | 1:00 PM |
| 2) Overview of Project   | 1:10 PM |
| 3) Introduce City of Cambridge Hazard Mitigation Planning Map Series and Digitized Ortho Photo Map.  | 1:15 PM |
| 4) Identify:   | 1:25 PM |
| <ul style="list-style-type: none"> <li>a) Flood Hazard Areas<br/><small>(incl. areas with concentration of repetitive loss properties)</small></li> <li>b) Fire Hazard Areas<br/><small>(incl. approx. # of annual wildfires and recent incidences that resulted in property damage)</small></li> <li>c) Other Hazards and their Profiles</li> <li>d) Future Potential Development Areas</li> <li>e) Historical, Cultural or Natural Resource Areas</li> <li>f) Dams (incl. type and ownership)</li> </ul> |         |
| 5) Review and Assess Plan Goals (see over)   | 2:15 PM |
| 6) Discuss Public Involvement and Outreach (see over)  | 2:30 PM |
| 7) Set Date for First Public Meeting and Discuss Public Outreach   | 2:45 PM |
| 8) Conclude and Set Tentative Date Second Staff Meeting to:  | 2:55 PM |
| <ul style="list-style-type: none"> <li>a) Review Existing Mitigation Measures</li> <li>b) Review Mitigation Measures from the 2005 Plan</li> <li>c) Discuss Potential Mitigation Measures</li> <li>d) Prioritize Mitigation Measures</li> </ul>  |         |

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**Project Overview** - MAPC received a grant to prepare natural hazards *Pre-Disaster Mitigation Plan* for the communities of Boston, Brookline, Cambridge, Chelsea, Everett, Malden, Medford and Somerville. MAPC is working with the eight communities to update their plans to mitigate potential damages of natural hazards such as floods, winter storms, hurricanes, earthquakes and wild fires, before such hazards occur. The federal *Disaster Mitigation Act of 2000* requires that all municipalities adopt a *Pre-Disaster Mitigation Plan* for natural hazards in order to remain eligible for FEMA Disaster Mitigation Grants.

This FEMA planning program is separate from new or ongoing homeland security initiatives, and is focused solely on addressing natural hazards, although some of the data collected for this plan may be useful for other aspects of emergency planning as well.

**Local Team Meeting #3 Agenda  
Local Natural Hazard Plan Update  
June 2013  
City of Cambridge**

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- |   |         |
|---|---------|
| 1) Welcome and Introductions  | 1:30 PM |
| 2) Project Update   | 1:35 PM |
| a) Public Meetings  |         |
| b) Critical Infrastructure  |         |
| 3) Conclude and Set Tentative Date Second Staff Meeting to:             | 1:45 PM |
| a) Discuss Progress on 2008 Plan Implementation and Maintenance         |         |
| b) Review Existing Mitigation Measures                                  |         |
| c) Review Status of Proposed New Mitigation Measures from the 2008 Plan |         |
| d) Identify and Discuss Potential New Mitigation Measures for Update    |         |
| e) Prioritize Mitigation Measures for Update                            |         |
| 4) Plan for Second Public Meeting and related Public Outreach           | 3:15 PM |
| 5) Meeting Conclusion   | 3:30 PM |

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This FEMA planning program is separate from new or ongoing homeland security initiatives, and is focused solely on addressing natural hazards, although some of the data collected for this plan may be useful for other aspects of emergency planning as well.

## **APPENDIX B**

### **HAZARD MAPPING**

The MAPC GIS (Geographic Information Systems) Lab produced a series of maps for each community. Some of the data came from the Northeast States Emergency Consortium (NESEC). More information on NESEC can be found at <http://www.serve.com/NESEC/>. Due to the various sources for the data and varying levels of accuracy, the identification of an area as being in one of the hazard categories must be considered as a general classification that should always be supplemented with more local knowledge. The documentation for some of the hazard maps was incomplete as well.

The map series consists of four panels with two maps each plus one map taken from the State Hazard Mitigation Plan.

Map 1.	Population Density
Map 2.	Potential Development
Map 3.	Flood Zones
Map 4.	Earthquakes and Landslides
Map 5.	Hurricanes and Tornadoes
Map 6.	Average Snowfall
Map 7.	Composite Natural Hazards
Map 8.	Hazard Areas

**Map 1: Population Density** – This map uses the US Census block data for 2000 and shows population density as the number of people per acre in seven categories with 60 or more people per acre representing the highest density areas.

**Map 2: Development** – This map shows potential future developments, and critical infrastructure sites. MAPC consulted with City staff to determine areas that were likely to be developed or redeveloped in the future. The map also depicts current land use.

**Map 3: Flood Zones** – The map of flood zones used the FEMA NFIP Flood Zones as depicted on the FIRMs (Federal Insurance Rate Maps) as its source. At the time this plan was developed, these flood zones had not yet been officially adopted and were therefore considered draft. This map is not intended for use in determining whether or not a specific property is located within a FEMA NFIP flood zone. The currently adopted FIRMS for Cambridge are kept by the City. For more information, refer to the FEMA Map Service Center website <http://www.msc.fema.gov>. The definitions of the flood zones are described in detail on this site as well. The flood zone map for each community also shows critical infrastructure and repetitive loss areas.

**Map 4: Earthquakes and Landslides** – This information came from NESEC. For most communities, there was no data for earthquakes because only the epicenters of an earthquake are mapped.

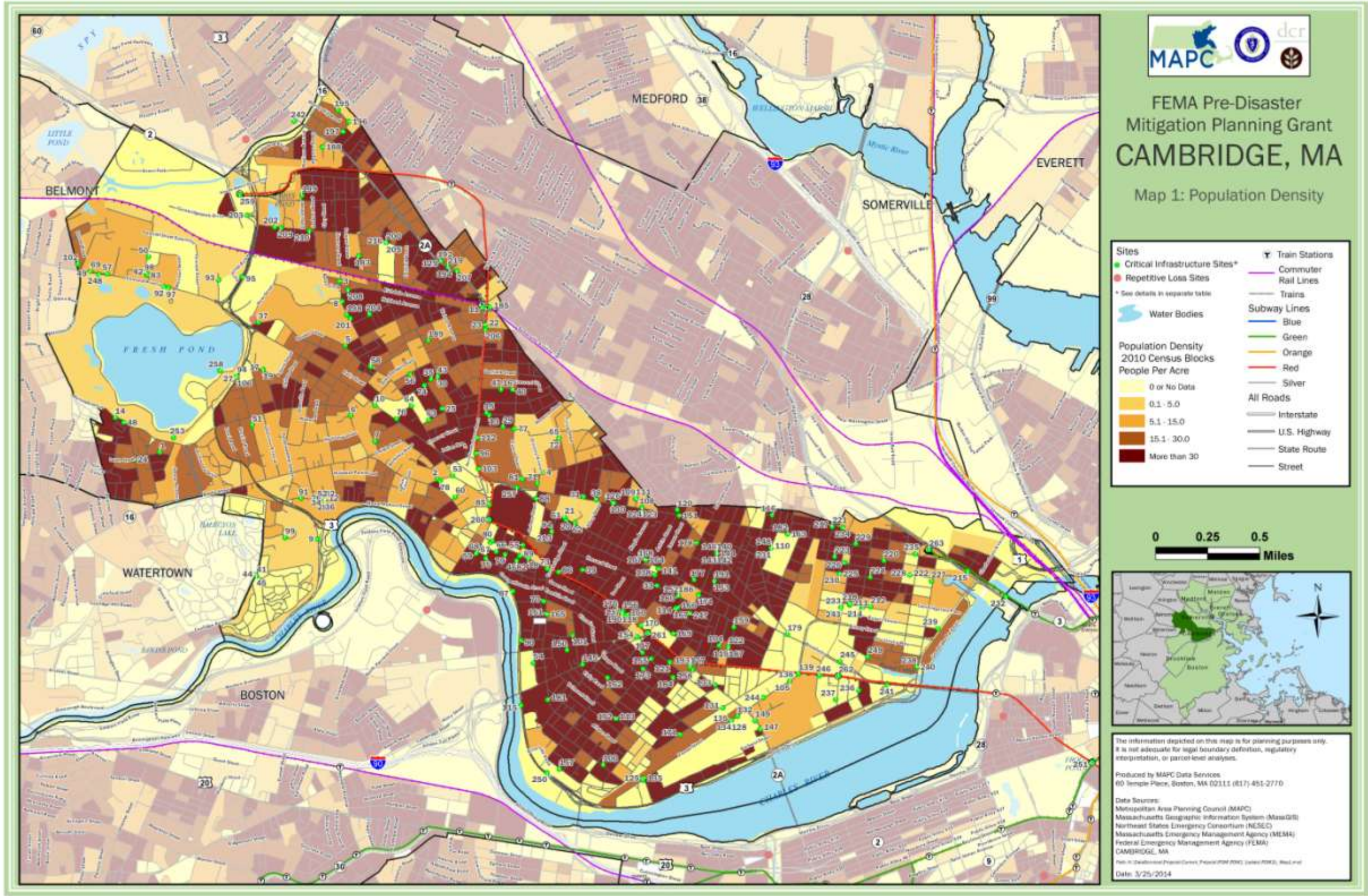
The landslide information shows areas with either a low susceptibility or a moderate susceptibility to landslides based on mapping of geological formations. This mapping is highly general in nature. For more information on how landslide susceptibility was mapped, refer to <http://pubs.usgs.gov/pp/p1183/pp1183.html>.

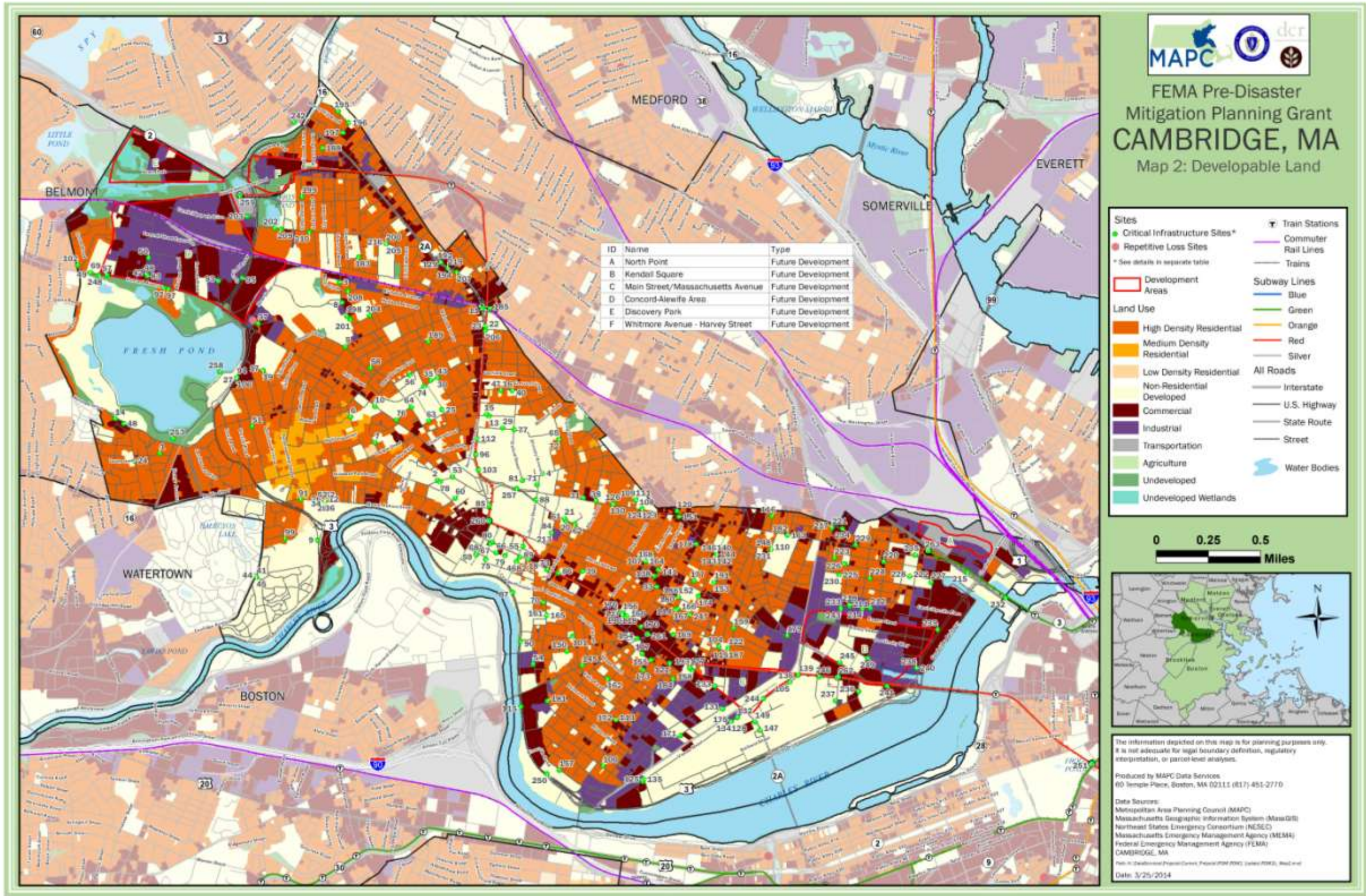
**Map 5: Hurricanes and Tornadoes** – This map shows a number of different items. The map includes the storm tracks for both hurricanes and tropical storms. This information must be viewed in context. A storm track only shows where the eye of the storm passed through. In most cases, the effects of the wind and rain from these storms were felt in other communities even if the track was not within that community. This map also shows the location of tornadoes with a classification as to the level of damages. What appears on the map varies by community since not all communities experience the same wind-related events. These maps also show the 100 year wind speed.

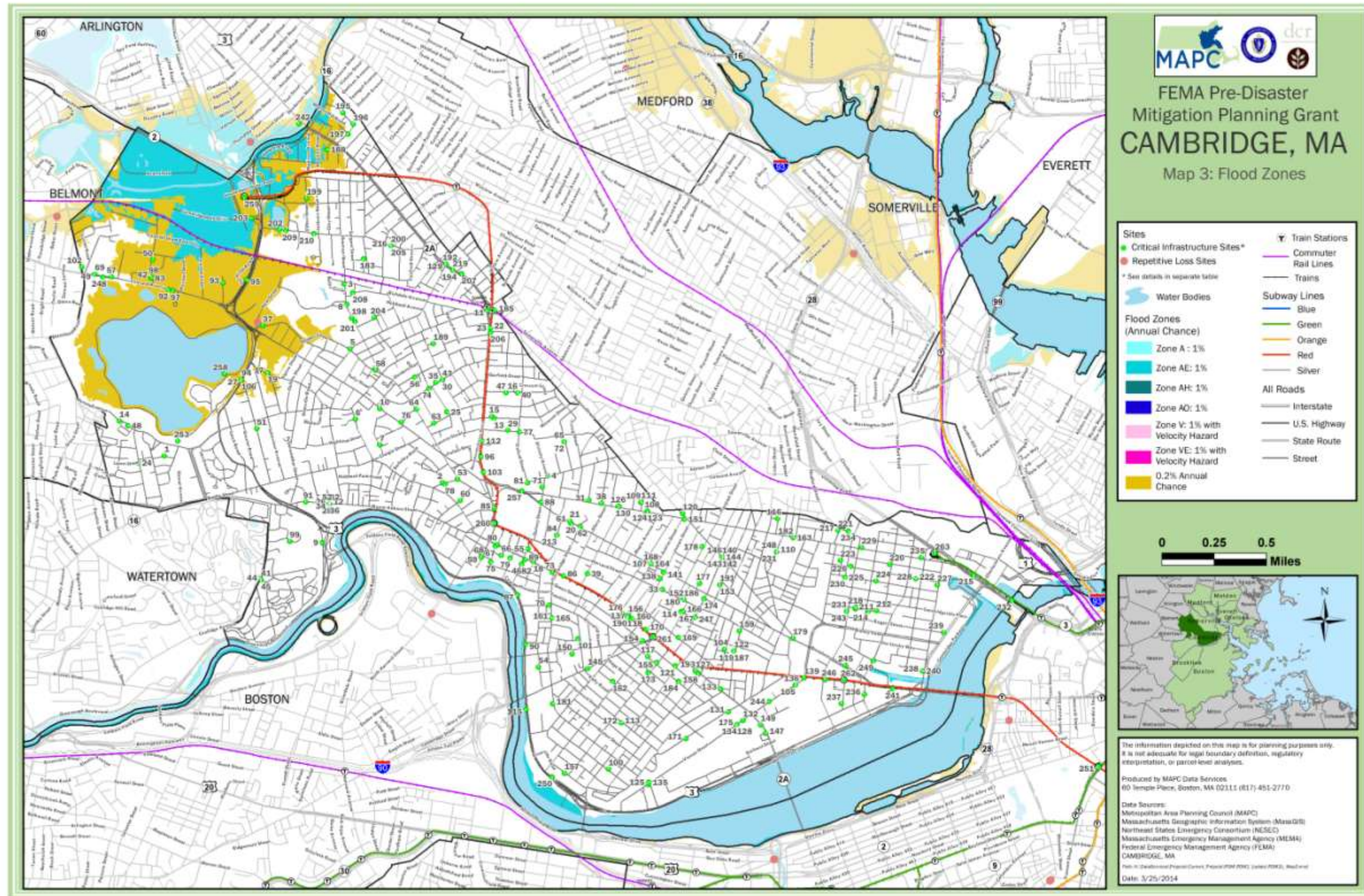
**Map 6: Average Snowfall** - This map shows the average snowfall and open space. It also shows storm tracks for nor'easters, if any storms tracked through the community.

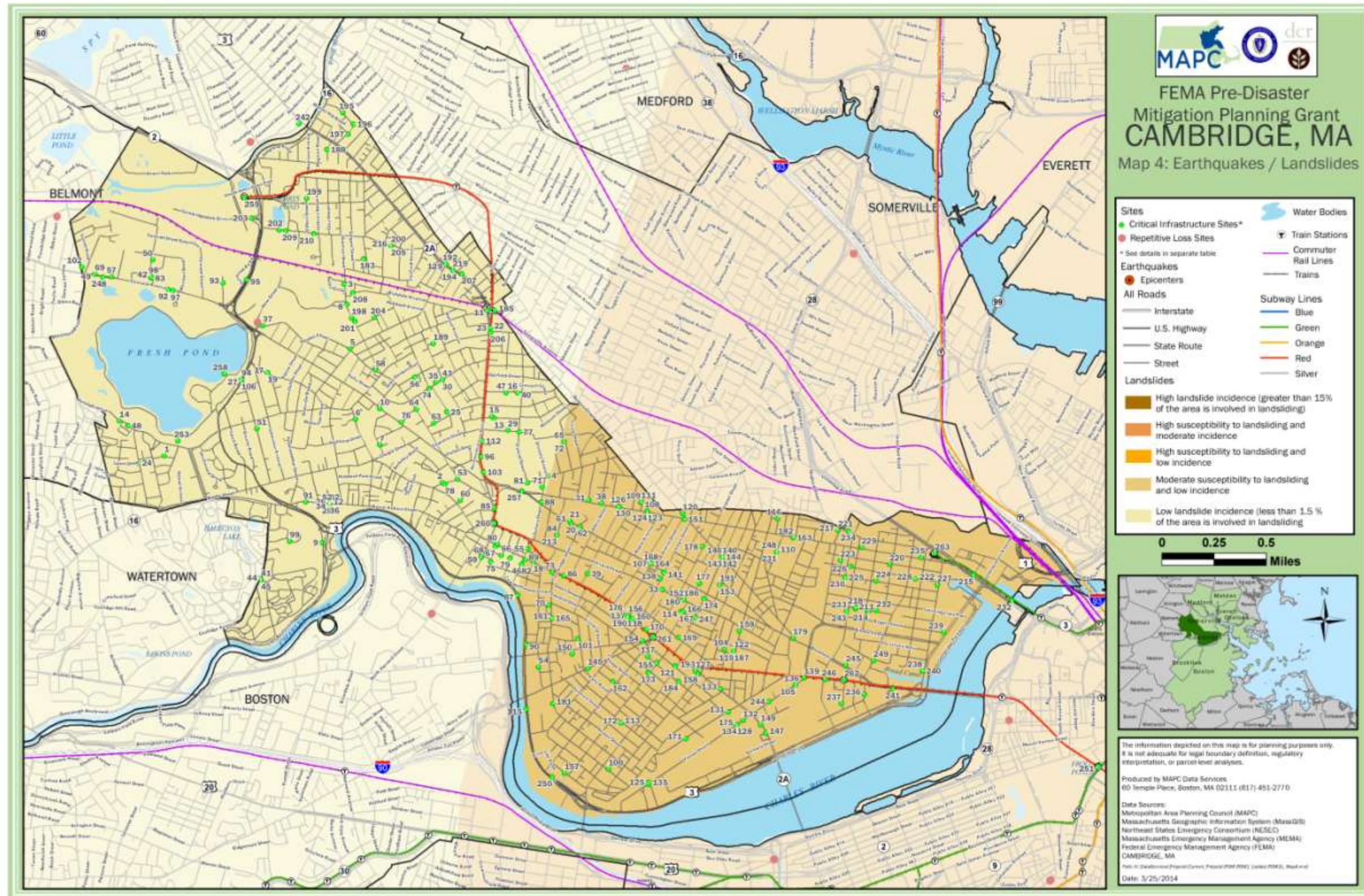
**Map 7: Composite Natural Hazards** - This map shows four categories of composite natural hazards for areas of existing development. The hazards included in this map are 100 year wind speeds of 110 mph or higher, low, and moderate landslide risk, FEMA Q3 flood zones (100 year and 500 year) and hurricane surge inundation areas. Areas with only one hazard were considered to be low hazard areas. Moderate areas have two of the hazards present. High hazard areas have three hazards present and severe hazard areas have four hazards present.

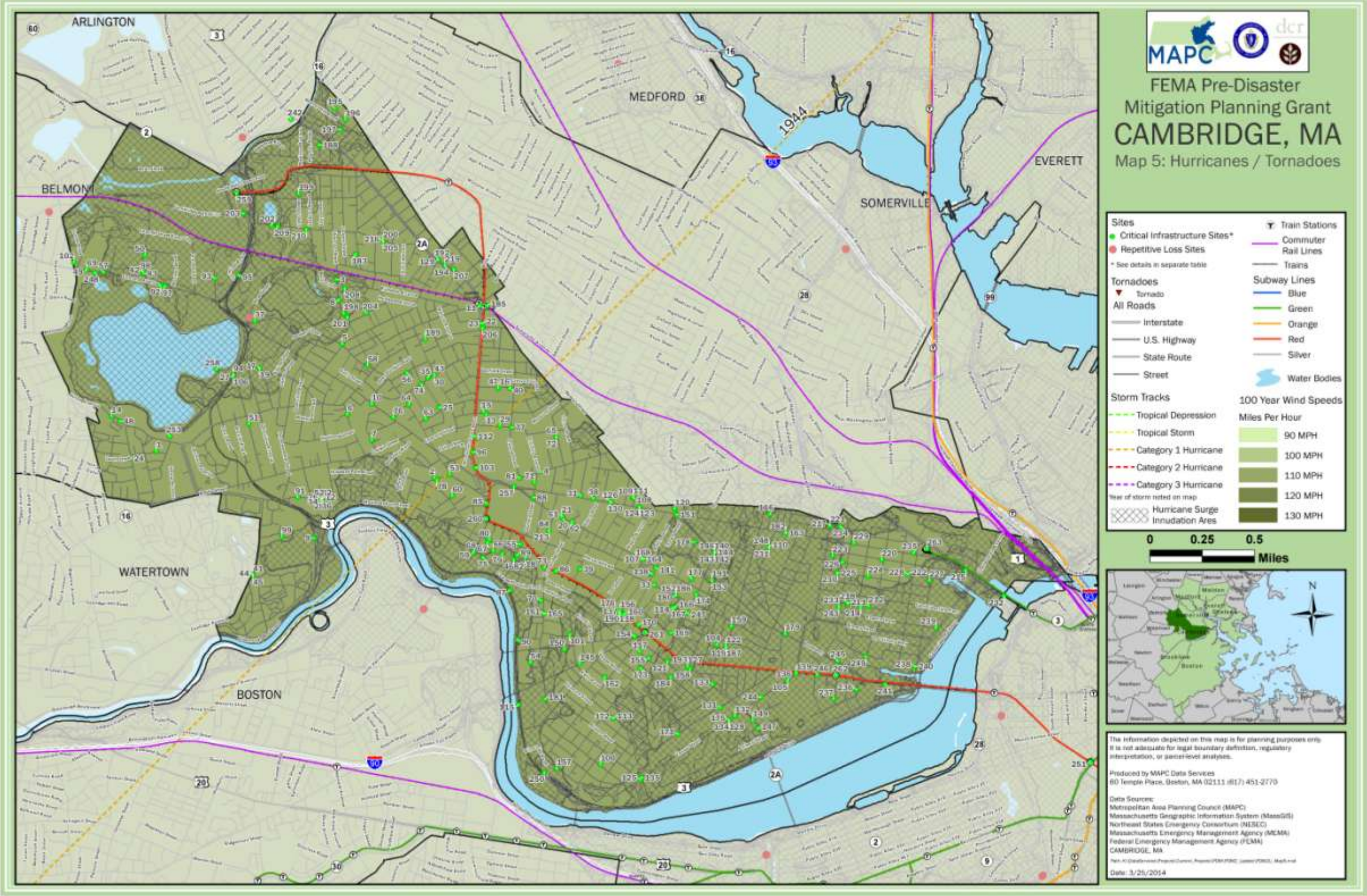
**Map 8: Hazard Areas** – For each community, locally identified hazard areas are overlaid on an aerial photograph dated April, 2008. The critical infrastructure sites are also shown. The source of the aerial photograph is Mass GIS.

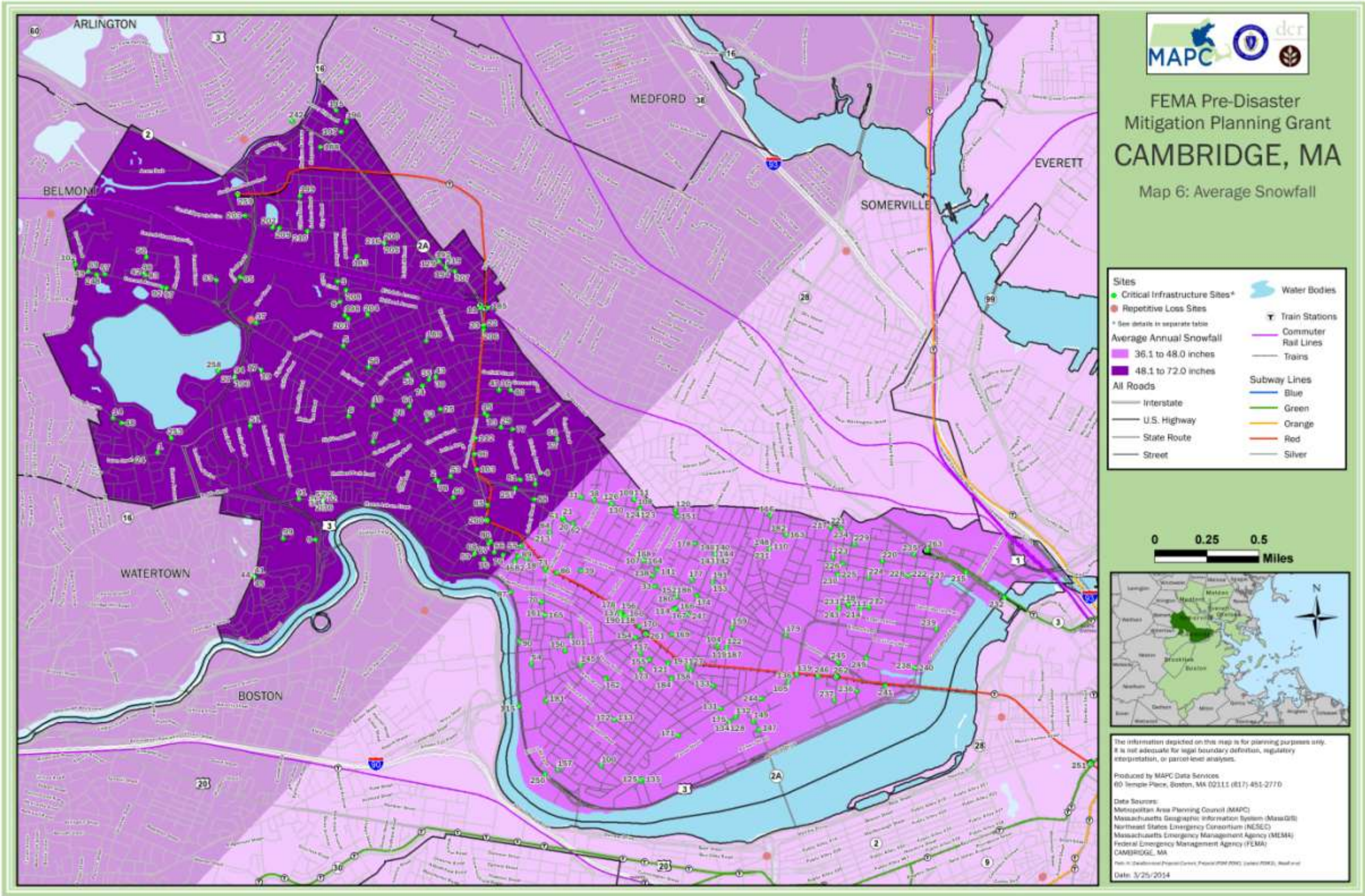


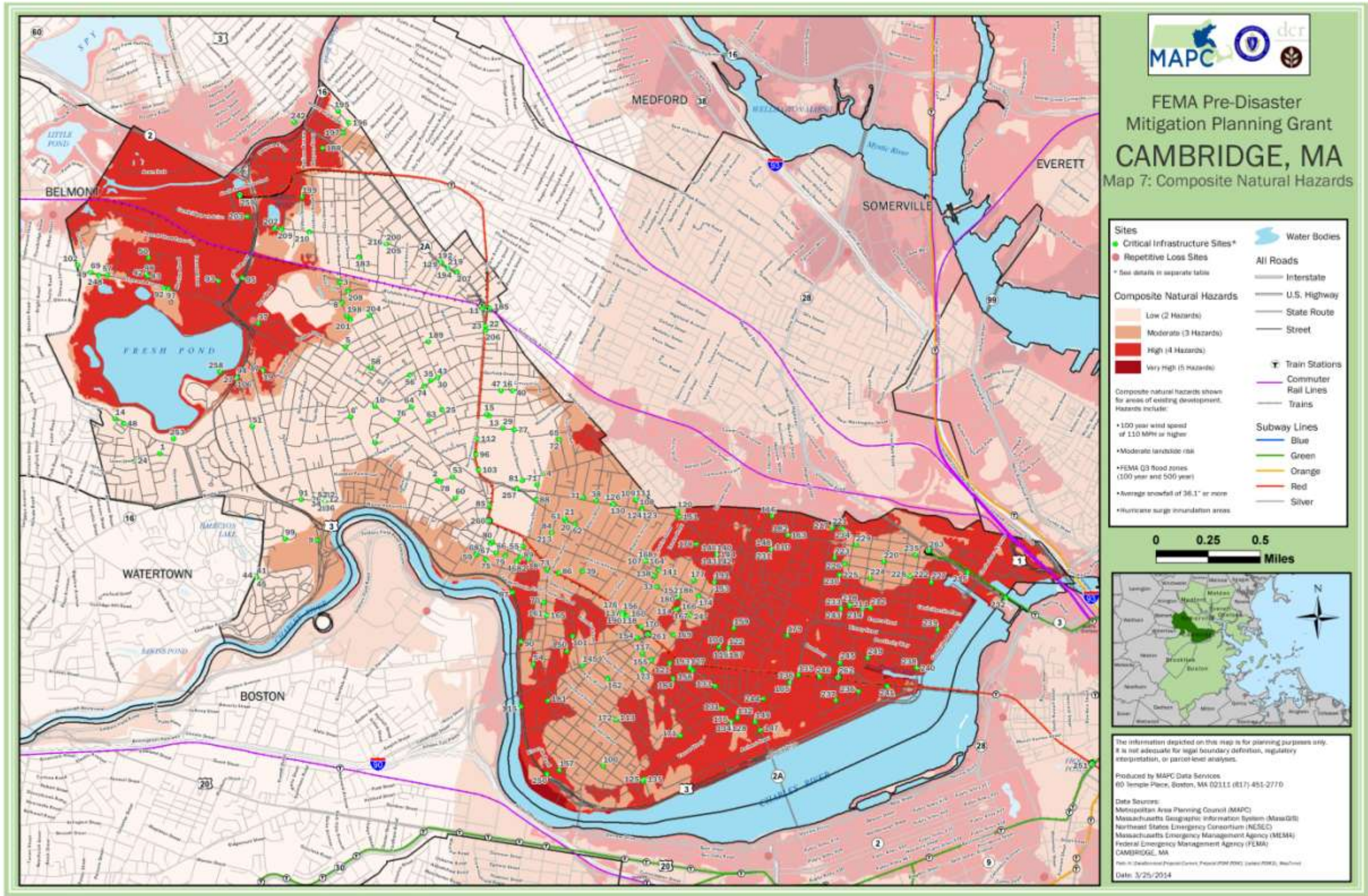


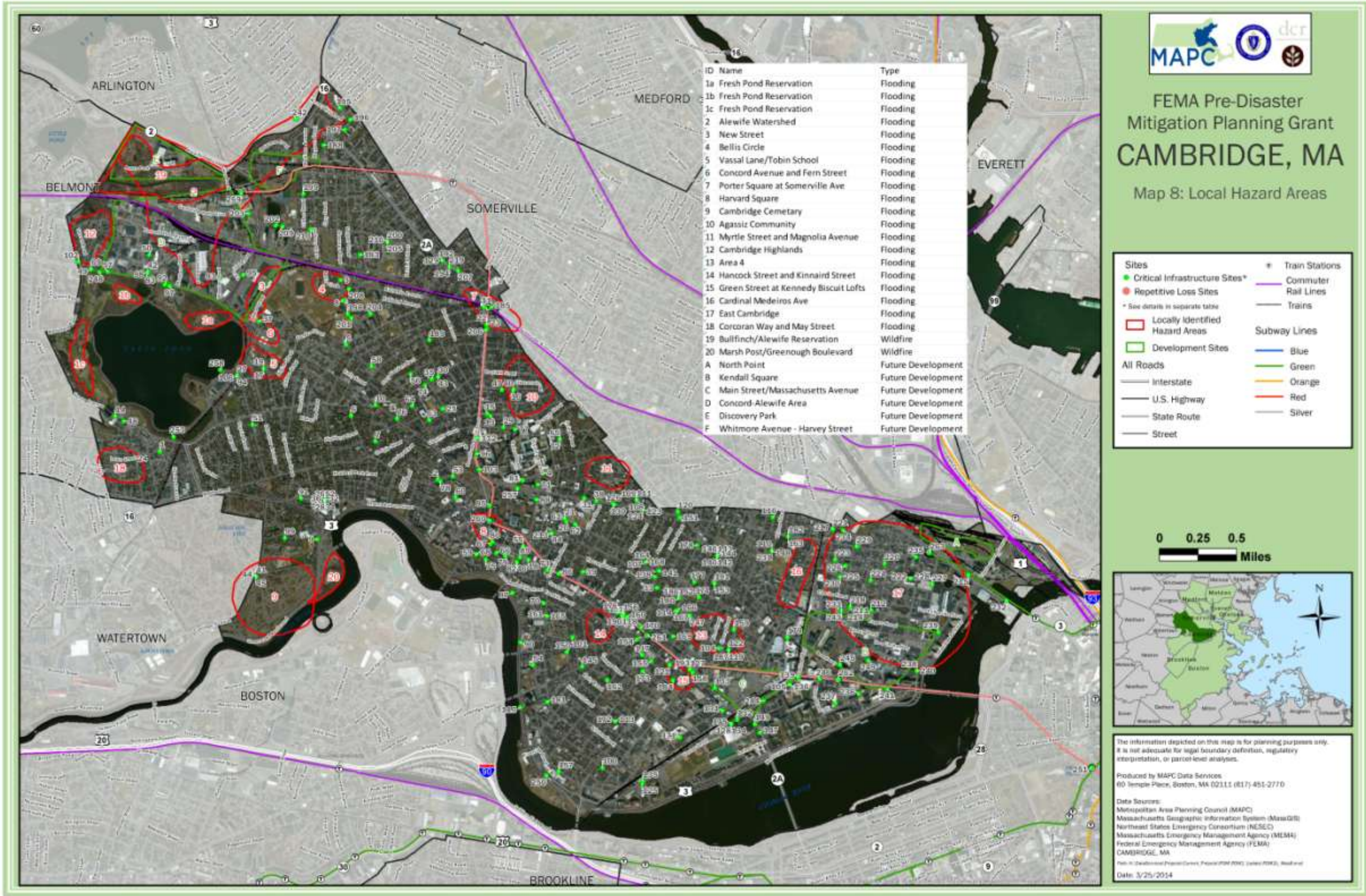




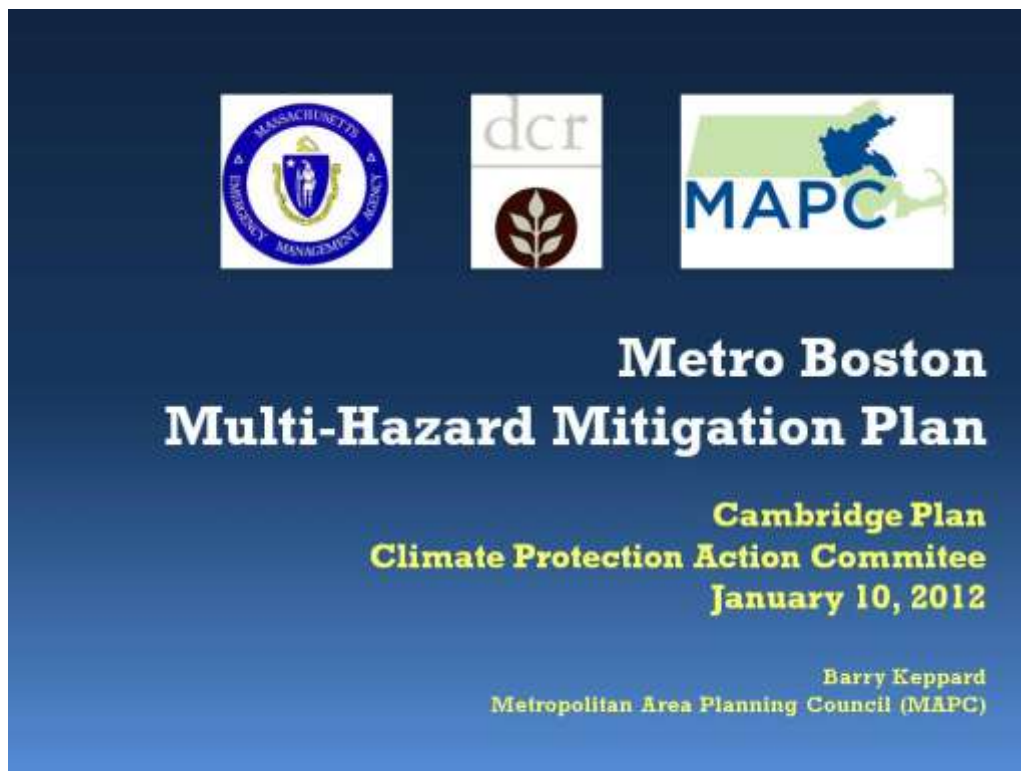








**APPENDIX C**  
**DOCUMENTATION OF PUBLIC PARTICIPATION**



# HAZARD MITIGATION PLAN PUBLIC MEETING

*Natural hazards can have serious impacts on the  
City of Cambridge and its residents*



The Cambridge Hazard Mitigation Plan presents a strategy for reducing the City's vulnerability to the impacts of natural hazard events such as flooding, hurricanes, and winter storms.

Join the City for a presentation and discussion about the update to the Cambridge Hazard Mitigation Plan

**Date: Tuesday, March 18, 2014**

**Time: 6:30PM -7:30PM**

**Location: Department of Public Works  
147 Hampshire Street**

For more information, please contact

Barry Keppard via phone at (617) 933-0750 or  
email [bkeppard@mapc.org](mailto:bkeppard@mapc.org)



*If you need any special accommodations, such as language interpretation, assistive listening devices or meeting materials in alternate formats, please use the contact information above to notify us in advance. We would appreciate notice as soon as possible, but at least one week prior to the event would be appreciated.*



# **Metro Boston Multi-Hazard Mitigation Plan**

**Cambridge Plan Update  
DPW Building  
March 18, 2014**

**Barry Keppard  
Metropolitan Area Planning Council (MAPC)**

**APPENDIX D**  
**DOCUMENTATION OF PLAN ADOPTION**

## **DOCUMENTATION OF PLAN ADOPTION**

[To be added to final plan after adoption by the City]