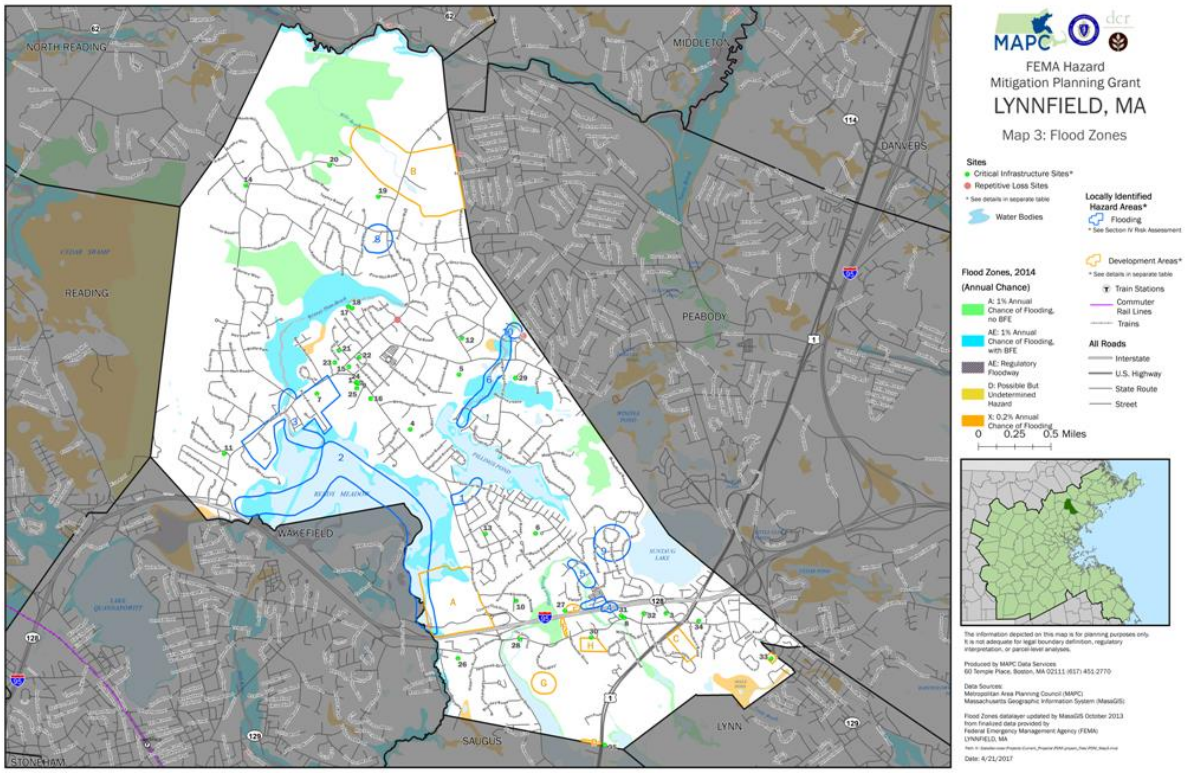
TOWN OF LYNNFIELD
HAZARD MITIGATION PLAN
2018 UPDATE



Final Plan
Adopted by the Town
June 18, 2018

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TOWN OF LYNNFIELD HAZARD MITIGATION PLAN
2018 UPDATE

ACKNOWLEDGEMENTS AND CREDITS

This plan was prepared for the Town of Lynnfield 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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Jim Boudreau	Town Administrator

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TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

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

This is an update of the original Lynnfield Hazard Mitigation Plan, which was adopted by Lynnfield on August 7, 2008. Planning for the Hazard Mitigation Plan update was led by the Lynnfield Local Hazard Mitigation Planning Team, composed of staff from a number of different Town Departments. This team met on November 22, 2016 and September 29, 2017 and discussed where the impacts of natural hazards most affect the Town, goals for addressing these impacts, updates to the Town's existing mitigation measures and new or revised hazard mitigation measures that would benefit the Town.

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 Town takes to mitigate them. The Town's Community Planning and Development Commission hosted two public meetings, the first on April 26, 2017 and the second on November 29, 2017 and the draft plan update was posted on the Town's website for public review. Key Town stakeholders and neighboring communities were notified and invited to review the draft plan and submit comments. See list of outreach contacts and press releases in Appendix C. No public comments on the draft plan were received by the town.

Risk Assessment

The Lynnfield Hazard Mitigation Plan assesses the potential impacts to the Town from flooding, high winds, winter storms, brush fire, geologic hazards, extreme temperatures, and drought. Flooding, driven by hurricanes, northeasters and other storms, clearly presents the greatest hazard to the Town. These are shown on the map series (Appendix B).

The Lynnfield Local Hazard Mitigation Planning Team identified 35 Critical Facilities. These are also shown on the map series and listed in Table 20, identifying which facilities are located within the mapped hazard zones.

A HAZUS-MH analysis provided estimates of damages from Hurricanes of category 2 and 4 ($10,288.22 thousand to $39,554.12 thousand) as well as earthquakes of magnitudes 5 and 7 ($174.46million to $1,378.44 million). Flood damage estimates range from $0 million to $0.06 million.

Hazard Mitigation Goals

The Lynnfield Local Hazard Mitigation Planning Team identified the following hazard mitigation goals for the Town:

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

2. Build and enhance local mitigation capabilities to ensure individual safety, reduce damage to public and private property and ensure continuity of emergency services.

3. Increase cooperation and coordination among private entities, Town officials and Boards, State agencies and Federal agencies.

4. Increase awareness of the benefits of hazard mitigation through outreach and education.

Hazard Mitigation Strategy

The Lynnfield Local Hazard Mitigation Planning Team identified a number of mitigation measures that would serve to reduce the Town's vulnerability to natural hazard events. Lynnfield would like to resubmit an EIR for work within the Saugus River/Reedy Meadow watershed area and finish making permanent repairs to the Pillings Pond Dam. Several of the Town's high priority drainage infrastructure projects are located between Fletcher Road and Timberhill Road and the Town would like to conduct an overall drainage study for this area. Lynnfield staff continue to work with the Lynn Water and Sewer Commission to clean and maintain streams and infrastructure and the Town hopes to collaborate with the Northeast Massachusetts Mosquito Control Board (NMMC) in order to maintain key drainage ditches and brooks. The Town recently completed a new 10-year Capital Improvements Plan.

Overall, the hazard mitigation strategy recognizes that mitigating hazards for Lynnfield 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. Global climate change and a variety of other factors impact the Town's vulnerability and in the future. Local officials will need to work together across municipal lines and with state and federal agencies in order to understand and address these changes. The Hazard Mitigation Strategy will be incorporated into the Town's other related plans and policies.

Plan Review and Update Process

Table 1 Plan Review and Update

Chapter	Reviews and Updates
III – Public Participation	The Local Hazard Mitigation Planning Team placed an emphasis on 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 two public meetings hosted by the Community Planning and Development Commission. The plan was also available on the Town's website for public comment.
IV – Risk Assessment	MAPC gathered the most recently available hazard and land use data and met with Town staff to identify changes in local hazard areas and development trends. Town 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 and endorsed by the Lynnfield Local Hazard Mitigation Planning Team.
VI – Existing Mitigation Measures	The list of existing mitigation measures was updated to reflect current mitigation activities in the Town.
VII & VIII – Hazard Mitigation Strategy	Mitigation measures from the 2008 plan were reviewed and assessed as to whether they were completed, in-progress, or deferred. The Local Hazard Mitigation Planning Team determined whether to carry forward measures into the 2018 Plan Update or modify or delete them. The Plan Update's hazard mitigation strategy reflects both new measures and measures carried forward from the 2008 plan. The Local Hazard Mitigation Team prioritized all of these 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 Town in incorporating hazard mitigation issues into other Town planning and regulatory review processes and better prepare the Town for the next comprehensive plan update.

As indicated on Table 27, Lynnfield made progress on implementing mitigation measures identified in the 2008 Hazard Mitigation Plan. Several projects have been completed, including installing upgraded replacement culverts at Yorkshire Drive, completing drainage upgrades in the Grey Lane neighborhood and collaborating with the Lynn Water and Sewer Commission to have Hawkes Brook near Salem Street and Route 128 cleaned of debris and silt to prevent flooding reoccurrences. Lynnfield also adopted a stormwater

management bylaw and regulations in 2010 and has updated its site plan review requirements for adding pervious surfaces that contribute to stormwater runoff and flooding.

Other projects were partially completed, most notably the Saugus River/Reedy Meadow Environmental Impact Review, the Pillings Pond Dam work, drainage work along Beaver Dam Brook, upgrades to drainage for the Summer Street/Rout 128 overpass area, the restoration of Hawkes Brook to improve drainage and reduce flooding, and drainage improvements at Pyburn Road. These mitigation measures, excepting Pyburn Road, will be continued in this 2018 Plan Update.

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

Though not formally done in the 2008 Plan, the Town will document any actions taken within this iteration of the Hazard Mitigation Plan on challenges met and actions successfully adopted as part of the ongoing plan maintenance to be conducted by the Lynnfield Hazard Mitigation Implementation Team, as described in Section IX, Plan Adoption and Maintenance.

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).

The Metropolitan Area Planning Council (MAPC) subcontracted with the Town of Lynnfield to update its local Hazard Mitigation Plans, which was first adopted in 2008. The local Hazard Mitigation Plan update produced under this grant is designed to individually meet the requirements of the Disaster Mitigation Act for each community while listing regional concerns and hazards that impact the Town or City creating the plan.

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 Town of Lynnfield, a part of Essex County, has experienced 20 natural hazards that triggered federal or state disaster declarations since 1991. These are listed in Table 2 below. The majority of these events involved flooding, while five were due to hurricanes or nor'easters, and four were due to severe winter weather.

Table 2 Previous Federal/State Disaster Declarations

DISASTER NAME (DATE OF EVENT)	TYPE OF ASSISTANCE	DECLARED AREAS
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
	FEMA Individual Household Program	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (10 projects)
March Blizzard (March 1993)	FEMA Public Assistance Project Grants	All 14 Counties
January Blizzard (January 1996)	FEMA Public Assistance Project Grants	All 14 Counties
May Windstorm (May 1996)	State Public Assistance Project Grants	Counties of Plymouth, Norfolk, Bristol
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 (36 projects)

DISASTER NAME (DATE OF EVENT)	TYPE OF ASSISTANCE	DECLARED AREAS
1997	Community Development Block Grant-HUD	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
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 (19 projects)
(1998)`	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	All 14 Counties
January Blizzard (January 22-23, 2005)	FEMA Public Assistance Project Grants	All 14 Counties
Hurricane Katrina (August 29, 2005)	FEMA Public Assistance Project Grants	All 14 Counties
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

DISASTER NAME (DATE OF EVENT)	TYPE OF ASSISTANCE	DECLARED AREAS
Tropical Storm Irene (August 27-28, 2011)	FEMA Public Assistance	Statewide
Hurricane Sandy (October 27-30, 2012)	FEMA Public Assistance	Statewide
Severe snowstorm and Flooding (February 8-09, 2013	FEMA Public Assistance; Hazard Mitigation Grant Program	Statewide
Blizzard of 2015 (January 26-28, 2015)	FEMA Public Assistance; Hazard Mitigation Grant Program	Statewide

Source: database provided by MEMA)

FEMA Funded Mitigation Projects

The Town of Lynnfield has received funding from FEMA for one mitigation project under the Hazard Mitigation Grant Program (HMGP).

Project Description/Title	Scope of Work	Total Project Cost (100%)	Federal Funding	Local Funding	Project Status
Yorkshire Drive Drainage Improvements	Installation of new drainage structure and piping designed to handle a 25-year storm event.	$85,746	$59,604	$26,142	Completed

Community Profile

The Town of Lynnfield is a traditional New England residential community located in the western part of Essex County, in the northeastern part of Massachusetts, known as the North Shore. Lynnfield is bordered by North Reading on the north; Reading on the west; Middleton, Peabody and Lynn on the east; and Saugus and Wakefield on the south. With a total area of 10.22 square miles, Lynnfield is 15 miles north of Boston, 19 miles east of Concord and 28 miles south of Newburyport. Lynnfield's location on the North Shore, with direct access to major highways, makes it easy for residents to commute within

Metro Boston, and to access nearby mountains and beaches. (Town of Lynnfield Housing Production Plan, 2006)

The Town is governed by a Board of Selectmen with a Town manager. The Town operates under a representative Town meeting format. The 2010 population was 11,596 people and there were 7,251 housing units. (2010 US Census)

The Town maintains a website at http://www.town.lynnfield.ma.us/Pages/index

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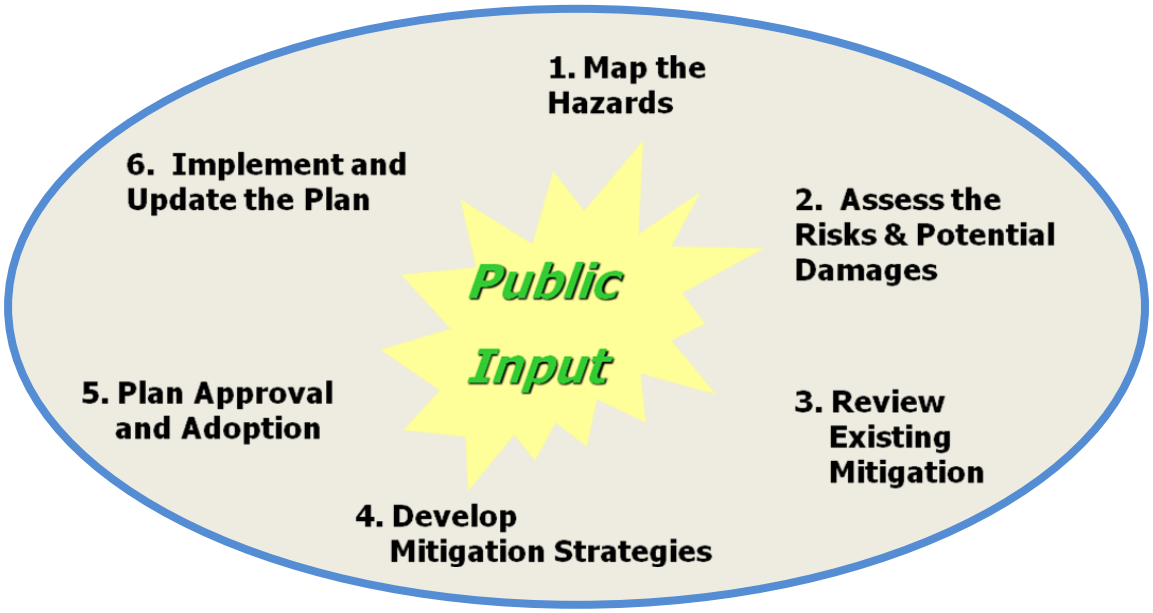
III. PLANNING PROCESS AND PUBLIC PARTICIPATION

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 Teams, two public meetings hosted by the local Hazard Mitigation Team, posting of the plan to the Town's website, and invitations sent to neighboring communities, Town boards and commissions, the local chamber of commerce, 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. 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. MAPC is also 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.



- 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.

- 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. MAPC drew on the following resources to complete the plan:

    - Town of Lynnfield, General Bylaws
    - Town of Lynnfield, Zoning Bylaw
    - Town of Lynnfield Master Plan 2002
    - Town of Lynnfield Open Space Plan, 2010
    - Massachusetts State Hazard Mitigation Plan, 2013
    - FEMA, Local Mitigation Plan Review Guide; October 1, 2011
    - FEMA, Flood Insurance Rate Maps for Essex County, MA, 2014
    - Metropolitan Area Planning Council, GIS Lab, Regional Plans and Data.
    - New England Seismic Network, Boston College Weston Observatory, http://aki.bc.edu/index.htm
    - NOAA National Climatic Data Center, http://www.ncdc.noaa.gov/
    - Northeast States Emergency Consortium, http://www.nesec.org/
    - USGS, National Water Information System, http://nwis.waterdata.usgs.gov/usa/nwis
    - US Census, 2010

- Review Existing Mitigation – Municipalities in the Boston Metropolitan Region have an active history in hazard mitigation as most 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.

- 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.

- 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 (Approval Pending Adoption), 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.

- 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.

The Local Multiple Hazard Community Planning Team

MAPC worked with the local community representatives to organize a local Multiple Hazard Community Planning Team for Lynnfield (Local Committee). MAPC briefed the local representatives as to the desired composition of that team as well as the need for representation from the business community, civic organizations and citizens at large.

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. The local team was tasked with working with MAPC to set plan goals, provide information on the hazards that impact the Town, existing mitigation measures, and helping to develop new mitigation measures for this plan update. The Local Hazard Mitigation Planning Team membership can be found in Table 3 below.

The Lynnfield Planning Board, as well as the Lynnfield Conservation Commission, are the primary entities responsible for regulating development in town. Feedback from the Planning Board and the Conservation Commission was assured through the participation of the Lynnfield Planning Department and the Conservation Administrator, as well as the Town Administrator, who oversees all town functions. The Planning Board hosted two public meetings on the plan, in April and November of 2017. In addition, MAPC, the State designated regional planning authority for Lynnfield, works with all agencies that that regulate development in the region, including the listed municipal entities and state agencies, such as the MassDOT.

On July 20, 2016, MAPC and MEMA staff held a meeting with the Local Committee to outline the hazard mitigation planning and updating process at Lynnfield Town Hall.

On May 23, 2016, MAPC conducted a meeting of the Lynnfield Local Committee. The meeting was organized by Town Engineer Charles Richter. The purpose of the meeting was to review and develop hazard mitigation goals, review the status of mitigation measures identified in the 2008 hazard mitigation plan, identify new potential mitigation measures and to gather information on local hazard mitigation issues and sites or areas

related to these. The meeting also covered measures to be carried forward from the previous plan and to prioritize new measures.

The following Table lists the attendees at each meeting of the team. The agendas for these meetings are included in Appendix A.

The agendas for these meetings are included in Appendix A.

Table 3
Membership of the Lynnfield Hazard Mitigation Planning Team

Name	Representing
Charles Richter	Town Engineer
Mark Tetreault	Emergency Management Director
Kathy L. Randele	Planning and Land Use Assistant
Betty Adelson	Conservation Administrator
Jim Boudreau	Town Administrator

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 Town hosted two public meetings, one during the planning process and one after a complete draft plan is 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 members of the public 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, expanding the audience that has the opportunity to hear the presentation and provide comment.

The public had an opportunity to provide input to the Lynnfield hazard mitigation planning process during a meeting on April 26, 2017 held in the Town Hall. The draft plan update was presented at a Planning Board meeting held on November 29, 2017 in

Lynnfield Town Hall. Both meetings were publicized as regular meetings of the Community Planning and Development Commission according to the Massachusetts Public Meeting Law. The attendance list for each meeting can be found in Table 4. See public meeting notices in Appendix C.

Table 4
Lynnfield Public Meetings

Name	**Representing**
Meeting #1 April 26, 2017	
Brian R. Charville	Lynnfield Planning Board
Heather T. Sievers, Vice Chairman	Lynnfield Planning Board
Charles B. Wills, Clerk	Lynnfield Planning Board
Michael J. Sheehan	Lynnfield Planning Board
Sam Cleaves	MAPC
Approximately 5 members of the public	
Meeting #2 November 29, 2017	
Brian R. Charville, Chairman	Lynnfield Planning Board
Heather T. Sievers, Vice Chairman	Lynnfield Planning Board
Charles B. Wills, Clerk	Lynnfield Planning Board
Michael J. Sheehan	Lynnfield Planning Board
Sam Cleaves	MAPC
Approximately 8 members of the public	

Local Stakeholder Involvement

The local Hazard Mitigation Planning Team was encouraged to reach out to local stakeholders that might have an interest in the Hazard Mitigation Plan including neighboring communities, agencies, businesses, nonprofits, and other interested parties. Notice was sent to the following organizations and neighboring municipalities inviting them to review the Hazard Mitigation Plan and submit comments to the Town: See list of outreach contacts and press releases in Appendix C. However, no public comments on the plan were received by the town.

Town of North Reading
Town of Reading
Town of Wakefield
Town of Saugus
City of Lynn
City of Peabody
Lynnfield/North Lynnfield Chamber of Commerce
Lynnfield Conservation Commission
Lynnfield Villager
Lynnfield Department Heads

Town Web Site

The draft Lynnfield Hazard Mitigation Plan 2018 Update was posted on the Town's website following the second public meeting. Members of the public could access the draft document and submit comments or questions to the Town.

Continuing Public Participation

Following the adoption of the plan update, the planning team will continue to provide residents, businesses, and other stakeholders the opportunity to learn about the hazard mitigation planning process and to contribute information that will update the Town's understanding of local hazard. As updates and a review of the plan are conducted by the Hazard Mitigation Implementation Team, these will be placed on the Town's web site, and any meetings of the Hazard Mitigation Implementation Team will be publicly noticed in accordance with Town and state open meeting laws.

Planning Timeline

July 20, 2016	Kickoff and Review of Scope Meeting with Hazard Mitigation Planning Team, MEMA and MAPC
November 22, 2016	Meeting of the Lynnfield Local Hazard Mitigation Planning Team
April 26, 2017	First Public Meeting with Lynnfield Planning Board
November 29 ,2017	Second Public Meeting with Lynnfield Planning Board
February 8, 2018	Draft Plan Update submitted to MEMA following posting and review
March 6, 2018	Plan Review Tool received from MEMA with requested edits
March 8, 2018	Revised Draft Plan submitted to MEMA
April 10, 2018	Revised Draft Plan submitted to MEMA
April 12, 2018	Approval Pending Adoption issued by FEMA
June 18, 2018	Final Plan adopted by the Town
	Final Plan Approval issued by FEMA

IV. RISK ASSESSMENT

The risk assessment analyzes the potential natural hazards that could occur within the Town of Lynnfield 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 Lynnfield's risk assessment, MAPC gathered the most recently available hazard and land use data and met with Town staff to identify changes in local hazard areas and development trends. MAPC also used FEMA's damage estimation software, HAZUS (described below).

Overview of Hazards and Impacts

The Massachusetts Hazard Mitigation Plan provides an in-depth overview of natural hazards in Massachusetts. Previous state and federal disaster declarations since 1991 are summarized in Table 2. Table 5 below summarizes the hazard risks for Lynnfield. 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 Massachusetts State Hazard Mitigation Plan. The statewide assessment was modified to reflect local conditions in Lynnfield using the definitions for hazard frequency and severity listed below. Based on this, the Town set an overall priority for each hazard. Lynnfield is not a coastal community and therefore not subject to coastal hazards, storm surge or tsunamis.

Table 5 - Hazard Risks Summary

Hazard	Frequency		Severity	
	Massachusetts	Lynnfield	Massachusetts	Lynnfield
Flooding	High	High	Serious	Serious
Dam failures	Very Low	Very Low	Extensive	Serious
Hurricane/Tropical Storm	Medium	Medium	Serious	Serious
Tornadoes	Medium	Very Low	Serious	Serious
Thunderstorms	High	High	Minor	Minor
Nor'easter	High	High	Minor	Minor
Winter-Blizzard/Snow	High	High	Minor	Minor
Winter-Ice Storms	Medium	Medium	Minor	Minor
Earthquakes	Very Low	Very Low	Serious	Serious
Landslides	Low	Very Low	Minor	Minor
Brush fires	Medium	High	Minor	Minor
Extreme Temperatures	Medium	Medium	Minor	Minor

Table 5 - Hazard Risks Summary

Drought	Low	Low	Minor	Minor
Coastal Hazards	High	N/A	Serious	N/A
Tsunami	Very Low	N/A	Extensive	N/A
Major Urban Fires	Low	N/A	Serious	N/A
Ice Jams	Low	N/A	Minor	N/A

Source, Massachusetts State Hazard Mitigation Plan, 2013, modified for Lynnfield

Note: Of the hazards listed in the 2013 Massachusetts State Hazard Mitigation Plan, several categories are not applicable to Lynnfield:

- coastal hazards and tsunami, due to the town's inland
- major urban fires, due to the lack of significant wildfire areas in close proximity to urban development that could pose a significant threat of urban fire.
- Ice Jams, due to the lack of a river subject to ice jams in Lynnfield

Definitions used in the Commonwealth of Massachusetts State Hazard Mitigation Plan

Frequency

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

Severity

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

Flood Related Hazards

Flooding was the most prevalent serious natural hazard identified by local officials in Lynnfield. Flooding is generally caused by hurricanes, nor'easters, severe rainstorms, and thunderstorms. Global climate change has the potential to exacerbate these issues over time with the potential for changing rainfall patterns leading to heavier storms.

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 Lynnfield have included:

- The Blizzard of 1978
- January 1979
- April 1987
- October 1991 ("The Perfect Storm") Considered to be a 100-year storm.
- October 1996
- June 1998
- March 2001
- April 2004
- May 2006
- April 2007
- March 2010
- December 2010

Local data for previous flooding occurrences are not collected by the Town of Lynnfield. The best available local data is for Essex County through the National Climatic Data Center (see Table 6). Essex County, which includes the Town of Lynnfield, experienced 33 flood events from 1996 –May, 2017. No deaths or injuries were reported and the total reported property damage in the county was $20.667 million dollars. Damages from the March 2010 floods in Essex County totaled $1.37 million, while total damages for all floods since 2005 totaled $20.667 million. There were no deaths or injuries reported. The vulnerability analysis conducted by MAPC estimates a range of damages from flooding of $0 to $0.06 million (see Table 25).

Table 6 Essex County Flood Events, 1996- May, 2017
Source: NOAA, National Climatic Data Center

Location	Date	Type	Deaths	Injuries	Property Damage $
WESTERN ESSEX (ZONE)	10/22/1996	Flood	0	0	0
WESTERN ESSEX (ZONE)	6/17/1998	Flood	0	0	0
WESTERN ESSEX (ZONE)	6/18/1998	Flood	0	0	0
EASTERN ESSEX (ZONE)	3/5/2001	Flood	0	0	0
WESTERN ESSEX (ZONE)	4/3/2004	Flood	0	0	0
WESTERN ESSEX (ZONE)	4/3/2004	Flood	0	0	0
EASTERN ESSEX (ZONE)	10/15/2005	Flood	0	0	50000

Location	Date	Type	Deaths	Injuries	Property Damage $
EASTERN ESSEX (ZONE)	10/25/2005	Flood	0	0	45000
ESSEX CO.	5/13/2006	Flood	0	0	0
ESSEX CO.	5/13/2006	Flood	2	0	7000000
ESSEX CO.	7/11/2006	Flood	0	0	10000
ESSEX CO.	7/28/2006	Flood	0	0	20000
ESSEX CO.	3/2/2007	Flood	0	0	20000
ESSEX CO.	4/16/2007	Flood	0	0	45000
ESSEX CO.	2/13/2008	Flood	0	0	30000
ESSEX CO.	3/8/2008	Flood	0	0	0
ESSEX CO.	8/8/2008	Flood	0	0	25000
ESSEX CO.	9/6/2008	Flood	0	0	5000
ESSEX CO.	3/14/2010	Flood	0	1	9800000
ESSEX CO.	3/30/2010	Flood	0	2	3270000
ESSEX CO.	4/1/2010	Flood	0	0	0
ESSEX CO.	8/5/2010	Flood	0	0	7000
ESSEX CO.	8/25/2010	Flood	0	0	0
ESSEX CO.	10/4/2011	Flood	0	0	0
ESSEX CO.	10/4/2011	Flood	0	0	5000
ESSEX CO.	10/4/2011	Flood	0	0	300000
ESSEX CO.	6/23/2012	Flood	0	0	0
ESSEX CO.	6/23/2012	Flood	0	0	0
ESSEX CO.	8/10/2012	Flood	0	0	0
ESSEX CO.	6/24/2013	Flood	0	0	5000
ESSEX CO.	7/1/2013	Flood	0	0	0
ESSEX CO.	7/1/2013	Flood	0	0	0
ESSEX CO.	7/1/2013	Flood	0	0	0
ESSEX CO.	7/27/2014	Flood	0	0	0
ESSEX CO.	10/23/2014	Flood	0	0	30000
ESSEX CO.	10/23/2014	Flood	0	0	0
ESSEX CO.	10/23/2014	Flood	0	0	0
ESSEX CO.	12/9/2014	Flood	0	0	0
ESSEX CO.	12/9/2014	Flood	0	0	0
ESSEX CO.	12/9/2014	Flood	0	0	0
ESSEX CO.	8/18/2015	Flood	0	0	0
ESSEX CO.	9/30/2015	Flood	0	0	0
ESSEX CO.	6/29/2016	Flood	0	0	0
ESSEX CO.	4/6/2017	Flood	0	0	0
TOTAL			**2**	**3**	**$20,667,000**

Overview of Town-Wide Flooding

Flooding from Reedy Meadow has been a longstanding problem in Lynnfield. The earliest study was done by the Mass. Department of Public Works in 1957. In 1988 state funding became available for flood control studies. The Saugus River Watershed Committee was formed and Lynnfield was designated as lead for the study funded by Mass. Dept. of Environmental Management – Office of Waterways. In 1992 CDM prepared the first report to be done under this funding program.
The findings included the following:

- Most of the Saugus River may be characterized as being very flat and sluggish flowing with several large marshy areas that can store large volumes of flood waters. Reedy Meadow is critical to desynchronization of downstream flood flows.
- The Saugus River corridor is a heavily developed area where development has encroached into historic floodplain. Areas such as Perry Avenue in Lynnfield, Paon Boulevard in Wakefield, and Route 1 in Saugus are most subject to flooding, drainage problems, or high groundwater levels.
- Development has also encroached onto floodplain in the vicinity of Perry Avenue, Wirthmore Lane, Ford Avenue, Meadow Lane, Partridge Lane, Lee Road, Dale Road, Village Row Road, portions of Main Street and the Middle School playground in Lynnfield.
- Operation of the two sluice gates at the Saugus River Dam allow for the release of water downstream. Releases downstream to the Saugus River are limited by the grade elevation of Water Street. Diversion capacity to Hawkes Pond is also limited due to the flat grade of the diversion channel, and limited release capacity at the Hawkes Pond Dam.
- Reedy Meadow is exhibiting accelerated eutrophication that is causing the marsh to fill in over time and become overgrown as a swamp or meadow. This has greatly reduced the flow carrying capacity of the Upper Saugus River through the project area.
- The channel system (e.g. Upper Saugus River and Beaverdam Brook) through the meadow has become too restrictive to flow due to the clogging of former stream channels with sediments and vegetation. Also, clogging of the existing culverts (3) through the B&M Railroad embankment hydrologically segregates the upgradient and west-northwest portion of the meadow (about 25% of the surface area) from the remaining 75% surface area of the meadow.
- Multi-jurisdictional control over the project area (various municipalities) has resulted in a consistent lack of channel and infrastructure maintenance. The Saugus River receives stormwater from eight communities and forms portions of the corporate boundaries between Lynnfield and Wakefield, and Wakefield and Saugus. Additionally, the Saugus River Dam is located in both Lynnfield and Wakefield, but is controlled and operated by the LWSC. A need exists for a regional, or watershed approach for operations and maintenance.

- Flooding along the upper Mill River in Wakefield appears to be exacerbated by overflows from the Upper Saugus River basin into the Upper Mill River in the area of the Route 128 – MBTA Railroad underpass.
- Flooding to the rear of the commercial development along the western side of Route 1 appears to be due to the over development of parking areas into historic floodplain.
- The majority of the flooding reported in CDM (1992) represents nuisance flooding and should not be considered catastrophic or a threat to the public health, welfare or safety. However, this nuisance flooding poses significant financial hardship to individual property owners.

In 1998, the Saugus River Watershed Committee hired Normandeau Associates to prepare a Draft Environmental Impact Report on the proposed "Reedy Meadow Flood Control Dredging Project in Lynnfield and Wakefield. The proposed project consists of dredging portions of Beaver Dam Brook and the Saugus River within the Reedy Meadow wetlands system in Lynnfield and Wakefield. The purpose of the project was to lower the frequency and severity of flooding. In addition to dredging, new culverts would be placed under the Boston and Maine Railroad ROW, other culverts would be cleaned.

According to town engineering staff, this project never advanced beyond the draft EIR stage although a test section was done on the Saugus River. There was concern that dredging the river would cause issues for communities downstream. Lynnfield tried again to revive the project around 2008 but pressure from downstream communities and community groups concerned about flooding stopped the project.

Potential Flood Hazard Areas

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

Flood Insurance Rate Map Zone Definitions

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.

In addition, information on other areas subject to flooding was provided by local officials. The Locally Identified Areas of Flooding described below were identified by Town staff as areas where flooding is known to occur. All of these areas do not necessarily coincide with the flood zones from the FIRM maps. Some may be areas that flood due to inadequate drainage systems or other local conditions rather than location within a flood zone. Some of these sites were carried over from the 2008 Hazard Mitigation Plan. The numbers correspond to the numbers on Map 8, "Local Hazard Areas." Estimated damages associated flooding are shown in Table 25:

2018 Flooding Site #1.
Pilling's Pond Dam–. This is a carryover site from 2008. The dam was built in the early 2000's but during the May 2006 flood, the abutments to the spillway began to erode and water began to circumvent the dam. The town determined that the dam needed to have two foot wing walls added. The Town applied for a Hazard Mitigation Grant from FEMA to build the wing walls but it was not approved.

2018 Flooding Site #2
The Saugus River/Reedy Meadow– This is a carryover site from the 2008 plan. The town would still like to address the flooding issues at Reedy Meadow and the Saugus River. The first step in mitigation would be to complete the draft EIR and submit it to the state for final approval. Completing the EIR would now cost approximately $300,000. If approved, the project would move into an extensive permitting stage. The actual work would be done by the Army Corps of Engineers.

2018 Flooding Site #3
Beaver Dam Brook (Reedy Meadow to Chestnut Street) – This is a carryover site from the 2008 plan. Beaver Dam Brook needs to be restored. Beavers are now routinely trapped as a preventive measure against flooding, and several culverts need to be enlarged. As an intermediate step to help address the flooding issues along the Beaver Dam Brook, which is affected by the flooding in Reedy Meadow, the town is proposing to upgrade the culvert underneath the MBTA rail bed, which should alleviate the flooding upstream from this point along Beaver Dam Brook during heavy or prolonged precipitation events.
2018 Flooding Site #4
Summer Street/Route 128 Overpass – This is a carryover site from the 2008 plan. The town has maintained the drainage systems at this site since the 2008 plan. There is also a brook that runs underneath Route 128 that may need to be restored. Lynnfield would like to do drainage study here between Fletcher Road to Timberhill Road.

2018 Flooding Site #5
Hawkes Brook at Fletcher Road– This is a carryover site from the 2008 plan. The appropriate mitigation measure for flooding in this area would be to restore the brook and upgrade the size of the culverts at Fletcher Road and Timberhill Lane. The town would like to include this site as part of the drainage study for Fletcher Road to Timberhill Road.

2018 Flooding Site #6
Bates Brook-(Chatham Way to Pillings Pond) – This is a carryover site from the 2008 plan. Bates Brook needs to be restored and several culverts need to be replaced in this brook. This is one of the brooks that the Town has identified for work by the Northeast Massachusetts Mosquito Control Board.

2018 Flooding Site #7
Pyburn Road – This is a low priority. Stream restoration of Hawkes Brook in this area would help reduce the flooding potential. There is no active flooding known at the site but the town is planning to include it as part of the Route 128 drainage study. This is a low priority site and the cost of the study is estimated at $40,000.

Low Priority Mitigation Measures from the 2008 Plan

2008Flooding Site #4- *Grey Lane* – The Town has already implemented several of the remedial measures that were recommended in the DPW report. If the flooding continues, then consideration should be given to further mitigation measures downstream along Bates Brook. There have been no incidences since the 2008 and the town will not carry this project forward.

2008 Flooding Site #9*-Hawkes Brook at Route 128 and Salem Street*– Because flooding is caused by sedimentation, the brook will need to be restored and measures put into place to minimize sediment originating from Route 128. The Lynn Water and Sewer Commission has cleaned the brook and flooding has not happened again. This project will not be carried forward.

New Flooding sites for the 2018 Plan Update

2018 Flooding Site #8
Rourke Lane at Lowell Street- Lane floods during heavy rain; loses access, once every 5 years, 6 homes, - Drain needs to be tied into Lowell Street from current infiltration system. This is a high priority site for the plan update, with an estimated cost of $120,000.

2018 Flooding Site #9
14 Longbow Circle-Flooding occurs once per year; undersized drain, leaves clogging, road crown inadequate, catch-basins need to be aligned. This is a high priority project with an estimated cost of $1.2 million to redo Longbow Circle drainage systems. The town may seek a PDM grant to upgrade this area.

2018 Flooding Site #10
Midland Road at Bates Brook- Failed culvert causes water back up during heavy rains; undermining road; affects 4 houses on Midland Rd. This is a high priority project for the plan update with an estimated cost of $10,000. The town may seek a PDM grant to upgrade this site.

Drainage ditch restoration– Many of the brooks in town are in need of restoration. This used to be done by the Northeast Massachusetts Mosquito Control Board (NMMC). The brooks need to be cleared of vegetation, sand, sediment, trees and silt. Hawkes Brook is the first priority. In 2003 and again in April 2004, the Director of the Department of Public Works sent a letter to NMMC requesting that they consider re-establishing their ditch maintenance program. The letter included a list of priority locations as follows:

Brook Name	**Location**
Bates Brook	Bourque Road
Hawkes Brook	Salem Street at Walnut Street
Hawkes Brook	Carpenter Road
Hawkes Brook	Fletcher Road and Timberhill Road
Bates Brook	Pillings Pond Road

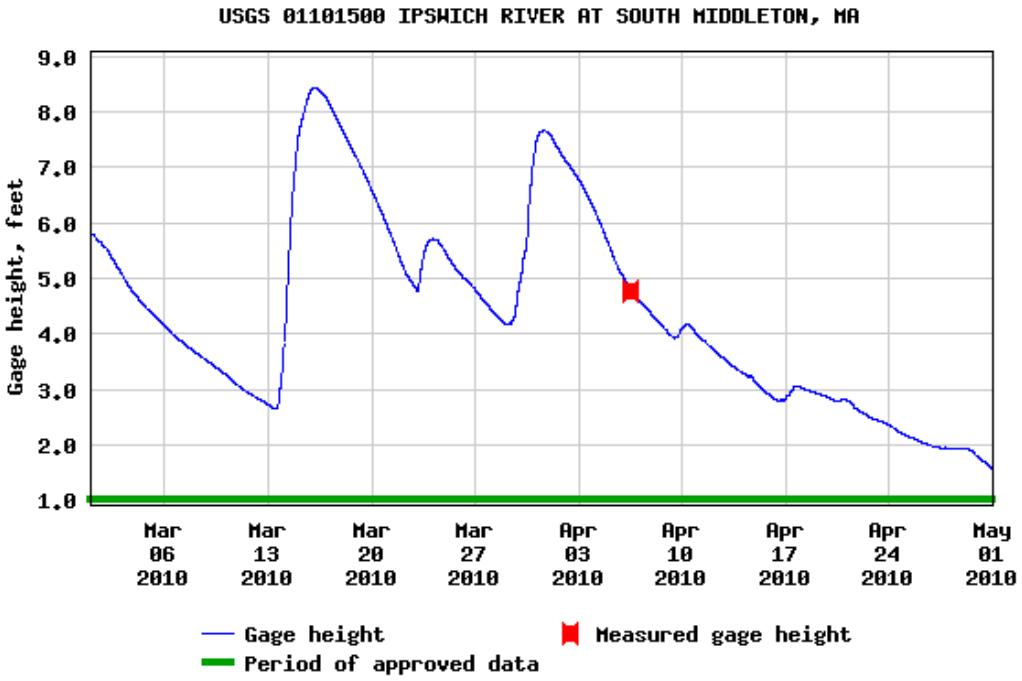
One difficulty with drainage ditch restoration is that the environmental regulations for this type of work are fairly stringent and can make it difficult to carry out the work. This project will not be carried forward in 2016 but the town will continue to contact the NMMC to see if the ditches can be improved.

Flooding Since the 2008 Plan

The most severe flooding since the previous plan occurred during March 2010, when a total of 14.83 inches of rainfall accumulation was recorded by the National Weather Service (NWS). The weather pattern that consisted of early springtime prevailing westerly winds that moved three successive storms, combined with tropical moisture from the Gulf of Mexico, across New England. Torrential rainfall caused March 2010 to be the wettest month on record.

One indication of the extent of flooding is the gage height at the nearest USGS streamflow gauging station, which is on the Ipswich River in South Middleton. The USGS gage height, shown in Figure 1, exceeded 8 feet on March 16, 2010 and exceeded 7 feet on March 31, 2010. Normal gage height in March is about 4 feet.

Figure 1- Ipswich River Gage Heights, March-April 2010



Source, US Geological Service, National Water Information System

Repetitive Loss Structures-

As defined by 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.

There are four repetitive loss structures in Lynnfield, two more than were listed in the 2008 plan. All of the properties are single family residences.
Table 7 summarizes the number and type of repetitive loss structures located within Lynnfield and the number of losses and total claims associated with them.

Table 7- Summary of Repetitive Losses and Claims 1979- 2017

	Single Family Residential	Other Residential	Non-Residential	Total
Number of Properties	4	0	0	4
Number of Losses	8			8
Total Claims	$67,999.07	0	0	$67,999.07

Source: Department of Conservation and Recreation, FEMA Repetitive Loss data

Based on the record of previous occurrences flooding events in Lynnfield are a High frequency event as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur more frequently than once in five years, or a greater than 20% chance per year.

Dams and 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.

DCR defines dam hazard classifications as follows:

> *High*: Dams located where failure or mis-operation will likely cause loss of life and serious damage to homes(s), industrial or commercial facilities, important public utilities, main highways(s) or railroad(s).
>
> *Significant:* 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:* Dams located where failure or mis-operation may cause minimal property damage to others. Loss of life is not expected.

Dam failure is a highly infrequent occurrence but a severe incident could result in loss of lives and significant property damage. Since 1984, three dams have failed in or very near to Massachusetts, one of which resulted in a death**.**

Lynnfield Dams

Pilling's Pond Dam–. This is a carryover site from 2008. The dam was built in the early 2000's but during the May 2006 flood, the abutments to the spillway began to erode and water began to circumvent the dam. The town determined that the dam needed to have two foot wing walls added. The Town applied for a Hazard Mitigation Grant from FEMA to build the wing walls but it was not approved.

Saugus River Dam- The Saugus River receives stormwater from eight communities and forms portions of the corporate boundaries between Lynnfield and Wakefield, and Wakefield and Saugus. Additionally, the Saugus River Dam is located in both Lynnfield and Wakefield, but is controlled and operated by the Lynn Water and Sewer Commission.

Based on the record of previous occurrences dam failure in Lynnfield is a Very Low frequency event as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur less frequently than once in 100 years (less than 1% chance per year).

Wind Related Hazards

Wind-related hazards include hurricanes, tropical storms, and tornadoes as well as high winds during Nor'easters and thunderstorms. As with many communities, falling trees that result in downed power lines and power outages are an issue in Lynnfield. Information on wind related hazards can be found on Map 5 in Appendix B

Hurricanes and Tropical Storms

A hurricane is a violent wind and rainstorm with wind speeds of 74-200 miles per hour. A hurricane is strongest as it travels over the ocean and is particularly destructive to coastal property as the storm hits the land. The Town's entire area is vulnerable to hurricanes. Hurricanes occur between June and November. A tropical storm has similar characteristics, but wind speeds are below 74 miles per hour.

Since 1900, 39 tropical storms have impacted New England (NESEC). Massachusetts has experienced approximately 32 tropical storms, nine Category 1 hurricanes, five Category 2 hurricanes and one Category 3 hurricane. 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 tracks through Lynnfield, a tropical storm in 1923. However, Lynnfield experiences the impacts of hurricanes and tropical storms regardless of whether the storm track passes directly through the Town, and numerous hurricanes have affected the communities of eastern Massachusetts (see Table 8) The hazard mapping indicates that the 100 year wind speed in Lynnfield is 110 miles per hour (see Appendix B).

Table 8- Hurricane Records for Massachusetts, 1938 – January, 2017

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

*Category 3. Source: National Oceanic and Atmospheric Administration

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

Hurricanes typically have regional impacts beyond their immediate tracks. 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. Hurricanes are a Town-wide hazard in Lynnfield. Potential hurricane damages to Lynnfield have been estimated using HAZUS-MH. Total damages are estimated at $39,554 thousand for a Category 2 hurricane and $39,554.12 thousand for a Category 4 hurricane. Other potential impacts are detailed in Table 21.

Based on records of previous occurrences, hurricanes in Lynnfield are a Medium frequency event as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard occurs from once in 5 years to once in 50 years, or a 2% to 20% chance per year.

Tornadoes

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud. These events are spawned by thunderstorms and occasionally by hurricanes, and may occur singularly or in multiples. They develop when cool air overrides a layer of warm air, causing the warm air to rise rapidly. Most vortices remain suspended in the atmosphere. Should they touch down, they become a force of destruction. Some ingredients for tornado formation include:

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

Tornado damage severity is measured by the Fujita Tornado Scale, in which wind speed is not measured directly but rather estimated from the amount of damage. As of February 01, 2007, the National Weather Service began rating tornados using the Enhanced Fujita-scale (EF-scale), which allows surveyors to create more precise assessments of tornado severity. The EF-scale is summarized below:

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

Source: Massachusetts State Hazard Mitigation Plan, 2013

The frequency of tornadoes in eastern Massachusetts is low; on average, there are six tornadoes that touchdown somewhere in the Northeast region every year. The strongest tornado in Massachusetts history was the Worcester Tornado in 1953 (NESEC).
The most recent tornado events in Massachusetts were in Springfield in 2011, Revere in 2014 and most recently in Concord (Middlesex County) on August 23, 2016. The Concord EF-1 tornado damaged 39 homes but no injuries or deaths were reported. (Source: *Concord Patch*) The Springfield tornado caused significant damage and resulted in 4 deaths in June of 2011. The Revere tornado touched down in Chelsea just south of Route 16 and moved north into Revere's business district along Broadway and ended near the intersection of Routes 1 and 60. The path was approximately two miles long and 3/8 mile wide, with wind speeds up to 120 miles per hour. Approximately 65 homes had substantial damages and 13 homes and businesses were uninhabitable.

Although there have been no recorded tornados within the limits of the Town of Lynnfield, since 1956 there have been 11 tornadoes in surrounding Essex County recorded by the NCDC. No tornados were F3, one was F2, eight were F1 and two were F 0. These 11 tornados resulted in no fatalities and four injuries and up to $560,280 in damages, as summarized in Table 9.

Table 9 - Tornado Records for Essex County

Location	Date	Type	Fujita Scale	Deaths	Injuries	Property Damage $	Length	Width
ESSEX CO.	6/13/1956	Tornado	F1	0	0	2500	1	10
ESSEX CO.	11/21/1956	Tornado	F2	0	0	25000	0.8	17
ESSEX CO.	12/18/1956	Tornado	F1	0	0	250	0.5	23
ESSEX CO.	7/13/1960	Tornado	F0	0	0	30	0.1	33
ESSEX CO.	7/21/1962	Tornado	F1	0	3	25000	2.7	33
ESSEX CO.	5/19/1964	Tornado	F0	0	0	2500	0.1	300
ESSEX CO.	5/19/1964	Tornado	F1	0	0	2500	2	300
ESSEX CO.	8/10/1965	Tornado	F1	0	0	0	3.6	33
ESSEX CO.	7/1/1968	Tornado	F1	0	1	250000	0.3	100
ESSEX CO.	7/21/1972	Tornado	F1	0	0	2500	0.3	20
ESSEX CO.	8/15/1991	Tornado	F1	0	0	250000	0.8	300
Total				**0**	**4**	**$560,280**		

Source: National Climatic Data Center

Buildings constructed prior to current building codes may be more vulnerable to damages caused by tornadoes. Evacuation of impacted areas may be required on short notice. Sheltering and mass feeding efforts may be required along with debris clearance, search and rescue, and emergency fire and medical services. Key routes may be blocked by downed trees and other debris, and widespread power outages are also typically associated with tornadoes.

Although tornadoes are a potential Town-wide hazard in Lynnfield, tornado impacts are relatively localized compared to severe storms and hurricanes. Damages from any tornado in Lynnfield would greatly depend on the track of the tornado. Generally the downtown, central and southern portions of the Town nearer Route 128, Route 1, Main Street and Walnut Street are more densely developed and would likely be subject to more damage in the event of a tornado.

Based on the record of previous occurrences since 1950, Tornado events in Lynnfield are a Medium frequency event as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur from once in 5 years to once in 50 years, or a 2% to 20% chance per year.

Nor'easters

A northeast coastal storm, known as a nor'easter, is typically a large counter-clockwise wind circulation around a low-pressure center. 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. 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.

Previous occurrences of Nor'easters include the following:

February 1978	Blizzard of 1978
October 1991	Severe Coastal Storm ("Perfect Storm")
December 1992	Great Nor'easter of 1992
January 2005	Blizzard/N or'easter
October 2005	Coastal Storm/Nor'easter
April 2007	Severe Storms, Inland & Coastal Flooding/Nor'easter
January 2011	Winter Storm/Nor'easter
October 2011	Severe Storm/Nor'easter
Blizzard of 2013	February 2013
Blizzard of 2015	January 2015

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, February 2013 and January 2015 were all large nor'easters that caused significant snowfall amounts.

Lynnfield is vulnerable to both the wind and precipitation that accompanies nor'easters. High winds can cause damage to structures, fallen trees, and downed power lines leading to power outages. Intense rainfall can overwhelm drainage systems causing localized flooding of rivers and streams as well as urban stormwater ponding and localized flooding. Fallen tree limbs as well as heavy snow accumulation and intense rainfall can impede local transportation corridors, and block access for emergency vehicles.

The entire Town of Lynnfield could be at risk from the wind, rain or snow impacts from a nor'easter, depending on the track and radius of the storm, but due to its inland location the Town would not be subject to coastal hazards.

Based on the record of previous occurrences, nor'easters in Lynnfield are high frequency events as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur more frequently than once in 5 years (greater than 20% per year).

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 tornados. 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 The Town's entire area is potentially subject to severe thunderstorms.

The Town does not keep records of thunderstorms, but estimates that at least eight to ten occur each year. Team members remembered severe thunderstorms in 2015 in the Town Center and South End. Trees were downed by high wind and the power was out for two hour town wide. Also in 2015, another severe thunderstorm occurred near Lowell Street in the Timberhill neighborhood. Two houses were damaged by trees knocked down by high winds and power was lost.

The best available data on previous occurrences of thunderstorms in Lynnfield is for Essex County through the National Climatic Data Center (NCDC). Between 1995 and April 30, 2017 NCDC records show 194 thunderstorm events in Essex County communities (Table 10). These storms resulted in a total of $2.573 million in property damages. There were no injuries and no deaths reported.

Table 10 Essex County Thunderstorm Wind Events, 1995-April, 2017

Location	Date	Type	Magnitude-knots	Deaths	Injuries	Damage-$
ESSEX CO.	9/14/1995	Thunderstorm Wind	0	0	0	0
ESSEX CO.	8/3/1997	Thunderstorm Wind	50	0	0	0
ESSEX CO.	5/29/1998	Thunderstorm Wind	50	0	0	0
ESSEX CO.	5/31/1998	Thunderstorm Wind	50	0	0	0
ESSEX CO.	5/31/1998	Thunderstorm Wind	50	0	0	0
ESSEX CO.	8/11/1998	Thunderstorm Wind	50	0	0	0
ESSEX CO.	9/7/1998	Thunderstorm Wind	50	0	0	0
ESSEX CO.	4/26/1999	Thunderstorm Wind	52	0	0	1000
ESSEX CO.	6/23/1999	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/6/1999	Thunderstorm Wind	52	0	0	0
ESSEX CO.	7/24/1999	Thunderstorm Wind	75	0	0	0
ESSEX CO.	7/24/1999	Thunderstorm Wind	52	0	0	0
ESSEX CO.	7/25/1999	Thunderstorm Wind	50	0	0	0
ESSEX CO.	6/27/2000	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/18/2000	Thunderstorm Wind	50	0	0	0

Location	Date	Type	Magnitude-knots	Deaths	Injuries	Damage-$
ESSEX CO.	5/12/2001	Thunderstorm Wind	50	0	0	0
ESSEX CO.	6/30/2001	Thunderstorm Wind	50	0	0	0
ESSEX CO.	6/30/2001	Thunderstorm Wind	55	0	0	0
ESSEX CO.	7/1/2001	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/1/2001	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/1/2001	Thunderstorm Wind	50	0	0	0
ESSEX CO.	8/10/2001	Thunderstorm Wind	50	0	0	0
ESSEX CO.	8/10/2001	Thunderstorm Wind	50	0	0	0
ESSEX CO.	5/31/2002	Thunderstorm Wind	50	0	0	4000
ESSEX CO.	6/2/2002	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	7/23/2002	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	6/27/2003	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	6/27/2003	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	7/2/2004	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	8/20/2004	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	6/26/2005	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	6/29/2005	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	7/27/2005	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	7/27/2005	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	8/5/2005	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	8/5/2005	Thunderstorm Wind	50	0	0	50000
ESSEX CO.	5/21/2006	Thunderstorm Wind	50	0	0	30000
ESSEX CO.	5/21/2006	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	7/11/2006	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	7/11/2006	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	7/11/2006	Thunderstorm Wind	78	0	0	500000
ESSEX CO.	7/28/2006	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	6/1/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	6/2/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	6/2/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	6/2/2007	Thunderstorm Wind	70	0	0	0
ESSEX CO.	6/2/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	6/2/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	6/2/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	6/2/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/5/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/5/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/5/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/5/2007	Thunderstorm Wind	50	0	0	0

Location	Date	Type	Magnitude-knots	Deaths	Injuries	Damage-$
ESSEX CO.	7/6/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/6/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/6/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/6/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/6/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/6/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/6/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/6/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/6/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/6/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/28/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/28/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/28/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/28/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	9/8/2007	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	9/8/2007	Thunderstorm Wind	50	0	0	8000
ESSEX CO.	9/8/2007	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	5/27/2008	Thunderstorm Wind	50	0	0	2000
ESSEX CO.	5/27/2008	Thunderstorm Wind	50	0	0	1000
ESSEX CO.	6/10/2008	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	6/10/2008	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	6/10/2008	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	6/10/2008	Thunderstorm Wind	50	0	0	4000
ESSEX CO.	6/22/2008	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	6/27/2008	Thunderstorm Wind	50	0	0	7000
ESSEX CO.	6/27/2008	Thunderstorm Wind	50	0	0	500
ESSEX CO.	7/1/2008	Thunderstorm Wind	50	0	0	20000
ESSEX CO.	7/1/2008	Thunderstorm Wind	50	0	0	3000
ESSEX CO.	7/1/2008	Thunderstorm Wind	50	0	0	4000
ESSEX CO.	7/2/2008	Thunderstorm Wind	50	0	1	10000
ESSEX CO.	7/2/2008	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/3/2008	Thunderstorm Wind	50	0	1	3000
ESSEX CO.	7/3/2008	Thunderstorm Wind	54	0	0	5000
ESSEX CO.	7/3/2008	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	7/18/2008	Thunderstorm Wind	50	0	0	3000
ESSEX CO.	7/19/2008	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	9/9/2008	Thunderstorm Wind	50	0	0	12000
ESSEX CO.	9/9/2008	Thunderstorm Wind	50	0	0	3000
ESSEX CO.	9/9/2008	Thunderstorm Wind	50	0	0	5000

Location	Date	Type	Magnitude-knots	Deaths	Injuries	Damage-$
ESSEX CO.	7/26/2009	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	7/31/2009	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	7/31/2009	Thunderstorm Wind	50	0	0	40000
ESSEX CO.	7/31/2009	Thunderstorm Wind	50	0	0	500
ESSEX CO.	6/3/2010	Thunderstorm Wind	50	0	0	0
ESSEX CO.	6/3/2010	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	6/3/2010	Thunderstorm Wind	50	0	0	1000
ESSEX CO.	6/3/2010	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	6/3/2010	Thunderstorm Wind	50	0	0	50000
ESSEX CO.	6/5/2010	Thunderstorm Wind	50	0	0	50000
ESSEX CO.	6/5/2010	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	6/6/2010	Thunderstorm Wind	50	0	0	3000
ESSEX CO.	6/6/2010	Thunderstorm Wind	50	0	0	1000
ESSEX CO.	6/6/2010	Thunderstorm Wind	52	0	0	75000
ESSEX CO.	6/6/2010	Thunderstorm Wind	50	0	0	500
ESSEX CO.	6/24/2010	Thunderstorm Wind	50	0	0	50000
ESSEX CO.	6/24/2010	Thunderstorm Wind	50	0	0	0
ESSEX CO.	6/24/2010	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	6/24/2010	Thunderstorm Wind	50	0	0	250
ESSEX CO.	6/24/2010	Thunderstorm Wind	50	0	0	500
ESSEX CO.	7/12/2010	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	7/12/2010	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	7/19/2010	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	6/9/2011	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	6/9/2011	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	6/9/2011	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	6/9/2011	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	6/9/2011	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	6/9/2011	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	6/9/2011	Thunderstorm Wind	50	0	0	20000
ESSEX CO.	6/9/2011	Thunderstorm Wind	50	0	0	3000
ESSEX CO.	6/9/2011	Thunderstorm Wind	50	0	0	3000
ESSEX CO.	7/4/2011	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	7/4/2011	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	7/4/2011	Thunderstorm Wind	50	0	0	3000
ESSEX CO.	7/4/2011	Thunderstorm Wind	50	0	0	3000
ESSEX CO.	7/18/2011	Thunderstorm Wind	39	0	0	20000
ESSEX CO.	8/19/2011	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	8/19/2011	Thunderstorm Wind	50	0	0	50000

Location	Date	Type	Magnitude-knots	Deaths	Injuries	Damage-$
ESSEX CO.	8/19/2011	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	10/4/2011	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	6/23/2012	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	6/23/2012	Thunderstorm Wind	50	0	0	50000
ESSEX CO.	6/23/2012	Thunderstorm Wind	40	0	0	500
ESSEX CO.	6/25/2012	Thunderstorm Wind	40	0	0	5000
ESSEX CO.	7/4/2012	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	6/24/2013	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	6/24/2013	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	7/1/2013	Thunderstorm Wind	50	0	0	3000
ESSEX CO.	7/1/2013	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	7/3/2014	Thunderstorm Wind	50	0	0	50000
ESSEX CO.	7/3/2014	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	7/3/2014	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	7/15/2014	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	7/28/2014	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	7/28/2014	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	9/2/2014	Thunderstorm Wind	45	0	0	5000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	3000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	30000
ESSEX CO.	9/6/2014	Thunderstorm Wind	85	0	0	100000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	30000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	5/28/2015	Thunderstorm Wind	61	0	0	50000
ESSEX CO.	5/28/2015	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	5/28/2015	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	5/28/2015	Thunderstorm Wind	50	0	0	30000
ESSEX CO.	5/28/2015	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	5/28/2015	Thunderstorm Wind	50	0	0	1000
ESSEX CO.	6/23/2015	Thunderstorm Wind	60	0	0	5000
ESSEX CO.	7/27/2015	Thunderstorm Wind	45	0	0	1000
ESSEX CO.	8/4/2015	Thunderstorm Wind	50	0	0	15000

Location	Date	Type	Magnitude-knots	Deaths	Injuries	Damage-$
ESSEX CO.	8/4/2015	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	8/4/2015	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	8/4/2015	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	8/4/2015	Thunderstorm Wind	50	0	0	20000
ESSEX CO.	2/25/2016	Thunderstorm Wind	45	0	0	5000
ESSEX CO.	2/25/2016	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	2/25/2016	Thunderstorm Wind	50	0	0	1000
ESSEX CO.	6/29/2016	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	7/1/2016	Thunderstorm Wind	40	0	0	5000
ESSEX CO.	7/1/2016	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	7/18/2016	Thunderstorm Wind	70	0	0	100000
ESSEX CO.	7/18/2016	Thunderstorm Wind	40	0	0	5000
ESSEX CO.	7/23/2016	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	7/23/2016	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	7/23/2016	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	7/23/2016	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	7/23/2016	Thunderstorm Wind	50	0	0	20000
ESSEX CO.	7/23/2016	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	7/23/2016	Thunderstorm Wind	50	0	0	35000
ESSEX CO.	7/23/2016	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	9/11/2016	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	9/11/2016	Thunderstorm Wind	50	0	0	5000
Total				**0**	**2**	**$2,573,750**

Source: NOAA, National Climatic Data Center Magnitude refers to maximum wind speed in knots.

Severe thunderstorms are a Town-wide hazard for Lynnfield. The Town's vulnerability to severe thunderstorms is similar to that of Nor'easters. High winds can cause falling trees and power outages, as well as obstruction of key routes and emergency access. Heavy precipitation may also cause localized flooding, both riverine and urban drainage related.

Based on the record of previous occurrences, severe thunderstorms in Lynnfield are high frequency events as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur more frequently than once in 5 years (greater than 20% per year).

Winter Storms

Winter storms, including heavy snow, blizzards, and ice 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.

Heavy Snow and Blizzards

A blizzard is a winter snow storm with sustained or frequent wind gusts to 35 mph or more, accompanied by falling or blowing snow reducing visibility to or below ¼ mile. These conditions must be the predominant condition over a 3 hour period. Extremely cold temperatures are often associated with blizzard conditions, but are not a formal part of the definition. The hazard created by the combination of snow, wind and low visibility increases with temperatures below 20 degrees.

Winter storms are a combination hazard because they often involve wind, ice and heavy snow fall. The National Weather Service defines "heavy snow fall" as an event generating at least 4 inches of snowfall within a 12 hour period. Winter Storms are often associated with a Nor'easter event, a large counter-clockwise wind circulation around a low-pressure center often resulting in heavy snow, high winds, and rain.

The Northeast Snowfall Impact Scale (NESIS) developed by Paul Kocin of The Weather Channel and Louis Uccellini of the National Weather Service (Kocin and Uccellini, 2004) characterizes and ranks high impact northeast snowstorms. These storms have large areas of 10 inch snowfall accumulations and greater. NESIS has five categories: Extreme, Crippling, Major, Significant, and Notable. 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, 2013

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. In Lynnfield blizzards and severe winter storms have occurred in the following years:

Table 11- 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
Severe Snow Storm	January 2011
Blizzard of 2013	February 2013
Blizzard of 2015	January 2015

Source: National Oceanic and Atmospheric Administration

The average annual snowfall for most of Lynnfield is 48 - 72 inches, with the southeast section of town averaging 36 to 72 inches. (See Map 6 in Appendix B).

The Town of Lynnfield does not keep local records of winter storms. Data for Essex County, which includes Lynnfield, is the best available data to help understand previous occurrences and impacts of heavy snow events. According to the National Climate Data Center (NCDC) records, from 1995 to January, 2017, Essex County experienced 113 heavy snowfall events, resulting in no deaths, no injuries, and $7.353 million dollars in property damage. See Table 12 for heavy snow events and impacts in Essex County.

Table 12 - Heavy Snow events and Impacts in Essex County 1996 – April, 2017

Location	Date	Type	Deaths	Injuries	Damage-$
EASTERN ESSEX (ZONE)	1/2/1996	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/2/1996	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	1/7/1996	Heavy Snow	0	0	1000000
WESTERN ESSEX (ZONE)	1/7/1996	Heavy Snow	0	0	1000000
EASTERN ESSEX (ZONE)	1/10/1996	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/12/1996	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/2/1996	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/16/1996	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/2/1996	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	3/2/1996	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/7/1996	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	3/7/1996	Heavy Snow	0	0	0

Location	Date	Type	Deaths	Injuries	Damage-$
EASTERN ESSEX (ZONE)	4/9/1996	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	4/9/1996	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	12/6/1996	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/6/1996	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	12/7/1996	Heavy Snow	0	0	1360000
WESTERN ESSEX (ZONE)	12/7/1996	Heavy Snow	0	0	1360000
EASTERN ESSEX (ZONE)	2/16/1997	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/31/1997	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	3/31/1997	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	4/1/1997	Heavy Snow	0	0	2500000
EASTERN ESSEX (ZONE)	4/1/1997	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	11/14/1997	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	11/14/1997	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/23/1997	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	12/23/1997	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/15/1998	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	1/15/1998	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	1/14/1999	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/14/1999	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/6/1999	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	3/6/1999	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	3/15/1999	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/15/1999	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/13/2000	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	1/13/2000	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/18/2000	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/18/2000	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/30/2000	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	1/20/2001	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/20/2001	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/5/2001	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/5/2001	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/5/2001	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	3/5/2001	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	3/9/2001	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/9/2001	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/30/2001	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/8/2001	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/1/2003	Heavy Snow	0	0	0

Location	Date	Type	Deaths	Injuries	Damage-$
EASTERN ESSEX (ZONE)	2/1/2003	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/16/2004	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	3/16/2004	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/21/2005	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/23/2006	Heavy Snow	0	0	20000
EASTERN ESSEX (ZONE)	12/13/2007	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/13/2007	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	12/16/2007	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/16/2007	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	12/19/2007	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/19/2007	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	1/14/2008	Heavy Snow	0	0	28000
WESTERN ESSEX (ZONE)	1/14/2008	Heavy Snow	0	0	20000
WESTERN ESSEX (ZONE)	2/22/2008	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/22/2008	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	12/19/2008	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/19/2008	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/21/2008	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	12/31/2008	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/31/2008	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	1/11/2009	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/11/2009	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/18/2009	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/1/2009	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	3/1/2009	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/9/2009	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	12/20/2009	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/20/2009	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/18/2010	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/16/2010	Heavy Snow	0	0	15000
WESTERN ESSEX (ZONE)	2/16/2010	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/12/2011	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	1/26/2011	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/26/2011	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/8/2013	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/8/2013	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	3/7/2013	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/7/2013	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/18/2013	Heavy Snow	0	0	0

Location	Date	Type	Deaths	Injuries	Damage-$
EASTERN ESSEX (ZONE)	3/18/2013	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	12/14/2013	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/14/2013	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	12/17/2013	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/17/2013	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	1/2/2014	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/2/2014	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/18/2014	Heavy Snow	0	0	10000
EASTERN ESSEX (ZONE)	2/5/2014	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/5/2014	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/13/2014	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/13/2014	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/18/2014	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	1/24/2015	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/24/2015	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/26/2015	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/2/2015	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/2/2015	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/8/2015	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/8/2015	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/14/2015	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/14/2015	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/5/2016	Heavy Snow	0	0	40000
Total			**0**	**0**	**$7,353,000**

The Town's overall vulnerability to heavy snow and blizzards is primarily related to restrictions on travel on roadways, temporary road closures, school closures, and potential restrictions on emergency vehicle access. Other vulnerabilities include power outages due to fallen trees and utility lines, and damage to structures due to heavy snow loads.

Blizzards are considered to be high frequency events based on past occurrences, as defined by the Massachusetts State Hazard Mitigation Plan, 2013. This hazard occurs more than once in five years, with a greater than 20 percent chance of occurring each year.

Ice Storms

The ice storm category covers a range of different weather phenomena that collectively involve rain or snow being converted to ice in the lower atmosphere leading to potentially hazardous conditions on the ground. Hail size typically refers to the diameter of the

hailstones. Warnings and reports may report hail size through comparisons with real-world objects that correspond to certain diameters:

Description	Diameter (inches)
Pea	0.25
Marble or Mothball	0.50
Penny or Dime	0.75
Nickel	0.88
Quarter	1.00
Half Dollar	1.25
Walnut or Ping Pong Ball	1.50
Golf ball	1.75
Hen's Egg	2.00
Tennis Ball	2.50
Baseball	2.75
Tea Cup	3.00
Grapefruit	4.00
Softball	4.50

While ice pellets and sleet are examples of these, the greatest hazard is created by freezing rain conditions, which is rain that freezes on contact with hard surfaces leading to a layer of ice on roads, walkways, trees, and other surfaces. The conditions created by freezing rain can make driving particularly dangerous and emergency response more difficult. The weight of ice on tree branches can also lead to falling branches damaging electric lines.

Town-specific data for previous ice storm occurrences are not collected by the Town of Lynnfield. The best available local data is for Essex County through the National Climatic Data Center (see Table 13). Essex County, which includes the Town of Lynnfield, experienced one ice storm event from 1995 – April, 2017. No deaths or injuries were reported and the total reported property damage in the county was $2.0 million dollars.

Table 13- Essex County Ice Storm Events, 1995- April, 2017

Date	Date	Type	Deaths	Injuries	Damage-$
WESTERN ESSEX (ZONE)	12/11/2008	Ice Storm	0	0	$2,000,000

Source: NOAA, National Climatic Data Center

Ice storms are considered to be medium frequency events based on past occurrences, as defined by the Massachusetts State Hazard Mitigation Plan, 2013. This hazard occurs once in 5 years to once in 50 years, with 2% to 20% chance of occurring each year.

The impacts of winter storms are often related to the weight of snow and ice, which can cause roof collapses and also causes tree limbs to fall which can in turn cause property damage and potential injuries.

Winter storms are a potential Town-wide hazard in Lynnfield. The Town's vulnerability is primarily related to restrictions to travel on roadways, temporary road closures, school closures, and potential restrictions on emergency vehicle access. The Town works to clear roads and carries out general snow removal operations, and bans on-street parking during snow removal to ensure that streets can be plowed and public safety vehicle access is maximized. Transit operations may also be impacted, as they were in the 2015 blizzard which caused the closure of the MBTA system for one day and limited services on several transit lines for several weeks. Another winter storm vulnerability is power outages due to fallen trees and utility lines.

Winter storms are considered to be high frequency events based on past occurrences, as defined by the Massachusetts State Hazard Mitigation Plan, 2013. This hazard occurs more than once in five years, with a greater than twenty percent chance of occurring each year.

Geologic Hazards

Geologic hazards include earthquakes and landslides. 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 in Lynnfield 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).

Seismologists use a Magnitude scale (Richter scale) to express the seismic energy released by each earthquake. The typical effects of earthquakes in various ranges are summarized below.

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

Source: Nevada Seismological Library (NSL), 2005

According to the State Hazard Mitigation Plan, New England experiences an average of five earthquakes per year. From 1668 to 2010, 544 earthquakes were recorded in Massachusetts (NESEC). Most have originated from the La Malbaie fault in Quebec or from the Cape Anne fault located off the coast of Rockport. The region has experienced larger earthquakes, including a magnitude 5.0 earthquake in 1727 and a 6.0 earthquake that struck in 1755 off the coast of Cape Ann. More recently, a pair of damaging earthquakes occurred near Ossipee, NH in 1940, and a 4.0 earthquake centered in Hollis, Maine in October 2012 was felt in the Boston area. Historical records of some of the more significant earthquakes in the region are shown in Table 14.

Table 14- Historical Earthquakes in Massachusetts or Surrounding Area

Location	Date	Magnitude
MA - Cape Ann	11/10/1727	5
MA - Cape Ann	12/29/1727	NA
MA – Cape Ann	2/10/1728	NA
MA – Cape Ann	3/30/1729	NA
MA – Cape Ann	12/9/1729	NA
MA – Cape Ann	2/20/1730	NA
MA – Cape Ann	3/9/1730	NA
MA - Boston	6/24/1741	NA
MA - Cape Ann	6/14/1744	4.7
MA - Salem	7/1/1744	NA
MA - Off Cape Ann	11/18/1755	6
MA – Off Cape Cod	11/23/1755	NA
MA - Boston	3/12/1761	4.6
MA - Off Cape Cod	2/2/1766	NA
MA - Offshore	1/2/1785	5.4
MA – Wareham/Taunton	12/25/1800	NA
MA - Woburn	10/5/1817	4.3
MA - Marblehead	8/25/1846	4.3
MA - Brewster	8/8/1847	4.2

Table 14- Historical Earthquakes in Massachusetts or Surrounding Area

Location	Date	Magnitude
MA - Boxford	5/12/1880	NA
MA - Newbury	11/7/1907	NA
MA - Wareham	4/25/1924	NA
MA – Cape Ann	1/7/1925	4
MA – Nantucket	10/25/1965	NA
MA – Boston	12/27/74	2.3
VA –Mineral	8/23/11	5.8
MA - Nantucket	4/12/12	4.5
ME - Hollis	10/17/12	4.0

Source: (NESEC).

One measure of earthquake risk is ground motion, which is measured as maximum peak horizontal acceleration, expressed as a percentage of gravity (1 g). The range of peak ground acceleration in Massachusetts is from 10g to 20g, with a 2% probability of exceedance in 50 years. Lynnfield is in the middle part of the range for Massachusetts, at 14g to 16g, making it a relatively moderate area of earthquake risk within the state, although the state as a whole is considered to have a low risk of earthquakes compared to the rest of the country. There have been no recorded earthquake epicenters within Lynnfield.

Although New England has not experienced a damaging earthquake since 1755, seismologists state that a serious earthquake occurrence is possible. There are five seismological faults in Massachusetts, but there is no discernible pattern of previous earthquakes along these fault lines. Earthquakes occur without warning and may be followed by aftershocks. Most older buildings and infrastructure were constructed without specific earthquake resistant design features.

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.

Earthquakes are a potential Town-wide hazard in Lynnfield. The Town has many older buildings that pre-date current building code which could be vulnerable in the event of a severe earthquake. Potential earthquake damages to Lynnfield have been estimated using HAZUS-MH. Total building damages, including business interruption losses are estimated at $206.53 million for a 5.0 magnitude earthquake and $1,580.13 million for a 7.0 magnitude earthquake. Other potential impacts are detailed in Table 22.

According to the Boston College Weston Observatory, in most parts of New England, there is a one in ten chance that a potentially damaging earthquake will occur in a 50 year time period. The Massachusetts State Hazard Mitigation Plan classifies earthquakes as "very low" frequency events that occur less frequently than once in 100 years, or a less than 1% per year.

Landslides

According to the USGS, "The term landslide includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over steepened slope is the primary reason for a landslide, there are other contributing factors." Among the contributing factors are: erosion by rivers or ocean waves over steepened slopes; rock and soil slopes weakened through saturation by snowmelt or heavy rains; earthquakes create stresses that make weak slopes fail; and excess weight from accumulation of rain or snow, and stockpiling of rock or ore, from waste piles, or from man-made structures.

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. Typically, a landslide occurs when the condition of a slope changes from stable to unstable. Natural precipitation such as heavy snow accumulation, torrential rain and run-off may saturate soil creating instability enough to contribute to a landslide. The lack of vegetation and root structure that stabilizes soil can destabilize hilly terrain.

There is no universally accepted measure of landslide extent but it has been represented as a measure of the destructiveness. The table below summarizes the estimated intensity for a range of landslides. For a given landslide volume, fast moving rock falls have the highest intensity while slow moving landslides have the lowest intensity.

Estimated Volume	**Expected Landslide Velocity**		
($m^{3)}$	Fast moving landslide (Rock fall)	Rapid moving landslide (Debris flow)	Slow moving landslide (Slide)
<0.001	Slight intensity		
<0.5	Medium intensity		
>0.5	High intensity		
<500	High intensity	Slight intensity	
500-10,000	High intensity	Medium intensity	Slight intensity
10,000 – 50,000	Very high intensity	High intensity	Medium intensity
>500,000		Very high intensity	High intensity
>>500,000			Very high intensity

Source: *A Geomorphological Approach to the Estimation of Landslide Hazards and Risks in Umbria, Central Italy*, M. Cardinali et al, 2002

The entire Town has been classified as having a low incidence risk for landslides, less than 1.5 % of the area is involved in land sliding. (Map 4, Appendix B) The Town does not have records of any damages caused by landslides in Lynnfield. Because of this, no specific mitigation measures for landslides have been included in the plan update.

Potential damages would depend on how many properties were affected. Given the relatively high assessed value of property in Lynnfield, damages affecting a single residence could exceed $500,000, and damages affecting several homes or business properties could theoretically extend from $1 million to several million. However, there are no data available on landslide damages in Lynnfield, as there are no records of any damages caused by landslides in the town.

Should a landslide occur in the future, the type and degree of impacts would be highly localized, and the Town's vulnerabilities could include damage to structures, damage to transportation and other infrastructure, and localized road closures. Injuries and casualties, while possible, would be unlikely given the low extent and impact of landslides in Lynnfield.

Based on past occurrences and the Massachusetts Hazard Mitigation Plan, landslides are of Low frequency, events that can occur once in 50 to100 years (a 1% to 2% chance of occurring each year).

Fire Related Hazards

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. Wildfire season can begin in March and usually ends in late November. The majority of wildfires typically occur in April and May, when most vegetation is void of any appreciable moisture, making them highly flammable. Once "green-up" takes place in late May to early June, the fire danger usually is reduced somewhat.

These fires can 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 approximately 12 to 20 brush fires annually. About 10% of these involve significant property damage but none have resulted in any injuries or deaths. Most brush fires are caused by careless disposal of cigarettes and by weather conditions such as lack of rainfall, winds and lightning.

The following areas of Town were identified as having the highest potential for brush fires based on past occurrences and their potential for the accumulation of dried vegetation growth. The numbers correspond to the numbers on Map 8, "Hazard Areas".

11. Reedy Meadow

12. Ledge Rd at Bow Ridge: area needs fire roads maintained but no fires in 2016; one fire between 2008 and 2017

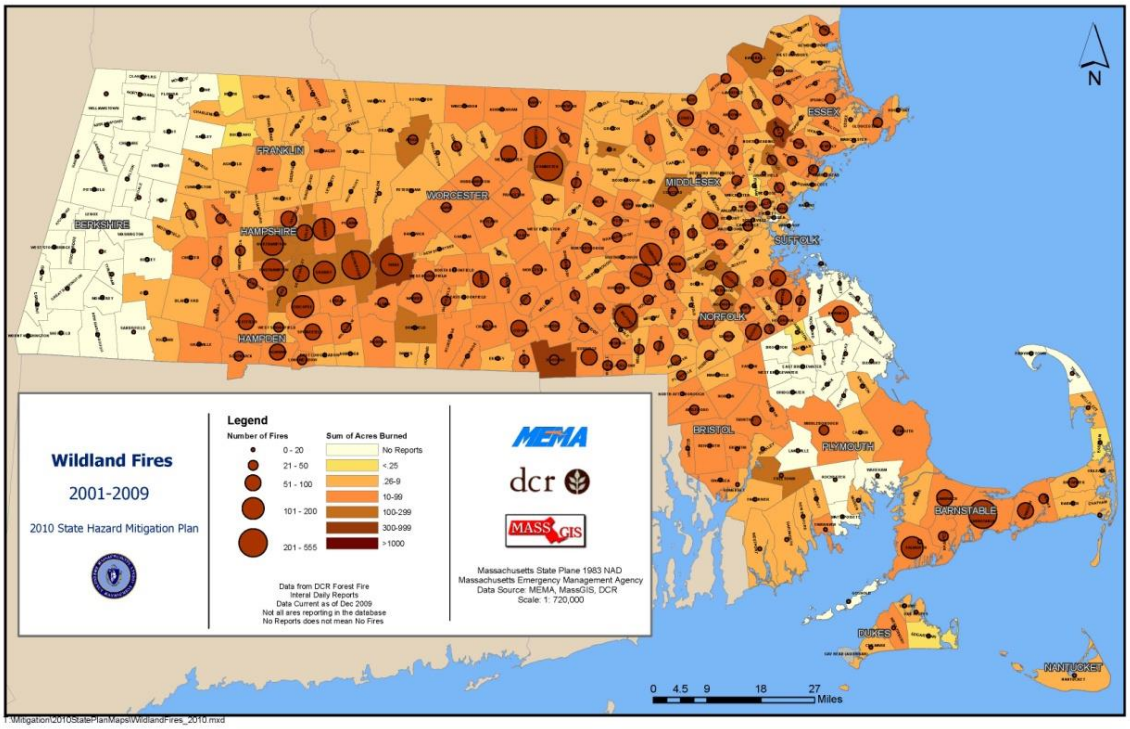
13. Bennett Keenan Conservation Area: Access via N. Reading and Middleton; bridge access issue; 2-3 fires per year; kids, fires, cigarettes, ATVs; come up RR bed to access area.

14. Unnamed area: ATVs have access; 1-2 fire per year

15. Hawkes Pond Wooded area: Access via Route 1 by ATV; kids use; occasional brush fires over 5 years ago.

Wildfires in Massachusetts are measured by the number of fires and the sum of acres burned. The most recent data available for wildfires in Massachusetts, shown in Figure 2 below, indicates that the wildfire extent in Lynnfield consists of .26 - 9 acres burned, with 0- 20 fires from 2001 to 2009.

Figure 2 Massachusetts Wildfires 2001-2009



Source: 2013 Massachusetts State Hazard Mitigation Plan

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

Potential damages from wildfires in Lynnfield would depend on the extent and type of land affected. There could be the need for post-fire revegetation to restore burned properties, which could cost from a few thousand dollars to tens of thousands for an extensive area. However, there are no data on actual wildfire damages.

Based on past occurrences and the Massachusetts Hazard Mitigation Plan 2013, brushfires are of High frequency, events that occur more frequently than once in 5 years (Greater than 20% per year)

Extreme Temperatures

Extreme temperatures occur when either high temperature or low temperatures relative to average local temperatures occur. These can occur for brief periods of time and be acute, or they can occur over long periods of time when there is a prolonged period of excessively hot or cold weather. Lynnfield has four well-defined seasons. The seasons have several defining factors, with temperature one of the most significant. Extreme temperatures can be defined as those, which are far outside of the normal seasonal ranges for Massachusetts. The average temperatures for Massachusetts are: winter (Dec-Feb) Average = 31.8°F and summer (Jun-Aug) Average = 71°F. Extreme temperatures are a Town-wide hazard.

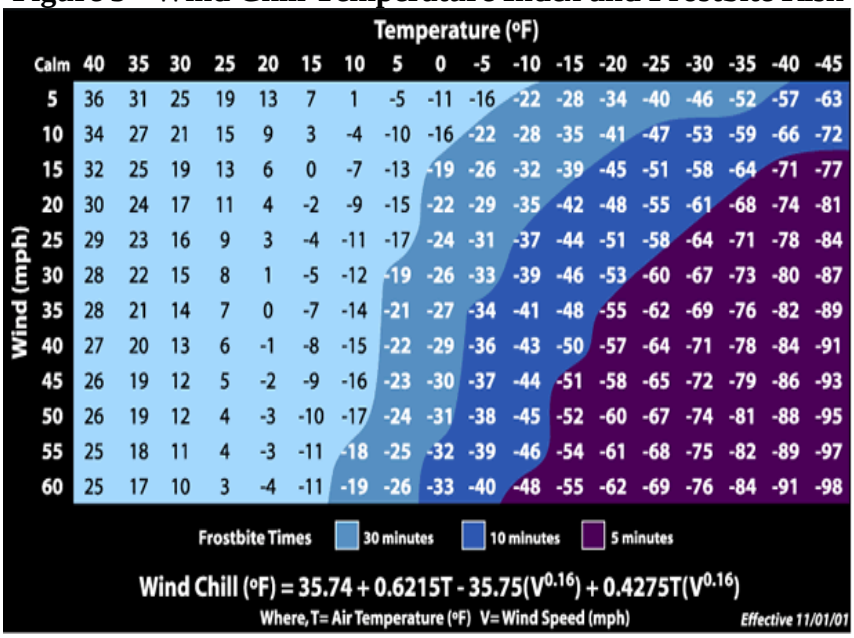
Extreme Cold

For extreme cold, temperature is typically measured using Wind Chill Temperature Index, which is provided by the National Weather Service (NWS). The latest version of the index was implemented in 2001 and it meant to show how cold conditions feel on unexposed skin. The index is provided in Figure 3 below.

Extreme cold is also relative to the normal climatic lows in a region. Temperatures that drop decidedly below normal and wind speeds that increase can cause harmful wind-chill factors. The wind chill is the apparent temperature felt on exposed skin due to the combination of air temperature and wind speed.

Extreme cold is a dangerous situation that can result in health emergencies for susceptible people, such as those without shelter or who are stranded or who live in homes that are poorly insulated or without heat. The elderly and people with disabilities are often most vulnerable. In Lynnfield, 14.9 percent of the population are over 65 and 4.5% of the population has a disability.

Figure 3 - Wind Chill Temperature Index and Frostbite Risk



The Town of Lynnfield does not collect data for previous occurrences of extreme cold. The best available local data are for Essex County, 1995- 2016, through the National Climatic Data Center (NCDC). There are four extreme cold events on record which caused no deaths and no injuries, and no property damage (see Table 15).

Table 15 – Essex County Extreme Cold and Wind Chill Occurrences

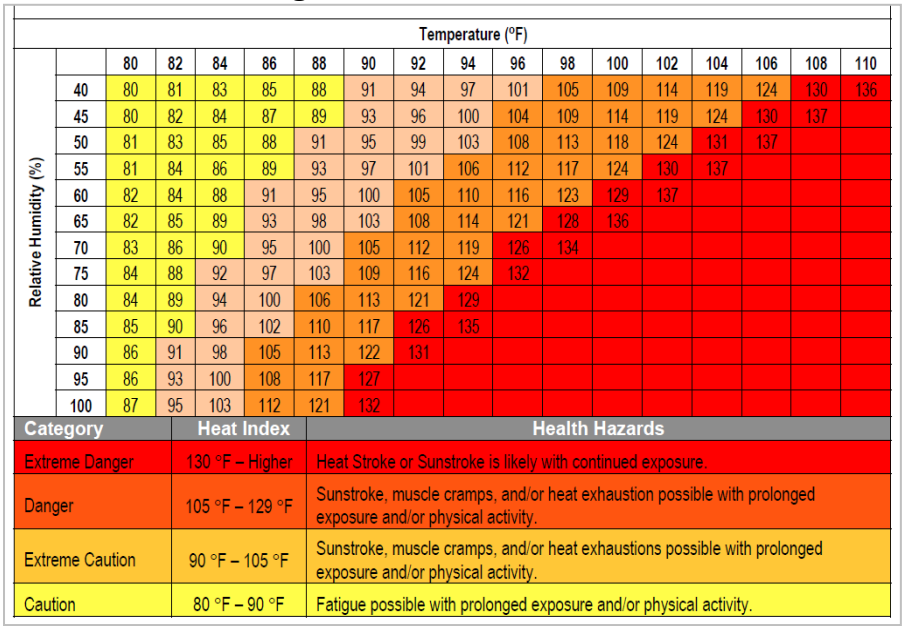
Location	Date	Type	Deaths	Injuries	Damage-$
EASTERN ESSEX	2/15/2015	Extreme Cold/Wind Chill	0	0	0
WESTERN ESSEX	2/16/2015	Extreme Cold/Wind Chill	0	0	0
WESTERN ESSEX	2/13/2016	Extreme Cold/Wind Chill	0	0	0
EASTERN ESSEX	2/13/2016	Extreme Cold/Wind Chill	0	0	0

Source: NOAA, National Climatic Data Center

Extreme Heat

While a heat wave for Massachusetts is defined as three or more consecutive days above 90°F, another measure used for identifying extreme heat events is through a Heat Advisory from the NWS. These advisories are issued when the heat index (Figure 4) is forecast to exceed 100 degree Fahrenheit (F) for 2 or more hours; an excessive heat advisory is issued if forecast predicts the temperature to rise above105 degree F.

Figure 4- Heat Index Chart



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

Category	Heat Index	Health Hazards
Extreme Danger	130 °F – Higher	Heat Stroke or Sunstroke is likely with continued exposure.
Danger	105 °F – 129 °F	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Extreme Caution	90 °F – 105 °F	Sunstroke, muscle cramps, and/or heat exhaustions possible with prolonged exposure and/or physical activity.
Caution	80 °F – 90 °F	Fatigue possible with prolonged exposure and/or physical activity.

Extreme heat poses a potentially greater risk to the elderly, children, and people with certain medical conditions, such as heart disease. However, even young and healthy individuals can succumb to heat if they participate in strenuous physical activities during hot weather. Hot summer days can also worsen air pollution. With increased extreme heat, urban areas of the Northeast are likely to experience more days that fail to meet air quality standards.

The Town of Lynnfield does not collect data on excessive heat occurrences. The best available local data are for Essex County, through the National Climatic Data Center. From 1995 – April, 2017, there has been a total of one excessive heat event, with no reported deaths, no injuries, and no property damage resulting from excessive heat (see Table 16).

Extreme temperature events are projected to be medium frequency events based on past occurrences, as defined by the Massachusetts State Hazard Mitigation Plan, 2013. Both extreme cold and hot weather events occur between once in five years to once in 50 years, or a 2 percent to 20 percent chance of occurring each year.

Table 16 – Essex County Extreme Heat Occurrences 1995 to April, 2017

Date	Type	Deaths	Injuries	Damage
7/22/2011	Excessive Heat	0	0	0

Source: NOAA, National Climatic Data Center

Drought

Drought is a temporary irregularity in precipitation and differs from aridity since the latter is restricted to low rainfall regions and is a permanent feature of climate. Drought is a period characterized by long durations of below normal precipitation. Drought conditions occur in virtually all climatic zones yet its characteristics vary significantly from one region to another, since it is relative to the normal precipitation in that region. Drought can affect agriculture, water supply, aquatic ecology, wildlife, and plant life.

In Massachusetts, droughts are caused by the prevalence of dry northern continental air and a decrease in coastal- and tropical-cyclone activity. During the 1960's, a cool drought occurred because dry air from the north caused lower temperatures in the spring and summer of 1962-65. The northerly winds drove frontal systems to sea along the Southeast Coast and prevented the Northeastern States from receiving moisture (U.S. Geological Survey). This is considered the drought of record in Massachusetts.

Average annual precipitation in Massachusetts is 44 inches per year, with approximately 3 to 4 inch average amounts for each month of the year. Regional monthly precipitation ranges from zero to 17 inches. Statewide annual precipitation ranges from 30 to 61 inches. Thus, in the driest calendar year (1965), the statewide precipitation total of 30 inches was 68 percent of average.

Although Massachusetts is relatively small, it has a number of distinct regions that experience significantly different weather patterns and react differently to the amounts of precipitation they receive. The DCR precipitation index divides the state into six regions: Western, Central, Connecticut River Valley, Northeast, Southeast, and Cape and Islands. Lynnfield is located in the Northeast Region. In Lynnfield drought is a potential Town-wide hazard.

Five levels of drought have been developed to characterize drought severity: Normal, Advisory, Watch, Warning, and Emergency. These drought levels are based on the conditions of natural resources and are intended to provide information on the current status of water resources. The levels provide a basic framework from which to take actions to assess, communicate, and respond to drought conditions. They begin with a normal situation where data are routinely collected and distributed, move to heightened vigilance with increased data collection during an advisory, to increased assessment and proactive education during a watch. Water restrictions might be appropriate at the watch or warning stage, depending on the capacity of each individual water supply system. A warning level indicates a severe situation and the possibility that a drought emergency may be necessary. A drought emergency is one in which mandatory water restrictions or use of emergency supplies is necessary. Drought levels are used to coordinate both state agency and local response to drought situations.

As dry conditions can have a range of different impacts, a number of drought indices are available to assess these various impacts. Massachusetts uses a multi-index system that takes advantage of several of these indices to determine the severity of a given drought or extended period of dry conditions. Drought level is determined monthly based on the number of indices which have reached a given drought level. Drought levels are declared on a regional basis for each of six regions in Massachusetts. County by county or watershed-specific determinations may also be made.

A determination of drought level is based on seven indices:

1. Standardized Precipitation Index (SPI) reflects soil moisture and precipitation.
2. Crop Moisture Index: (CMI) reflects soil moisture conditions for agriculture.
3. Keetch Byram Drought Index (KBDI) is designed for fire potential assessment.
4. Precipitation Index is a comparison of measured precipitation amounts to historic normal precipitation.
5. The Groundwater Level Index is based on the number of consecutive month's groundwater levels are below normal (lowest 25% of period of record).
6. The Stream flow Index is based on the number of consecutive months that stream flow levels are below normal (lowest 25% of period of record).
7. The Reservoir Index is based on the water levels of small, medium and large index reservoirs across the state, relative to normal conditions for each month.

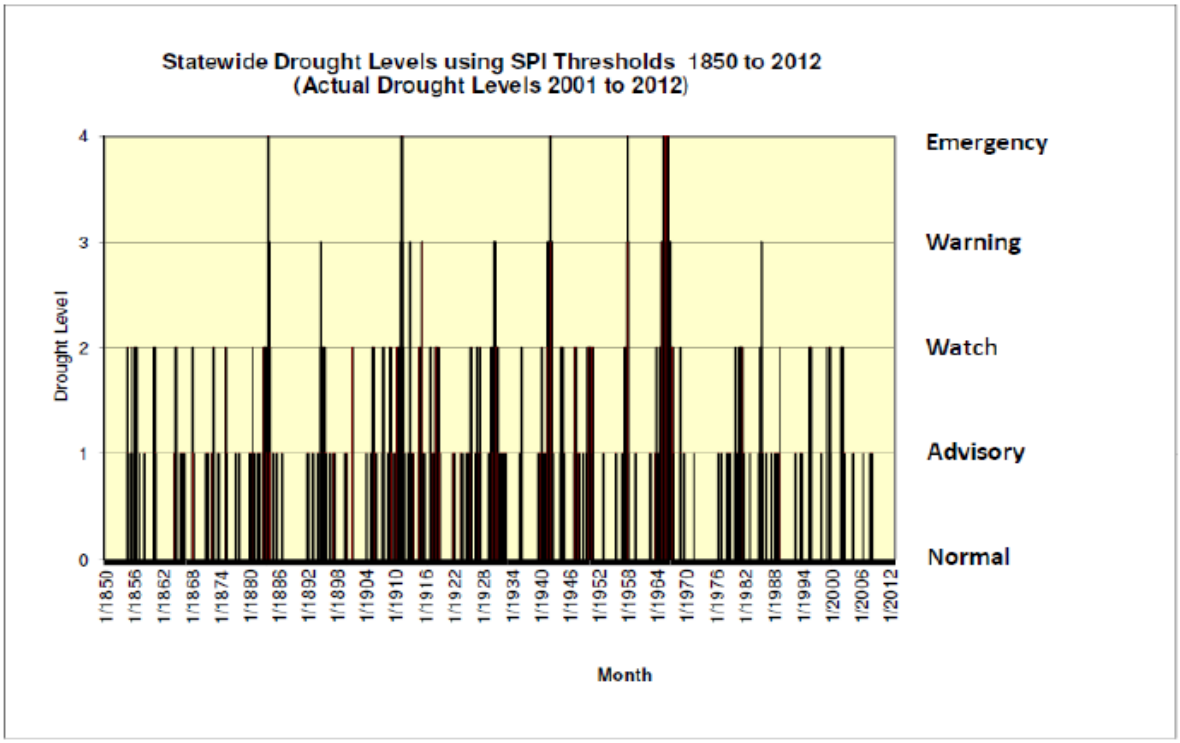
Determinations regarding the end of a drought or reduction of the drought level focus on two key drought indicators: precipitation and groundwater levels. These two factors have the greatest long-term impact on stream flow, water supply, reservoir levels, soil moisture and potential for forest fires.

Previous Occurrences

Lynnfield does not collect data relative to drought events. Because drought tends to be a regional natural hazard, this plan references state and county data as the best available data for drought. The statewide scale is a composite of six regions of the state. Regional composite precipitation values are based on monthly values from six stations, and three stations in the smaller regions (Cape Cod/Islands and West).

Figure 5 depicts the incidents of drought levels' occurrence in Massachusetts from 1850 to 2012 using the Standardized Precipitation Index (SPI) parameter alone. On a monthly basis, the state would have been in a Drought Watch to Emergency condition 11 percent of the time between 1850 and 2012. Table 17 summarizes the chronology of major droughts from 1929 to 2017.

Figure 5 - Statewide Drought Levels using SPI Thresholds 1850 – 2012



(Source: Mass. State Drought Management Plan 2013)

Drought Emergency

Drought emergencies have been reached infrequently, with 5 events occurring in the period between 1850 and 2012: in 1883, 1911, 1941, 1957, and 1965-1966. The 1965-1966 drought period is viewed as the most severe drought to have occurred in modern times in Massachusetts because of its long duration. On a monthly basis over the 162-year period of record, there is a one percent chance of being in a drought Emergency.

Drought Warning

Drought Warning levels not associated with drought Emergencies have occurred five times, in 1894, 1915, 1930, and 1985, and 2016. On a monthly basis over the 162-year period of record, there is a two percent chance of being in a drought Warning level.

Drought Watch

Drought Watches not associated with higher levels of drought generally have occurred in three to four years per decade between 1850 and 1950. In the 1980s, there was a lengthy drought Watch level of precipitation between 1980 and 1981, followed by a drought Warning in 1985. A frequency of drought Watches at a rate of three years per decade

resumed in the 1990s (1995, 1998, 1999). In the 2000s, Drought Watches occurred in 2001 and 2002.

On July 8, 2016, following four continuous months of unusually dry weather, Massachusetts Energy and Environmental Affairs (EEA) Secretary Matthew Beaton declared a Drought Watch for Central and Northeast Massachusetts, which includes the Town of Lynnfield, and a Drought Advisory for Southeast Massachusetts and the Connecticut River Valley. In August 2016 the Northeast Region was upgraded to a Drought Warning. As of January 1, 2017, four of the six statewide regions in Massachusetts were listed in Drought Warning, the second highest drought stage, and the Northeast Region was listed in the third-ranked Drought Watch stage. By June 1, 2017 all areas of the state were listed as being in a normal condition.

The overall frequency of being in a drought Watch is 8 percent on a monthly basis over the 162-year period of record.

Table 17 - Chronology of Major Droughts in Massachusetts

Date	Area affected	Recurrence interval (years)	Remarks
1929-32	Statewide	10 to >50	Water-supply sources altered in 13 communities. Multistate.
	Statewide	15 to >50	More severe in eastern and extreme western Massachusetts. Multistate.
1957-59	Statewide	5 to 25	Record low water levels in observation wells, northeastern Massachusetts.
1961-69	Statewide	35 to >50	Water-supply shortages common. Record drought. Multistate.
1980-83	Statewide	10 to 30	Most severe in Ipswich and Taunton River basins; minimal effect in Nashua River basin. Multistate.
1985-88	Housatonic River basin	25	Duration and severity unknown. Streamflow showed mixed trends elsewhere.
2016	Statewide	N/A	Drought declaration began in July 2016 with a Drought Watch, which was upgraded to a Drought Warning in August 2016. The Central and Northeast regions were the most severely affected.

Data on drought occurrences for Essex County, is available through the National Climatic Data Center. From 1995 – April, 2017, there have been a total of 8 months of drought events, with no reported deaths, no injuries, and no property damage resulting from drought (see Table 18).

Table 18 – Essex County Drought Occurrences 1995- April, 2017

Location	Date	Type	Deaths	Injuries	Damage-$
WESTERN ESSEX	4/12/2012	Drought	0	0	0
WESTERN ESSEX	7/5/2016	Drought	0	0	0
WESTERN ESSEX	8/1/2016	Drought	0	0	0
WESTERN ESSEX	9/1/2016	Drought	0	0	0
WESTERN ESSEX	10/1/2016	Drought	0	0	0
WESTERN ESSEX	11/1/2016	Drought	0	0	0
WESTERN ESSEX	12/1/2016	Drought	0	0	0
WESTERN ESSEX	1/1/2017	Drought	0	0	0
Total			0	0	0

Source: NOAA, National Climatic Data Center

Under a severe long term drought the Lynnfield could be vulnerable to restrictions on water supply. Potential damages of a severe drought could include losses of landscaped areas if outdoor watering is restricted and potential loss of business revenues if water supplies were severely restricted for a prolonged period. As this hazard has never occurred in Lynnfield, there are no data or estimates of potential damages, but under a severe drought scenario it would be reasonable to expect a range of potential damages from several million to tens of millions of dollars. However, given the resilience of the MWRA water system due to its large amount of storage in the Quabbin and Wachusett Reservoirs, (equivalent to five years of water demand), severe impacts on the Town is unlikely. For example, even during the multi-year drought of record in the 1960s, there were no severe limitations of supply from the regional water system, which at the time was operated by the Metropolitan District Commission.

Probability of Future Occurrences

The state has experienced Emergency Droughts five times between 1850 and 2012. Even given that regional drought conditions may occur at a different interval than state data indicates, droughts remain primarily regional and state phenomena in Massachusetts. Emergency Drought conditions over the 162 period of record in Massachusetts are a Low Frequency natural hazard event that can occur from once in 50 years to once in 100 years (1% to 2% chance per year), as defined by the Massachusetts State Hazard Mitigation Plan, 2013.

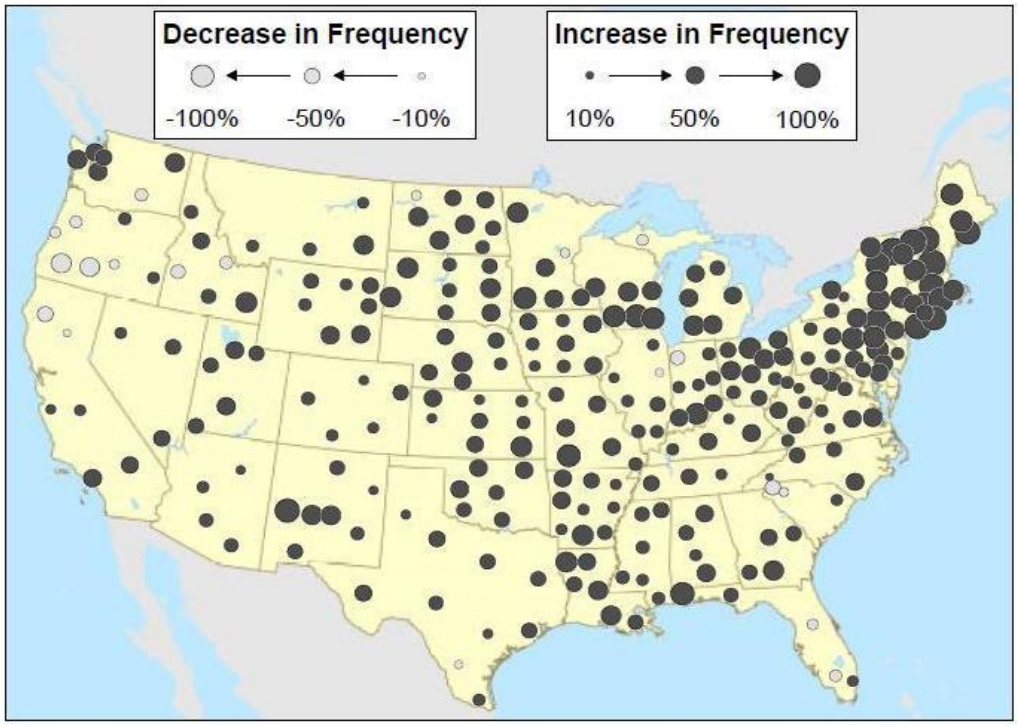
Impacts of Climate Change

Many of the natural hazards that Lynnfield has historically experienced are likely to be exacerbated by climate change in future years. This is particularly true for flooding caused by extreme precipitation and extreme heat. These are described in more detail below.

Climate Change Impacts: Extreme Precipitation

Lynnfield's average annual precipitation is 47.83 inches. While total annual precipitation has not changed significantly, 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 (see Figure 6). 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.

Figure 6- Changes in Frequency of Extreme Downpours, 1948 – 2011



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

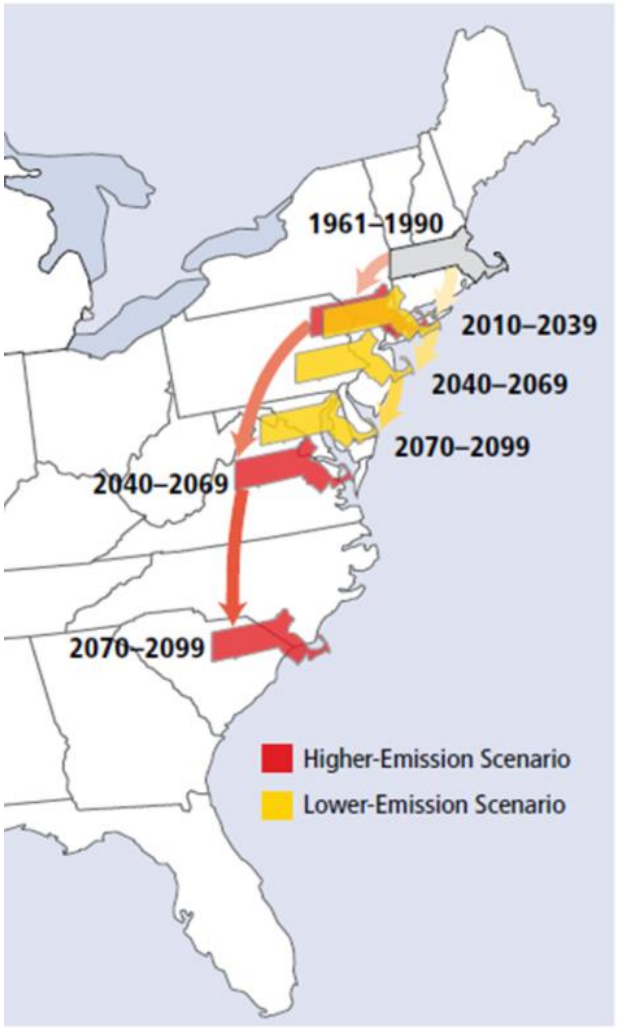
Not only are these intense storm events more frequent, they are also more severe: the largest annual storms now produce 10 percent more precipitation, on average, than in

1948. In particular, the report finds that New England has experienced the greatest change with intense rain and snow storms occurring 85 percent more often than in 1948.

At the other extreme, changes in precipitation patterns and the projected future rising temperatures due to climate change (discussed below) will likely increase the frequency of short-term (one- to three-month) droughts and decrease stream flow during the summer.

Climate Change Impacts: Extreme Heat

Recent temperature trends suggest greater potential impacts to come due to climate change. In the report "Confronting Climate Change in the U.S. Northeast," (2007), the Union of Concerned Scientists presented temperature projections to 2099 based on two scenarios, one with lower carbon dioxide emissions, and the other with high emissions.



Source: Union of Concerned Scientists

Figure 7 – Mass. Extreme Heat Scenarios
Between 1961 and 1990, Boston experienced an average of 11 days per year over 90°F. That could triple to 30 days per year by 2095 under the low emissions scenario, and increase to 60 days per year under the high emissions scenario. Days over 100°F could increase from the current average of one day per year to 6 days with low emissions or 24 days with high emissions By 2099, Massachusetts could have a climate similar to Maryland's under the low emissions scenario, and similar to the Carolinas' with high emissions (Figure 12). Furthermore, the number of days with poor air quality could quadruple in Boston by the end of the 21st century under higher emissions scenario, or increase by half under the lower emissions scenario. These extreme temperature trends could have significant impacts on public health, particularly for those individuals with asthma and other respiratory system conditions, which typically affect the young and the old more severely.

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 19 shows the acreage and percentage of land in 10 categories. If the three residential categories are aggregated, residential uses make up 33 % of the area of the Town (2,180.1) acres). Commercial and industrial uses combined make up 1.5 % of the Town, or 103.9 acres.

Table 19- 2005 Land Use

High Density Residential	152.0
Medium Density Residential	910.7
Low Density Residential	1117.4
Non-Residential Developed	488.6
Commercial	92.2
Industrial	11.6
Transportation	115.8
Agriculture	9.4
Undeveloped	2,264.7
Undeveloped Wetlands	1,520.9
TOTAL ACRES	**6,683.3**

For more information on how the land use statistics were developed and the definitions of the categories, please go to http://www.mass.gov/mgis/lus.htm.

Description and Economic Elements

The Town of Lynnfield is a traditional New England residential community located in the western part of Essex County, in the northeastern part of Massachusetts, known as the North Shore. Lynnfield is bordered by North Reading on the north; Reading on the west; Middleton, Peabody and Lynn on the east; and Saugus and Wakefield on the south. With a total area of 10.22 square miles, Lynnfield is 15 miles north of Boston, 19 miles east of Concord and 28 miles south of Newburyport. Lynnfield's location on the North Shore, with direct access to major highways, makes it easy for residents to commute within Metro Boston, and to access nearby mountains and beaches.

(Lynnfield Housing Production Plan, 2006)

The median income for a household in the town as of the 2010 census was $136,101, and the median income for a family was $95,804, which are both well over the national averages. Males had a median income of $82,386 versus $50,589 for females. The per capita income for the town was $50,916. The average household net worth is $966,273. (2010 US Census)

Historic, Cultural, and Natural Resource Areas

The first European settlers came to the area known today as Lynnfield in 1634. Prior to 1634, the Saugus Indian Tribe inhabited the area for as many as three thousand years. Native American artifacts have been found at campsites around Lynnfield. These areas include the Kallenberg Quarry, the Sagamore Spring Golf Club, and Partridge Island, located at the edge of Reedy Meadow. The newly settled area was known as Lynn End and was a parish of the town of Lynn for many years. In 1782, Lynnfield was incorporated, and in 1814 became a Town. Lynnfield has an open town meeting form of government, headed by a three-member Board of Selectmen and a Town Administrator.

The Newburyport Turnpike (U.S. Route 1) was completed in 1806. The Lynnfield Hotel, built in 1804 and destroyed by fire in 1894, was the first stagecoach stop from Boston. During the mid-1800s, the railroad began operating in Lynnfield. This access brought many people to the area, particularly in the summer, to use the water resources such as Suntaug Lake and Pillings Pond. Until the beginning of the 19th century, Lynnfield was mostly an agrarian community. During the 1800's, a few industries appeared, including several mills and shoe factories. Additionally, the Town became a source for peat, excavated from Reedy Meadow, and granite, quarried in the Kallenberg Quarry. Both sites are now conservation areas.

Lynnfield is primarily made up of gently rolling countryside and is rich in water resources. The Ipswich River flows along the Town's northern border while the Saugus River makes up part of the southern and western borders. Pillings Pond is a manmade body of water located near the center of Lynnfield and has been the setting for many recreational activities in the community. The City of Peabody receives part of its water supply from Suntaug Lake, which abuts Lynnfield and Peabody. Hawkes Pond is shared with the Town of Saugus and is part of the Lynn water supply. Reedy Meadow is a freshwater marsh and is one of eleven National Natural Landmarks in Massachusetts. The surface water of Reedy Meadow does not belong to Lynnfield even though the land beneath the water is within the confines of the Town. By an act of legislation in 1883, the City of Lynn acquired the right to dam the Saugus River and to use the meadow for water conservation. Lynnfield and Wakefield, both bordering Reedy Meadow, share in their desire to keep the marsh in its natural state and retain its open space qualities. (2006 Lynnfield Housing Production Plan)

Development Trends

Lynnfield remained a rural community until after World War II when the Town experienced significant growth similar to many of its neighboring towns. The population

more than doubled during the 1950s and 1960s spurred by the development of new housing (1,654 houses, or 40% of today's housing stock, were built during this 20-year span). The expansion of population resulted in increased public services such as post offices, fire and police stations, new shopping centers and an addition to the library. The once rural community was transformed into a suburb. Prior to 1960, Lynnfield students attended Wakefield or Lynn High Schools. The first class at Lynnfield High School graduated in 1960. Within five years, a new high school was needed and the former high school became a middle school. During this decade, the Town acquired conservation land and built recreational facilities. (2006 Lynnfield Housing Production Plan)

Development trends throughout the metropolitan region are tracked by MAPC's Development Database, which provides an inventory of new development over the last decade. The database tracks both completed developments and those currently under construction. The database includes 5 developments in the Town of Lynnfield since 2008, of which 5 are completed.

The database also includes several attributes of the new development, including site acreage, housing units, and commercial space. The developments in Lynnfield include a total of 504 housing units, 475,000 square feet of commercial space, and are sited on a total of 123.98 acres (see Table 21).

In order to characterize any change in the Town's vulnerability associated with new developments, a GIS mapping analysis was conducted which overlaid the development sites with the FEMA Flood Insurance Rate Map. The analysis shows that two of the developments, Colonial Golf Course and Sagamore Golf Course, are located within a flood zone.

Recent and Potential Future Development

MAPC consulted with Town planning staff to determine areas that have been recently developed or may be developed in the future, based on the Town's comprehensive planning efforts and current trends and projects. These areas are described below. Two of these sites are in a flood hazard zone, with both located in an AE or A zone with a 1 % annual chance of flooding. All of the developments are in the areas defined as "Low Landslide Incidence." Other hazards are categorized at the same level throughout town. For snowfall, most of Lynnfield is in the zone of 48 to 72 inches average annual snowfall, with the southeast section having an average snowfall of 36 to 48 inches. With respect to wind, there is no variation across different sites in the town; the hazard map depicts the entire town of Lynnfield within a 100-year wind speed of 110 miles per hour. (See hazard maps in Appendix B).

Table 20
Relationship of Recent and Potential Development to Hazard Areas

Parcel	Landslide risk	Flood Zone	Brush Fire Area
Colonial Golf Course	Low incidence	19.94% in AE: 1% Annual Chance of Flooding, with BFE , and 1.97% in AE: Regulatory Floodway	No
Sagamore Golf Course	Low incidence	4.45% in A: 1% Annual Chance of Flooding, no BFE	No
Herb Chambers	Low incidence		No
Two Broadway	Low incidence		No
Pyburn Mews	Low incidence		No
470 Salem Street	Low incidence		No
Grandview Estates	Low incidence		No
Heritage Woods	Low incidence		No
Windsor Estates	Low incidence		No

Table 21- Summary of Lynnfield Developments 2008-2016

DEVELOPMENTS COMPLETED 2008-2016	Acres	HOUSING UNITS	COMMERCIAL (SQ FEET)	PROJECT TYPE
Heritage Woods	5.67	40	-	Over age 55 housing
Grandview Estates	10.60	40	-	Grand View Estates a 40 unit 40B condominium that is located off Ramdsdell Way.
Windsor Estates	14.03	44	-	Market rate age 55 and over condominiums
Lynnfield Commons	13.42	200	-	The 40B project located on the north side of Route 1 made up of three apartment buildings consisting of 200 units and a club house.
Market Street at Lynnfield	80.25	180	475,000	Retail, office, residential
Total	123.98	504	475,000	

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.). There are 137 facilities identified in Lynnfield. These are listed in Table 22 and are shown on the maps in Appendix B.

Explanation of Columns in Table 22

Column 1: ID #: The first column in Table 10 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.

Column 6.Brush Fires- Areas determined by Local Hazard Mitigation Team to be at risk for brush fires.

Table 22- Critical Facilities and Relationship to Hazard Areas

PDM _ID	NAME	TYPE	Landslides	Within FEMA Flood Zone	Within Locally Identified Area of Flooding	Within Brush Fire Area
164-001	Lynnfield Town Hall	Municipal	Low incidence	No	No	No
164-002	Lynnfield Police Department	Police Station	Low incidence	No	No	No
164-003	Our Lady Of Assumption	School	Low incidence	No	No	No
164-004	Summer Street	School	Low incidence	No	No	No
164-005	Lynnfield High	School	Low incidence	No	No	No
164-006	Huckleberry Hill	School	Low incidence	No	No	No
164-007	Lynnfield Middle School	School	Low incidence	No	Beaver Dam Brook (Reedy Meadow to Chestnut)	No
164-008	Lynnfield Fire Department	Fire Station	Low incidence	No	No	No
164-009	Lynnfield Fire Department	Fire Station	Low incidence	No	No	No
164-010	DeBonis, Melinda	Child Care	Low incidence	No	No	No
164-011	Zdanwich, Jean M.	Child Care	Low incidence	No	No	No
164-012	Migliero, Susan M.	Child Care	Low incidence	No	No	No
164-013	Griffin, Marie	Child Care	Low incidence	No	No	No
164-014	Messiah Lutheran Day School	Child Care	Low incidence	No	No	No
164-015	Tower Day School	Child Care	Low incidence	No	No	No
164-016	Bethlehem School - St. Paul's Episcopal	Child Care	Low incidence	No	No	No
164-017	Lynnfield Center Water District	Well Pump Station	Low incidence	No	No	No
164-018	Lynnfield Center Water District	Well Pump Station	Low incidence	No	No	No
164-019	Lynnfield Center Water	Well Pump Station	Low incidence	No	No	No

Table 22- Critical Facilities and Relationship to Hazard Areas

PDM _ID	NAME	TYPE	Landslides	Within FEMA Flood Zone	Within Locally Identified Area of Flooding	Within Brush Fire Area
	District Pumping					
164-020	Lynnfield Center Well Water Pump Station	Well Pump Station	Low incidence	No	No	No
164-021	Verizon Switching Station	Telecommunications	Low incidence	No	No	No
164-022	Center Village	Elder Housing	Low incidence	No	No	No
164-023	Lynnfield Center Substation	Power Substation	Low incidence	No	No	No
164-024	Lynnfield Emergency Operations Center	Emergency Operations Center	Low incidence	No	No	No
164-025	DPW Garage	Municipal	Low incidence	No	No	No
164-026	Sunrise Assisted Living of Lynnfield	Elder Housing	Low incidence	No	No	No
164-027	Switching Station for Peabody Municipal	Telecommunications Switching Station	Low incidence	No	No	No
164-028	Keyspan	Smell Additive Station	Low incidence	No	No	No
164-029	Essex Village	Elder Housing	Low incidence	No	No	No
164-030	Seam Collaborative Day Care	Child Care	Low incidence	No	No	No
164-031	South Lynnfield Fire Station	Fire Station	Low incidence	No	No	No
164-032	Colonial Gardens	Elder Housing	Low incidence	No	No	No
164-033	Heritage Woods	Elder Housing	Low incidence	No	No	No
164-034	Lynnfield Water District	Municipal	Low incidence	No	No	No
164-035	Lynnfield Water District	Well Pump Station	Low incidence	No	No	No

Vulnerability Assessment

The purpose of the vulnerability assessment is to estimate the extent of potential damages from natural hazards of varying types and intensities. A vulnerability assessment and estimation of damages was performed for hurricanes, earthquakes, and flooding. 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 Town of Lynnfield, 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 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.

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 1% and .0.2% 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 Town, 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 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 23 - Estimated Damages from Hurricanes

	100 Year	500 Year
Building Characteristics		
Estimated total number of buildings	4,509	
Estimated total building replacement value (2010$)	$1,592	
Millions of dollars		
Building Damages		
# of buildings sustaining minor damage	149	814
# of buildings sustaining moderate damage	7	128
# of buildings sustaining severe damage	0	10
# of buildings destroyed	0	8
Population Needs		
# of households displaced	0	1
# of people seeking public shelter	0	0
Debris		
Building debris generated (tons)	3,790	9,820
Tree debris generated (tons)	1,216	3,411
# of truckloads to clear building debris	15	89
Value of Damages (Thousands of dollars)		
Total property damage (buildings and content)	$10,288.22	$39,554.12
Total losses due to business interruption	$289.99	$2,559.55

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-24
Estimated Damages from Earthquakes

	Magnitude 5.0	**Magnitude 7.0**
Building Characteristics		
Estimated total number of buildings	4,509	
Estimated total building replacement value (2010 $) Millions of dollars	$1,592	
Building Damages		
# of buildings sustaining slight damage	1,333	124
# of buildings sustaining moderate damage	692	900
# of buildings sustaining extensive damage	178	1,315
# of buildings completely damaged	44	2,162
Population Needs		
# of households displaced	83	2,063
# of people seeking public shelter	44	1,119
Debris		
Building debris generated (million tons)	0.03	0.28
# of truckloads to clear debris (@ 25 tons/truck)	1,280	11,320
Value of Damages (Millions of dollars)		
Total property damage	$174.46	$1,378.44
Total losses due to business interruption	$32.07	$201.70

Estimated Damages from Flooding

The HAZUS-MH flood risk module was used to estimate damages to the municipality at the 100 and 500 return periods. These return periods correspond to flooding events that have a 1% and a 0.2% likelihood of occurring in any given year.

Table-25
Estimated Damages from Flooding

	100 Year Flood	**500 Year Flood**
Building Characteristics		
Estimated total number of buildings	4,509	
Estimated total building replacement value (2010 $) Millions of dollars	$1,592	
Building Damages		
# of buildings sustaining slight damage (1-10%)	0	4
# of buildings sustaining moderate damage (11-50%)	0	0
# of buildings sustaining substantial damage (>50%)	0	0
Value of Damages (millions of dollars)		
Total property damage	0	0.06
Total losses due to business interruption	0	0

V. HAZARD MITIGATION GOALS

The Lynnfield Local Hazard Mitigation Planning Team reviewed and discussed the goals from the 2008 Hazard Mitigation Plan for the Town of Lynnfield. The Team modified their 2008 goals to reflect a more inclusive and streamlined approach for this plan update. All of the goals are considered critical for the Town and they are not listed in order of importance.

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

2. Build and enhance local mitigation capabilities to ensure individual safety, reduce damage to public and private property and ensure continuity of emergency services.

3. Increase cooperation and coordination among private entities, Town officials and Boards, State agencies and Federal agencies.

4. Increase awareness of the benefits of hazard mitigation through outreach and education.

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VI. EXISTING MITIGATION MEASURES

The existing protections in the Town of Lynnfield are a combination of zoning, land use, and environmental regulations, infrastructure maintenance and drainage infrastructure improvement projects. Infrastructure maintenance generally addresses localized drainage clogging problems, while large scale capacity problems may require pipe replacement or invert elevation modifications. These more expensive projects are subject to the capital budget process and lack of funding is one of the biggest obstacles to completion of some of these.

The Town's existing mitigation measures are listed by hazard type here and are summarized in Table 25 below.

Flooding – Existing Town-wide mitigation

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

National Flood Insurance Program (NFIP) – Lynnfield participates in the NFIP with 60 policies in force as of the April 30, 2017. FEMA maintains a database on flood insurance policies and claims. This database can be found on the FEMA website at https://www.fema.gov/policy-claim-statistics-flood-insurance/policy-claim-statistics-flood-insurance/policy-claim-13

The following information is provided for the Town of Lynnfield:

Flood insurance policies in force (as of July 31, 2017)	60
Coverage amount of flood insurance policies	$17,443,000
Premiums paid	$51,366
Total losses (all losses submitted regardless of the status)	33
Closed losses (Losses that have been paid)	27
Open losses (Losses that have not been paid in full)	0
CWOP losses (Losses that have been closed without payment)	6
Total payments (Total amount paid on losses)	$242,833.74

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

Massachusetts State Building Code – The Massachusetts State Building Code contains many detailed regulations regarding wind loads, earthquake resistant design, flood-proofing, and snow loads. The Town has adopted the state building code.

Street sweeping **–** Every street gets swept once a year or as needed. Street sweeping is contracted out as part of the services negotiated by the North Reading – Lynnfield – Middleton Consortium.

Catch basin cleaning **–** All 1,500 catch basins are cleaned out once a year. This service is contracted out.

Roadway treatments **–** The town uses a mixture of sand and salt with a bit more salt in the mix. This is done to minimize the amount of sand that enters catch basins and streams.

Subdivision Rules and Regulations – The subdivision rules and regulations contain a number of requirements that address flood hazard mitigation. Some of these provisions also relate to other hazards.

Section 5.4.2(7) regulates preliminary plans submittals. Preliminary plans must show Size and location of existing and proposed storm drains/culverts, water mains, and appurtenances thereto. All existing and proposed structures shall show the rim elevations, sump elevations, and all pipe invert elevations.

Section 6.4.6(4) regulates definitive plan submittals. Definitive plans must show the location, detail drawing, & specifications of controls used during construction to divert stormwater and to mitigate/eliminate sediments, contaminants, or pollutants.

Section 6.6.1 (1) relates to various departments that must approve proposed facilities including the DPW for storm drainage and the Fire Chief for any special water supply facilities.

Section 6.6.3 requires that the applicant for a definitive plan must provide the Board of Health and the Planning Board with a report from a qualified engineer that provides an estimate of the maximum height of the water table, the minimum elevation of the lowest floor in a dwelling to avoid inundation in a 50 year flood, any soil characteristics, such as recent filling, that might preclude a stable foundation. The Planning Board may rule that certain lots may not be approved for building purposes.

Section 7.2 relates to requirements for easements for storm drains and underground utilities. If a subdivision is traversed by a water course, drainage way, channel or stream, the Board may require an easement of adequate width.

Section 8.3 relates to storm drainage. This section regulates the installation of storm drainage to ensure adequate disposal of surface water from all streets within the subdivision and adjacent land Each subdivision, regardless of its size, shall have a stormwater management system compliant with the latest edition of the Department of Environmental Protection's (DEP) Stormwater and the subdivision's stormwater management system shall be designed as to not increase the peak rate of runoff of

stormwater in the two, ten, and one-hundred year storm events. Holding ponds, dry wells, or other equivalent permanent means shall be provided to prevent an increase in the rate of rainfall runoff due to the construction of roadways, driveways, and other paved areas, building roofs, and grassed areas during these storm events.

Wetlands Regulations- the Town maintains 100-foot no-disturb zones from any vernal pool and 25-feet no-disturb zones from any wetland resource area. No-build zones are required for a minimum of 100 feet from any vernal pool and 50 feet from any wetland resource area.

The Lynnfield Zoning Bylaw

Establishment and Purpose of Districts -. The town's zoning preamble states that the bylaw is intended to secure safety from fire, flood, panic and other dangers; to facilitate the adequate provision of transportation, water, water supply, drainage, sewerage, schools, parks, open space and other public requirements.

The zoning bylaw establishes one overlay district relevant to hazard mitigation: the Flood Plain District. Section 9.1 of the zoning bylaw states that the purposes of the Floodplain District are:

- that lands in the Town of Lynnfield subject to seasonal or periodic flooding as described herein shall not be used for residence or other purposes in such a manner as to endanger the health or safety of the occupants.

The Floodplain District is established as an overlay district. The Floodplain District includes all special flood hazard areas within the Town of Lynnfield designated as Zone A and AE on the Essex County Flood Insurance Rate Map (FIRM) issued by the Federal Emergency Management Agency (FEMA) for the administration of the National Flood Insurance Program. Certain uses are allowed as of right and others are allowed under a Special Permit from the Zoning Board of Appeals. FEMA updated its Flood Hazard mapping of Lynnfield in 2012 and these maps were adopted at Town Meeting.

Groundwater Protection District- Section 9.3 establishes a Groundwater Protection District. The GPD exists largely in the Beaver Brook and Wills Brook watersheds, and close to the Ipswich River, Reedy Meadow, Broad Meadows and Pillings Pond areas. Section 9.3.6.3 (2) requires a Special Permit for any use that will render impervious more than 15% or 2,500 square feet of any lot, whichever is greater.

Site Plan Requirements - Section 7.4(11)- The addition of 600 square feet or more of impervious area shall require the applicant to specify a means to prevent an increase in the rate of rainfall runoff for the site resulting from the proposed alteration. No net increase in peak rate runoff is allowed.

Stormwater Management Bylaw and Regulations- Lynnfield adopted a stormwater management bylaw in 2010 that requires an approved stormwater management plan for any development disturbing one acre or more.

Green Belt Zoning- Section 8.4- This allows for the development of open space residential design subdivisions on tracts of land containing at least 25 acres with a minimum of 20% of Green Belt Land left as common open space.

Public Education on Stormwater-The Town DPW maintains a web page on good housekeeping practices and stormwater management frequently asked questions at: http://www.town.lynnfield.ma.us/Pages/LynnfieldMA_DPW/stormwater

Flooding – Existing Site Specific Mitigation

2008 Plan Flooding Areas of Concern mitigation measures and existing status.

1. The Saugus River/Reedy Meadow–The town would still like to address the flooding issues at Reedy Meadow and the Saugus River. The first step in mitigation would be to complete the draft EIR and submit it to the state for final approval. Completing the EIR would now cost approximately $300,000. If approved, the project would move into an extensive permitting stage. The actual work would be done by the Army Corps of Engineers. This site will be carried forward in the 2018 plan update.

2. Beaver Dam Brook (Reedy Meadow to Chestnut Street) Beaver Dam Brook needs to be restored. Beavers are now routinely trapped as a preventive measure against flooding, and several culverts need to be enlarged. As an intermediate step to help address the flooding issues along the Beaver Dam Brook, which is affected by the flooding in Reedy Meadow, the town is proposing to upgrade the culvert underneath the MBTA rail bed, which should alleviate the flooding upstream from this point along Beaver Dam Brook during heavy or prolonged precipitation events. This site will be carried forward in the 2018 plan.

3. Beaver Dam Brook-Yorkshire Drive- Flooding in this area has been remediated with an enlarged culvert replacement at the intersection of Beaver Dam Brook and Yorkshire Drive in 2013 by the town using a PDM grant. This site will not be carried forward.

4. Grey Lane – The Town has already implemented several of the remedial measures that were recommended in the DPW report. If the flooding continues, then consideration should be given to further mitigation measures downstream along Bates Brook. There has been no further flooding at this site since mitigation and it will not be carried forward into the 2018 plan.

5. Bates Brook-(Chatham Way to Pillings Pond) – Bates Brook still needs to be restored and several culverts need to be replaced in this brook. This is one of the brooks that the

Town has identified for work by the Northeast Massachusetts Mosquito Control Board. This project will be carried forward in the 2018 plan update.

6. *Hawkes Brook at Fletcher Road*– The appropriate mitigation measure for flooding in this area would be to restore the brook and upgrade the size of the culverts at Fletcher Road and Timberhill Lane. This project will be carried forward.

7. Salem and Summer Streets/Currier Plaza – The undersized drain at Currier Plaza needs to be replaced and a portion of Hawkes Brook will need to be restored. The Town would need to work with the property owner to accomplish this. The site was improved since the 2008 plan and no flooding has been reported. This site will not be carried forward.

8. Pyburn Road – This is a low priority. Stream restoration of Hawkes Brook in this area would help reduce the flooding potential. This will not be carried forward in the 2018 plan update.

9. Hawkes Brook at Route 128 and Salem Street– Because flooding is caused by sedimentation, the brook will need to be restored and measures put into place to minimize sediment originating from Route 128. The Lynn Water and Sewer Commission maintains the brook and this site will not be carried forward by the town.

10. Summer Street/Route 128 Overpass –The mitigation for flooding in this area would involve having MHD clean the pipe out and investigate its condition and structural integrity. There is also a brook that runs underneath Route 128 that may need to be restored. This project will be carried forward.

Drainage ditch restoration– Some of the brooks in town are in need of restoration. This used to be done by the Northeast Massachusetts Mosquito Control Board (NMMC). The brooks need to be cleared of vegetation, sand, sediment, trees and silt. Hawkes Brook is the first priority. The Director of the Department of Public Works has sent several letters to NMMC since 2003 requesting that they consider re-establishing their ditch maintenance program. The letter included a list of priority locations as follows:

Brook Name	**Location**
Bates Brook	Bourque Road
Hawkes Brook	Salem Street at Walnut Street
Hawkes Brook	Carpenter Road
Hawkes Brook	Fletcher Road and Timberhill Road
Bates Brook	Pillings Pond Road

One difficulty with drainage ditch restoration is that the environmental regulations for this type of work are fairly stringent and can make it difficult to carry out the work. The town will carry this project forward in the 2018 plan updated but will continue to remain in contact with the NMMC regarding brook cleanings.

Dams

11. Pilling's Pond Dam–During the May 2006 flood, the abutments to the spillway began to erode and water began to circumvent the dam. The town determined that the dam needed to have two foot wing walls added. Temporary wing walls have been installed since 2008 but the town would like to install permanent wing walls and will carry this project forward in the 2017 plan update.

Existing Wind Hazard Mitigation Measures

Tree-trimming program – The Town has an outside contract for tree trimming services. Tree-trimming of public street trees is done primarily based on reports from citizens.

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

Existing Winter Hazard Mitigation Measures

Roadway treatments –The Town treats its roads with calcium chloride to prevent icing and snow buildup before and during winter storm conditions.

Catch basin Cleaning: The Lynnfield DPW clears snow from clogged catch basins to prevent flooding.

Massachusetts State Building Code: The Town enforces the Massachusetts State Building Code, which contains regulations regarding snow loads on building roofs. The Town has adopted the state building code.

Existing Brush Fire Hazard Mitigation Measures

The Fire Department has a tanker truck, a small pumper for off-road fire-fighting and two "squads" which are 4 wheel drive vehicles. The Fire Department also uses special forestry hoses which are lighter, single layer hoses.

Permits Required for Outdoor Burning – The Fire Department requires a written permit for outdoor burning. The property-owner must come into the Fire Station, fill out a form and pay a $15.00 fee.

Subdivision review - The Fire Department is involved in reviewing subdivision plans from conceptual design through occupancy to ensure that there is adequate access for fire trucks and an adequate water supply.

Existing Geologic Hazard Mitigation Measures

Massachusetts State Building Code – The State Building Code, updated in 2010, contains a section on designing for earthquake loads (780 CMR 1612.0). Section 1612.1 states that the purpose of these provisions is "to minimize the hazard to life to occupants of all buildings and non-building structures, to increase the expected performance of higher occupancy structures as compared to ordinary structures, and to improve the capability of essential facilities to function during and after an earthquake". This section goes on to state that due to the complexity of seismic design, the criteria presented are the minimum considered to be "prudent and economically justified" for the protection of life safety. The code also states that absolute safety and prevention of damage, even in an earthquake event with a reasonable probability of occurrence, cannot be achieved economically for most buildings.

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

Existing Multihazard Mitigation

Comprehensive Emergency Management Plan (CEMP)

Every community in Massachusetts is required to have a Comprehensive Emergency Management Plan. These plans address mitigation, preparedness, response and recovery from a variety of natural and man-made emergencies. These plans contain important information regarding flooding, hurricanes, tornadoes, dam failures, earthquakes, and winter storms. Therefore, the CEMP is a mitigation measure that is relevant to all of the hazards discussed in this plan. The Town of Lynnfield's current CEMP was updated in 2016.

Emergency Management Team (EMT)

Lynnfield is a member of the 16-community Mystic Region Emergency Planning Committee. The Mystic REPC meets 10 times during the year and works to conduct and coordinate emergency exercises and procedures throughout the area encompassed by its members.

Natural Hazards Public Education- Lynnfield's Emergency Management site maintains links to winter safety, flood hazard and hurricane safety at:
http://www.town.lynnfield.ma.us/Pages/LynnfieldMA_Fire/EmerMgt

The Lynnfield Health Department website (http://www.town.lynnfield.ma.us/Pages/LynnfieldMA_Health/index) also offers a natural hazard emergency preparedness link to MEMA programs and emergency preparedness at http://www.mass.gov/eopss/agencies/mema/.

Table 26- Summary Existing Hazard Mitigation Measures

Hazard	Area	Mitigation Measure	Update/comments
Flooding	Town-wide	Participation in the National Flood Insurance Program (NFIP)	Effective / 60 policies in force
		Massachusetts Building Code	Effective
		Floodplain District	Updated /Effective
		Stormwater Management Bylaw and Regulations	Effective
		Street sweeping	Effective
		Catch basin cleaning	Effective
		Wetlands Regulations	Effective
		Subdivision and Zoning: Site Plan Review, Green Belt Zoning	Effective
		Town cleans & inspects catch basins every year.	Effective
		Public Education on Stormwater	Effective
		2010 Open Space and Recreation Plan-being updated in 2018.	Effective
		Existing Site Specific Flooding Mitigation	Effective
Wind	Town-wide	Town tree-pruning management follows MGL Chapter 87	Effective
		State Building Code addresses wind standards	Effective for new construction
Winter-Related	Town-wide	Regular snow removal operations and roadway treatments	Effective
		Catch basin cleaning to maintain drainage	Effective
		State Building Code addresses snow load standards	Effective for new construction
Fire	Town-wide	Outdoor burning permits	Effective
Fire	Town-wide	Subdivision review	Effective
Geologic	Town-wide	State Building Code addresses earthquake standards	Effective for new construction / Town has many older buildings
Multi hazard	Town-wide	Comprehensive Emergency Management Plan (CEMP)	Effective/Up to date
Multi hazard	Town-wide	Emergency Management Team (EMT)	Effective

Table 26- Summary Existing Hazard Mitigation Measures

Hazard	Area	Mitigation Measure	Update/comments
Multi-hazard	Town-wide	Health Department Emergency Preparedness	Effective to include reference to natural hazards planning and response
		2002 Master Plan- being updated 2018	Add Climate Adaptation to next plan update

Local Capacity for Implementation

Under the Massachusetts system of "Home Rule," the Town of Lynnfield is authorized to adopt and from time to time amend a number of local bylaws and regulations that support the town's capabilities to mitigate natural hazards. These include Zoning Bylaws, Subdivision and Site Plan Review Regulations, Wetlands Bylaws, Health Regulations, Public Works regulations, and local enforcement of the State Building Code. Local Bylaws may be amended each year at the annual Town Meeting to improve the town's capabilities, and changes to most regulations simply require a public hearing and a vote of the authorized board or commission, such as the Community Planning and Development Board or Conservation Commission.

The Town of Lynnfield has recognized several existing mitigation measures that require implementation or improvements, and has the capacity within its local boards and departments to address these. The Lynnfield Department of Public Works and Engineering Department will address the needs for catch basin cleaning, repairs and upgrades to drainage infrastructure. The Planning Board will address the updates to the Master Plan and implementation of the Zoning Ordinance, Floodplain District, and Subdivision Rules and Regulations. The Conservation Commission will oversee implementation of the Wetlands Bylaw and the Open Space Plan. The Department of Public Works together with the Planning Board and Conservation Commission will coordinate implementation and enforcement of the Stormwater Bylaw.

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VII. MITIGATION MEASURES FROM THE 2008 PLAN

Implementation Status of the Previous Plan

At a meeting of the Lynnfield Hazard Mitigation Planning Committee, Town staff reviewed the mitigation measures identified in the 2008 Lynnfield Hazard Mitigation Plan and determined whether each measure had been implemented or deferred. Of those measures that had been deferred, the committee evaluated whether the measure should be deleted or carried forward into this Hazard Mitigation Plan 2018 Update. 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 Town to take action on the measure. Table 27 summarizes the status of mitigation measures, and mitigation projects completed are described in more detail below.

Table 27- Mitigation Measures from the 2008 Plan

Mitigation Measure	Priority	Lead Implementation	Current Status	Include in 2018 Plan/Priority
1. Saugus River/Reedy Meadow	High	DPW/Engineering	Not completed: The town would still like to address the flooding issues at Reedy Meadow and the Saugus River. The first step in mitigation would be to complete the draft EIR and submit it to the state for final approval.	Yes- High
2. Pillings Pond Dam	High	DPW/Engineering	Not completed: The Town applied for a Hazard Mitigation Grant from FEMA to build permanent wing walls but it was not approved.	Yes- High

Mitigation Measure	Priority	Lead Implementation	Current Status	Include in 2018 Plan/Priority
3. Beaver Dam Brook(from Reedy Meadow to Chestnut Street)	High	DPW/Engineering	Not completed: This is a carryover site from the 2008 plan. Beaver Dam Brook needs to be restored. Beavers are now routinely trapped as a preventive measure against flooding, and several culverts need to be enlarged. Lynnfield developed a plan to remove culvert under MBTA railroad bed at Beaver Dam Brook; working with state to remove culvert from MBTA ROW.	Yes- High

Mitigation Measure	Priority	Lead Implementation	Current Status	Include in 2018 Plan/Priority
4. Summer St./Route 128 Overpass	High	DPW/Engineering	Not completed: This is a carryover site from the 2008 plan. The town has maintained the drainage systems at this site since the 2008 plan. There is also a brook that runs underneath Route 128 that may need to be restored. Lynnfield would like to do drainage study here between Fletcher Road to Timberhill Road.	Yes-High
5. Hawkes Brook at Fletcher Road	High	DPW/Engineering	Not completed: This is a carryover site from the 2008 plan. The appropriate mitigation measure for flooding in this area would be to restore the brook and upgrade the size of the culverts at Fletcher Road and Timberhill Lane. Part of drainage study for Site 4.	Yes-High

Mitigation Measure	Priority	Lead Implementation	Current Status	Include in 2018 Plan/Priority
6. Salem and Summer Streets/Currier Plaza	Medium	DPW/Engineering	Partially completed: The undersized drain at Currier Plaza needs to be replaced and a portion of Hawkes Brook will need to be restored. The Town would need to work with the property owner to accomplish this. The site was improved since the 2008 plan and no flooding has been reported.	No
7. Bates Brook (Chatham Way to Pilling's Pond)	Medium	DPW/Engineering	Not completed: This is a carryover site from the 2008 plan. Bates Brook needs to be restored and several culverts need to be replaced in this brook. This is one of the brooks that the Town has identified for work by the Northeast Massachusetts Mosquito Control Board.	No

Mitigation Measure	Priority	Lead Implementation	Current Status	Include in 2018 Plan/Priority
8. Yorkshire Drive	Medium	DPW/Engineering	Flooding in this area has been remediated with an enlarged culvert replacement at the intersection of Beaver Dam Brook and Yorkshire Drive in 2013 by the town using a PDM grant.	No
9. Drainage ditch/brook restoration	Medium	NMMC	Not completed: Some of the brooks in town are in need of restoration. This used to be done by the Northeast Massachusetts Mosquito Control Board (NMMC). The brooks need to be cleared of vegetation, sand, sediment, trees and silt. Hawkes Brook is the first priority. The Director of the Department of Public Works has sent several letters to NMMC since 2003 requesting that they consider re-establishing their ditch maintenance program.	No

Mitigation Measure	Priority	Lead Implementation	Current Status	Include in 2018 Plan/Priority
10. Grey Lane	Low	DPW/Engineering	Completed: The Town has already implemented several of the remedial measures that were recommended in the DPW report.	No
11. Hawkes Brook at Salem Street and Route 128	Low	DPW/Engineering	Completed: The Lynn Water and Sewer Commission has cleaned the brook and flooding has not happened again. This project will not be carried forward.	No
12. Pyburn Road	Low	DPW/Engineering	Completed: There is no active flooding known at the site but the town is planning to include it as part of the Route 128 drainage study.	No

Lynnfield has made progress on implementing mitigation measures identified in the 2008 Hazard Mitigation Plan, including upgrading drainage at Salem and Summer Streets at Currier Plaza, Yorkshire Drive, Grey Lane, Hawkes Brook at Salem Street and Route 128. It is also currently updating its 2010 Open Space and Recreation Plan and it 2002 Master Plan. Since 2008, the Town also updated some of its wetland regulations, as well as a adopting a new stormwater management bylaw in 2010. In 2012, Lynnfield adopted new flood plain maps from FEMA.

Overall, five mitigation measures from the 2008 plan will be carried forward in the plan update.

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

The challenges the Town faces in implementing these measures are primarily due to limited funding and available staff time. This plan should help the Town prioritize the best use of its limited resources for enhanced mitigation of natural hazards.

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VIII. 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/hmgp/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*)

Regional and Inter-Community Considerations

Some hazard mitigation issues are strictly local. The problem originates primarily within the municipality and can be solved at the municipal level. Other issues are inter-community issues that involve cooperation between two or more municipalities. 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.

Regional Partners

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 including but not limited to the Town of Lynnfield, the Lynn Water and Sewer Commission, the Northeast Massachusetts Mosquito Control Board, the Department of Conservation and Recreation (DCR), the Massachusetts Water Resources Authority (MWRA), Massachusetts Department of Transportation (MA DOT) 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. In the sections that follow, the plan includes recommendations for activities to be undertaken by these other agencies. Implementation of these recommendations will require that all parties work together to develop solutions.

Saugus River Watershed – As in the 2008 plan, the Town of Lynnfield recognizes that planned improvements within Lynnfield may impact other communities in the watershed and therefore, the mitigation of flood damage to roadways and properties within the Saugus River watershed is a true suburban challenge making resolution of flooding in this watershed the town's highest priority.

Northeast Massachusetts Mosquito Control Board (NMMC)- The Town will continue to try and gain assistance from the NMMC to help clean the following brooks of vegetation, sand, sediment, trees and silt:

Brook Name	**Location**
Bates Brook	Bourque Road
Hawkes Brook	Salem Street at Walnut Street
Hawkes Brook	Carpenter Road
Hawkes Brook	Fletcher Road and Timberhill Road
Bates Brook	Pillings Pond Road

Process for Setting Priorities for Mitigation Measures

The last step in developing Lynnfield's mitigation strategy is to assign a level of priority to each mitigation measure so as to guide the focus of the Town's limited resources towards those actions with the greatest potential benefit. At this stage in the process, the Local Hazard Mitigation Planning Team had limited access to detailed analyses of the cost and benefits of any given mitigation measure, so prioritization is based on the local team members' understanding of existing and potential hazard impacts and an approximate sense of the costs associated with pursuing any given mitigation measure.

Priority setting was based on local knowledge of the hazard areas, including impacts of hazard events, the extent of the area impacted, and the relation of a given mitigation measure to the Town's goals. In addition, the local Hazard Mitigation Planning Team 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 any environmental constraints existed, and whether the Town would be able to justify the costs relative to the anticipated benefits.

Table 28 below demonstrates the prioritization of the Town's potential hazard mitigation measures. 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, costs, and overall priority were evaluated in terms of:

Estimated 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

Estimated Costs	
High	Estimated costs greater than $100,000
Medium	Estimated costs between $10,000 to $100,000
Low	Estimated costs less than $10,000 and/or staff time

Priority	
High	Action very likely to have political and public support and necessary maintenance can occur following the project, and the costs seem reasonable considering likely benefits from the measure

Medium	Action may have political and public support and necessary maintenance has potential to occur following the project
Low	Not clear if action has political and public support and not certain that necessary maintenance can occur following the project

Table 28- Mitigation Measure Prioritization

Mitigation Action	Geographic Coverage	Estimated Benefit	Estimated Cost	Priority
Flood Hazard Mitigation				
Saugus River/Reedy Meadow– The first step in mitigation would be to redraft an EIR and submit it to the state for final approval.	South Lynnfield, Saugus, Wakefield	High	High	High
Beaver Dam Brook (Reedy Meadow to Chestnut Street - Beaver Dam Brook needs to be restored, beavers will need to be trapped, and several culverts need to be enlarged.	Chestnut/Main Streets neighborhoods	High	High	High
Drainage study for area between Fletcher Road to Timberhill Road	Fletcher Road to Timberhill Road	High	High	High
Summer Street/Route 128 Overpass –The mitigation for flooding in this area would involve having Mass Highway clean the pipe out and investigate its condition and structural integrity. There is also a brook that runs underneath Route 128 that may need to be restored.	Fletcher Road/Salem Street neighborhood	High	Medium	High

Table 28- Mitigation Measure Prioritization

Mitigation Action	Geographic Coverage	Estimated Benefit	Estimated Cost	Priority
Hawkes Brook at Fletcher Road– The appropriate mitigation measure for flooding in this area would be to restore the brook and upgrade the size of the culverts at Fletcher Road and Timberhill Lane.	Fletcher Road and Timberhill Lane.	High	High	High
Drainage ditch restoration– Many of the brooks in town are in need of restoration. This used to be done by the Northeast Massachusetts Mosquito Control Board (NMMC). The brooks need to be cleared of vegetation, sand, sediment, trees and silt. Hawkes Brook is the first priority	Town wide	High	Low	Medium
Rourke Lane at Lowell Street- Drain needs to be tied into Lowell Street from current infiltration system.	Lowell Street/Rourke Lane	High	High	High
14 Longbow Circle- Flooding occurs once per year due; need to redo street drainage.	Haverhill Street area	High	High	High
Midland Road at Bates Brook- Failed culvert causes water back up during heavy rains; undermining Road; affects 4 houses on Midland Rd.	Midland Road neighborhood	Medium	Low	High

Table 28- Mitigation Measure Prioritization

Mitigation Action	Geographic Coverage	Estimated Benefit	Estimated Cost	Priority
Ledge Road: failed drainage floods during heavy rains	Ledge Road neighborhood	High	High	High
Main Street and South Common Street intersection: failed drainage	Main Street and South Common Street neighborhood	Medium	High	Low
Wind Mitigation Measures				
Update the town-owned tree inventory and risk assessment data base	Town-wide	High	Low	Medium
Brushfire Mitigation				
Incorporate brushfire mitigation in master plan reviews and updates.	Town-wide	High	Low	Low
Winter Storm Hazard Mitigation				
Evaluate public buildings for ability to withstand snow loads; retrofit if needed to greatest degree feasible.	Town-Wide	Medium	Low	Low
Earthquake Mitigation				
Determine which buildings may be most vulnerable to earthquake damage and conduct a structural assessment if needed.	Town-Wide	Medium	Low	Low
Assess the vulnerability of roadways and utilities in high liquefaction susceptibility areas.	Localized	Low	Low	Low

Table 28- Mitigation Measure Prioritization

Mitigation Action	Geographic Coverage	Estimated Benefit	Estimated Cost	Priority
Dam Mitigation				
Pilling's Pond Dam- add permanent wing walls	Reedy Meadow, Walnut Street neighborhood	High	Medium	High
Extreme Temperature Mitigation				
Site Design to increase tree plantings near buildings, increase the percentage of trees used in parking areas, and along public ways.	Town-Wide	Medium	Medium	Medium
Promote Green Building and Cool Roof designs	Town-Wide	Medium	Low	Medium
Assess placement of cooling centers at schools, senior center and emergency shelters.	Town-wide	Medium	Low	High
Drought Mitigation				
Promote drought tolerant landscaping and site design measures	Town-Wide	Medium	Low	Medium
Climate Resilience/Adaptation				
Incorporate climate resilience/adaptation components into the next Master Plan update.	Town-Wide	High	Medium	High

Potential Mitigation Measures

The potential mitigation measures are provided in this section and summarized in Table 29.

Flooding and Drainage Infrastructure

Lynnfield would like to resubmit an EIR for work within the Saugus River/Reedy Meadow watershed area and finish making permanent repairs to the Pillings Pond Dam. Several of the Town's high priority drainage infrastructure projects are located between Fletcher Road and Timberhill Road and the Town would like to conduct an overall drainage study for this area. Lynnfield staff continue to work with the Lynn Water and Sewer Commission to clean and maintain streams and infrastructure and the Town hopes to collaborate with the Northeast Massachusetts Mosquito Control Board (NMMC) in order to maintain key drainage ditches and brooks. The Town recently completed a new 10-year Capital Improvements Plan.

Wind Hazards

The Town would like to update its current public tree inventory and risk assessment database. While the Tree Warden conducts regular "windshield surveys" of the Town's trees near public right of ways and responds to public calls to remove dead or diseased trees, updating the database would make the program more effective and help prevent future wind damage.

Fire Hazards

Incorporate brushfire mitigation into master plan reviews and updates. Identify brushfire hazard areas to facilitate analysis and planning decisions through comparison with zoning, development and infrastructure. Develop and maintain a database to track community vulnerability to brushfires if needed. The 2002 Master Plan is currently being updated.

Winter Hazards

Evaluate public buildings for ability to withstand snow loads; retrofit if needed to greatest degree feasible.

Earthquakes

Earthquake building assessment—Determine which buildings may be most vulnerable to earthquake damage and conduct a structural assessment if needed.

Earthquake infrastructure assessment— Assess the vulnerability of roadways and utilities in high liquefaction susceptibility areas.

Extreme Temperatures

Site Design guidelines to increase tree plantings near buildings, increase the percentage of trees used in parking areas, and along public ways.

Promote guidelines for Green Building and Cool Roof designs.

Assess placement of cooling centers at schools, senior center and emergency shelters.

Drought

Promote guidelines for drought tolerant landscaping and site design measures.

Climate Change

Incorporate climate resilience/adaptation components into the Town's next Master Plan update. The 2002 Master Plan is currently being updated.

Introduction to Potential Mitigation Measures Table (Table 29)

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.

Priority – As described above and summarized in Table 29, the designation of high, medium, or low priority was done considering potential benefits and estimated project costs, as well as other factors in the STAPLEE analysis.

Implementation Responsibility – The designation of implementation responsibility was done based on a general knowledge of what each municipal department is responsible for. 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.

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 team 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/stream bank 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.

Abbreviations Used in Table 29

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
DEP (SRF) = Department of Environmental Protection (State Revolving Fund)
USDA = United States Department of Agriculture
MA DOT = Massachusetts Department of Transportation
DCR = MA Department of Conservation and Recreation
CIP= Capital Improvement Program
HMPT=Hazard Mitigation Planning Team
CIP= Capital Improvement Plan

Table 29 – Potential Mitigation Measures

Mitigation Measure	Priority	Lead Implementation	Time Frame	Estimated Cost	Potential Funding Sources
FLOODING/DAMS					
Saugus River/Reedy Meadow- Complete and submit EIR	High	Public Works/Engineering	Long Term 2018-2023	Draft EIR: High $100,000; Permitting and design: $200,000	Lynnfield Capital Improvement Plan/Town Bond (CIP)
Beaver Dam Brook (Reedy Meadow to Chestnut Street - Beaver Dam Brook needs to be restored, beavers will need to be trapped, and several culverts need to be enlarged.	High	Public Works/Engineering	Medium Term 2019-2020	High $100,000	Lynnfield Capital Improvement Plan/Town Bond (CIP)/MBTA
Drainage study for area between Fletcher Road to Timberhill Road	High	Public Works/Engineering	Short Term 2018-2019	Medium $50,000	Lynnfield Capital Improvement Plan/Town Bond (CIP) and PDM
Summer Street/Route 128 Overpass- Clean the pipe out and investigate its condition and structural integrity. There is also a brook that runs underneath Route 128 that may need to be restored.	High	Public Works/Engineering	Medium Term 2019-2020	Medium $50,000	MA DOT/ Lynnfield CIP/Town Bond
Hawkes Brook at Fletcher Road–Restore the brook and upgrade the size of the culverts at Fletcher Road and Timberhill Lane.	High	Public Works/Engineering	Short Term 2018-2019	High $100,000	Lynnfield Capital Improvement Plan/Town Bond (CIP)

Table 29 – Potential Mitigation Measures

Mitigation Measure	Priority	Lead Implementation	Time Frame	Estimated Cost	Potential Funding Sources
Drainage ditch restoration– Many of the brooks in town are in need of restoration. Hawkes Brook is the first priority	Medium	Public Works/Engineering	Long Term/On going 2018-2023	Low <$10,000	Northeast Mosquito Control Board
Rourke Lane at Lowell Street- Drain needs to be tied into Lowell Street from current infiltration system.	High	Public Works/Engineering	Short Term 2018-2019	High $120,000	Lynnfield CIP/Town Bond/HMGP
14 Longbow Circle- Need to redo street drainage and rebuild street.	High	Public Works/Engineering	Long Term 2020-2022	High $1.2 million	Lynnfield CIP/Town Bond and HMGP
Midland Road at Bates Brook- upgrade failed culvert	High	Public Works/Engineering	Short Term 2018-2019	Low $10,000	Lynnfield CIP/Town Bond and HMGP
Pillings Pond Dam- upgrade wing walls	High	Public Works/Engineering	Long Term 2020-2023	Medium $40,000	Lynnfield CIP/Town Bond and HMGP
Ledge Road: upgrade drainage	High	Public Works/Engineering	Short Term 2018-2019	High $300,000	Lynnfield CIP/Town Bond and HMGP
Main Street and South Common Streets Intersection: failed drainage	Low	Public Works/Engineering	Medium Term 2019-2020	High $100,00	Lynnfield CIP/ and Northeast Mosquito Control Board
WIND RELATED HAZARDS					

Table 29 – Potential Mitigation Measures

Mitigation Measure	Priority	Lead Implementation	Time Frame	Estimated Cost	Potential Funding Sources
Develop a town-owned tree inventory and risk assessment data base	Medium	Tree Committee/Tree Warden	Long Term 2018-2023	Low Staff time	Lynnfield DPW Budget
BRUSHFIRES					
Increase brush fire access by opening and maintaining paths and fire roads.	Low	Fire/Engineering	Long Term 2018-2023	Low Estimated costs less than $5,000 per year staff time	Staff time / Town general operating budget
WINTER STORMS					
Evaluate public buildings for ability to withstand snow loads; retrofit if needed to greatest degree feasible.	Low	Building/HMPT	Long Term 2018-2023	Low Estimated costs less than $10,000 and/or staff time	Staff time / Town general operating budget
EARTHQUAKES					
Determine which buildings may be most vulnerable to earthquake damage and conduct a structural assessment if needed.	Low	Building/HMPT	Long Term TBD	Low Estimated costs less than $10,000 and/or staff time	Staff time / Town general operating budget
Assess the vulnerability of roadways and utilities in high liquefaction susceptibility areas.	Low	Public Works/HMPT	Long Term 2018-2023	Low Estimated costs less than $10,000 and/or staff time	Staff time / Town general operating budget
EXTREME TEMPERATURES					

Table 29 – Potential Mitigation Measures

Mitigation Measure	Priority	Lead Implementation	Time Frame	Estimated Cost	Potential Funding Sources
Site Design to increase tree plantings near buildings, increase the percentage of trees used in parking areas, and along public ways.	Low	Planning / Conservation	Long Term 2018-2023	Low Estimated costs less than $10,000 and/or staff time	Staff time / Town general operating budget
Promote Green Building and Cool Roof designs.	Low	Building/Planning	Long Term 2018-2023	Low Estimated costs less than $10,000 and/or staff time	Staff time / Town general operating budget
Assess placement of cooling centers at schools, senior center and emergency shelters.	Low	Fire/HMPT	Short Term 2018-2019	Low Estimated costs less than $10,000 and/or staff time	Staff time / Town general operating budget
DROUGHT					
Promote drought tolerant landscaping and site design measures.	Medium	Planning / Conservation	Long Term 2018-2023	Low Estimated costs less than $10,000 and/or staff time	Staff time / Town general operating budget
CLIMATE RESILIENCE / ADAPTATION					
Incorporate climate resilience/adaptation components into the next Comprehensive Plan.	High	HMPT/Planning/ Conservation/ Public Works/ Public Health	Long Term 2018-2023	Medium Estimated costs between $10,000 to $100,000	Town general operating funds / Staff time

IX. PLAN ADOPTION AND MAINTENANCE

Plan Adoption

The Lynnfield Hazard Mitigation Plan 2018 Update was adopted by the Board of Selectmen on June 18, 2018. 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]. – To be completed following MEMA and FEMA review.

Plan Maintenance

Although several of the mitigation measures from the Town's previous Hazard Mitigation Plan have been implemented, since that plan was adopted there has not been an ongoing local process to guide implementation of the plan. Such a process is needed over the next five years for the implementation of this plan update, and will be structured as described below.

MAPC worked with the Lynnfield Hazard Mitigation Planning Team to prepare this plan. After approval of the plan by FEMA, this group will meet on a regular basis, at least annually, to function as the Hazard Mitigation Implementation Team, with the Director of Public Works designated as the coordinator. Additional members could be added to the local implementation team from businesses, non-profits and institutions. The Town will encourage public participation during the next 5-year planning cycle. As updates and a review of the plan are conducted by the Hazard Mitigation Implementation Team, these will be placed on the Town's web site, and any meetings of the Hazard Mitigation Implementation Team will be publicly noticed in accordance with Town and state open meeting laws.

Implementation and Evaluation Schedule

Mid-Term Survey on Progress– The coordinator of the Hazard Mitigation Implementation Team will prepare and distribute a survey in year three 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 in order to evaluate its effectiveness in meeting the plan's goals and identify areas that need to be updated in the next plan. The Hazard Mitigation Implementation Team, coordinated by the Director of Public Works, will have primary responsibility for tracking progress and updating the plan.

Begin to prepare for the next Plan Update -- Given the lead time needed to secure funding and conduct the planning process, the Hazard Mitigation Implementation Team will

begin to prepare for an update of the plan in year three. The team will use the information from the Mid-Term progress review to identify the needs and priorities for the plan update and seek funding for the plan update process. Potential sources of funding may include FEMA Pre-Disaster Mitigation grants and the Hazard Mitigation Grant Program. Both grant programs can pay for 75% of a planning project, with a 25% local cost share required.

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 Town's approved plan status and its eligibility for FEMA mitigation grants. Once the resources have been secured to update the plan, 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 Lynnfield Hazard Mitigation Plan Update 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 Lynnfield Hazard Mitigation Plan 2017 Update by FEMA, the Local Hazard Mitigation Team coordinator 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. The plan will be reviewed and discussed with the following departments during the first six (6) months following plan adoption. During updates of any town department's plans or policies, the relevant portions of this mitigation strategy will be incorporated.

- Fire Department
- Emergency Management
- Police Department
- Public Works Department
- Engineering
- Planning Board/Planning and Community Development
- Conservation Commission
- Parks and Recreation
- Public Health
- Building

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.

The Hazard Mitigation Plan will be integrated into other Town plans and policies as they are updated and renewed, including the Lynnfield Master Plan, Open Space Plan, Comprehensive Emergency Management Plan, and Capital Investment Program.

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X. LIST OF REFERENCES

Lynnfield Comprehensive Emergency Management Plan, 2016

Lynnfield Master Plan, 2002
http://www.town.lynnfield.ma.us/Pages/LynnfieldMA_Planning/FinalPlan.pdf

Open Space and Recreation Plan for the Town of Lynnfield,
Lynnfield Conservation Commission, 2010

Lynnfield Town By-Laws
http://ecode360.com/LY3190

Lynnfield Zoning By-Law
http://ecode360.com/LY3190

Lynnfield Subdivision Regulations
http://ecode360.com/LY3190

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

FEMA, Flood Insurance Rate Maps for Essex County, MA, 2012

FEMA, Local Mitigation Plan Review Guide; October 1, 2011.

MA Emergency Management Agency, State *Hazard Mitigation Plan*, 2013
http://www.mass.gov/eopss/docs/mema/resources/plans/state-hazard-mitigation-plan/section-01-introduction-cover-and-executive-summary.pdf

MA Geographic Information System, *McConnell Land Use Statistics*, 2005

MA Office of Dam Safety, Inventory of Massachusetts Dams

Metropolitan Area Planning Council, Geographic Information Systems Lab

New England Seismic Network, Weston Observatory, http://aki.bc.edu/index.htm

Northeast States Emergency Consortium, website http://www.nesec.org/

NOAA, National Climatic Data Center, https://www.ncdc.noaa.gov/stormevents/

U. S. Census, 2010, and American Community Survey, 2015

USGS, National Water Information Center, https://waterdata.usgs.gov/nwis

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APPENDIX A

HAZARD MITIGATION PLANNING TEAM MEETING AGENDAS

Lynnfield Hazard Mitigation Plan Update

LOCAL HAZARD MITITGATION PLANNING TEAM

Thursday, July 20, 2016, 1:30 PM.

Lynnfield Town Hall

AGENDA

10:00 **Welcome and Introductions**

10:05 **Overview of FEMA Hazard Mitigation Planning**

Questions/Discussion

10:45 **Review of Project Scope and Milestones**

See handout materials
Sam Cleaves, MAPC

10:55 **Questions/Next Steps**

11:00 **Meeting Adjourn**

Meeting Agenda
Local Natural Hazard Mitigation Plan
Town of Lynnfield, Town Hall
November 22, 2016, 10:00 AM – 11:30 AM

Local Team Meeting (Information Gathering)

a) Hazard Mitigation Planning Map Series and Digitized Ortho Photo Map
b) Review 2008 mitigation actions
c) Identify Critical Facilities
d) Identify local hazards:
   i) Flood Hazard Areas
   ii) Fire Hazard Areas (brushfires/wildfires)
   iii) Dams
   iv) Ice jams
   v) Thunderstorms
   vi) Drought
   vii) Extreme Temps
   viii) Tornadoes
   ix) High winds
   x) Snow and Blizzards
   xi) Ice storms
   xii) Earthquakes
   xiii) Landslides
   xiv) Future Potential Development Areas

e) Review Plan Goals and Objectives- see over

f) Discuss Public Involvement and Outreach
   i) Identify local stakeholders
   ii) Schedule first public meeting
g) Identify draft priority projects and funding for update

Project Overview MAPC is working with Lynnfield to update its plan 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 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.

Recommended goals to align with State 2013 Plan and FEMA Guidelines:

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

2. Build and enhance local mitigation capabilities to ensure individual safety, reduce damage to public and private property and ensure continuity of emergency services.

3. Increase cooperation and coordination among private entities, Town officials and Boards, State agencies and Federal agencies.

4. Increase awareness of the benefits of hazard mitigation through outreach and education.

MEETING NOTICE
TOWN OF LYNNFIELD

PLANNING BOARD

WEDNESDAY APRIL 26, 2017

SELECTMEN'S MEETING ROOM

7:00 PM

- **Continued Public Hearing**
  Market Street Design Standards

- **Hazard Mitigation Plan**
  Presentation by Sam Cleaves, MAPC potential flooding areas

- **Board of Appeals Cases**
  #17-06B MAS Builder's, LLC 14 Lovell Road requesting a special permit to add second floor on existing foot print and a garage and rear addition.
  #17-07 Dr. Christopher B. Meehl, 70 Main Street requesting to transfer property at to an estate and retirement planning entity by condition 2 of the Board of Appeals decision in Case 92-11

- **Master Plan** - Progress Update

- **Zoning Bylaws** - Discussion

- **Rules and Regulations**

- **Zoning Map** – Progress Update

- **Propose Items for next meeting**

Meeting Agenda
Local Natural Hazard Mitigation Plan
Town of Lynnfield, Town Hall
September 29, 2017, 10:00 AM – 11:30 PM

Local Team Meeting #3 (Recommendations/Draft Plan)

(1) Review and finalize Critical Facilities

(2) Review and finalize local hazard identification

(3) Review vulnerability analysis

(4) Review Existing Mitigation Measures

(5) Discuss Potential Mitigation Measures

MEETING NOTICE
TOWN OF LYNNFIELD

Board/Committee Name: **PLANNING BOARD**

Day/Date: **WEDNESDAY November 29, 2017**

Location: **H. Joseph Maney Meeting Room**

Time: **7:00 PM**

FINAL AGENDA

- **7:00 p.m.: 2017 Local Hazard Mitigation Plan**—
  Presentation by Sam Cleaves, MAPC

- **7:30 p.m.: Public Hearing**
  Zepaj Lane (Green Street/Broadway), Flaminio Lanzillo & Margenglen Zepaj, Attorneys John H. Jr. and Jason Kimball

- **Approval Not Required Plan, Submission**
  325, 353r, and 365 Broadway (Map 52 Parcels 2468 and 2486, and Map 56 Parcel 319), Brian Kelly

- **Board of Appeals Case**
  Case #17-23 Kel-Route One, LLC, 325 Broadway, Route One, Lynnfield
  To apply for Variance for Signs in General Business Districts (Section 6.3) Vehicular Access (Section 7.3) and Overspill lighting waiver or Variance (Section 7.6.3.2). To apply for a Special Permit for relocated sign (Section 11.3 and 11.4) for a new Jeep dealership to be constructed at 325 Broadway. To apply for Site Plan Approval (Section 7.4): Section 7.3 (Vehicular Access): Section 7.6.3.2 (Overspill Limitations-Lighting -waiver or Variance). Addition of more than 600 square feet of impervious area.

- **Rules and Regulations** - Discussion

- **Zoning Map** – Progress Update

- **Propose items for next meeting**

NEXT REGULAR SCHEDULED MEETING

December 13, 2017 (Merritt Center)
Date Subject to Change

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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 map series consists of eight maps as described below. The maps in this appendix are necessarily reduced scale versions for general reference. Full sized higher resolution PDF's of the maps can be downloaded from:

ftp://ftp.mapc.org/Hazard_Mitigation_Plans/maps/Lynnfield/

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

Map1: Population Density – This map uses the US Census block data for 2010 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 Town 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) for Essex County as its source. 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 Lynnfield are kept by the Town. 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.

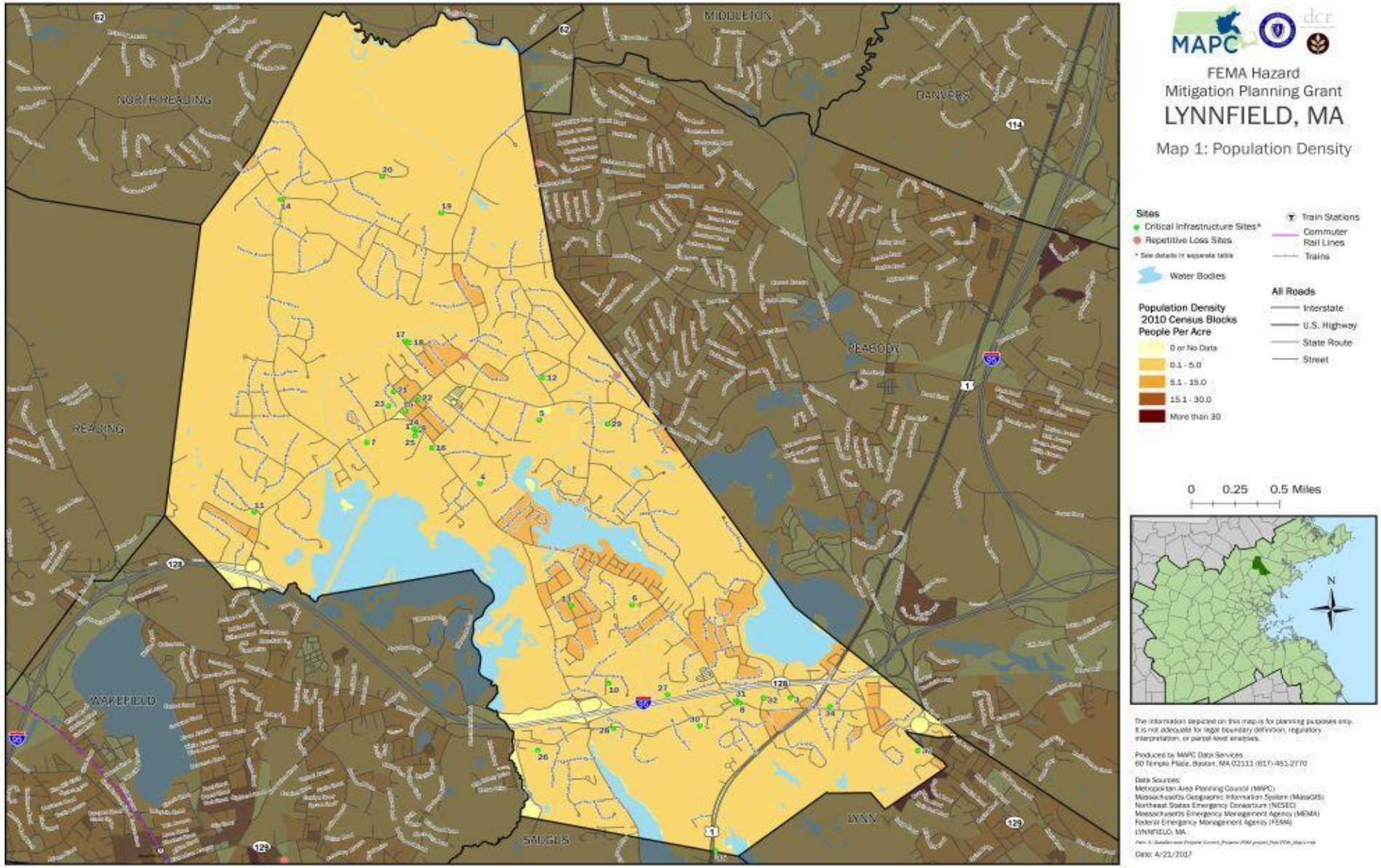
The landslide information shows areas with either a low susceptibility or a moderate susceptibility to landslides based on mapping of geological formations. This mapping is highly general in nature. For more information on how landslide susceptibility was mapped, refer to http://pubs.usgs.gov/pp/p1183/pp1183.html.

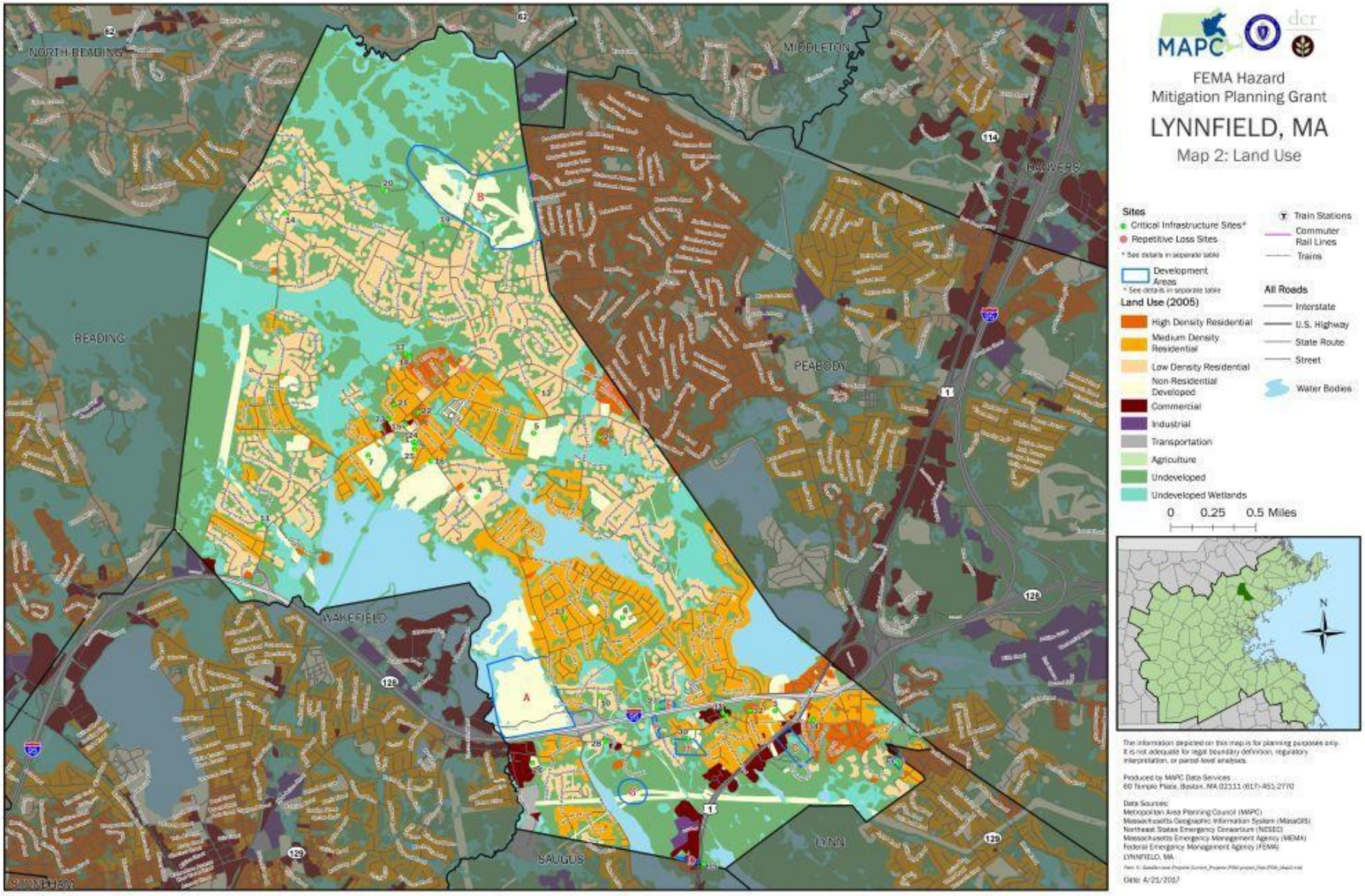
Map 5: Hurricanes and Tornadoes – This map shows a number of different items. The map includes the storm tracks for both hurricanes and tropical storms, if any occurred in this community. This information must be viewed in context. A storm track only shows where the eye of the storm passed through. In 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.

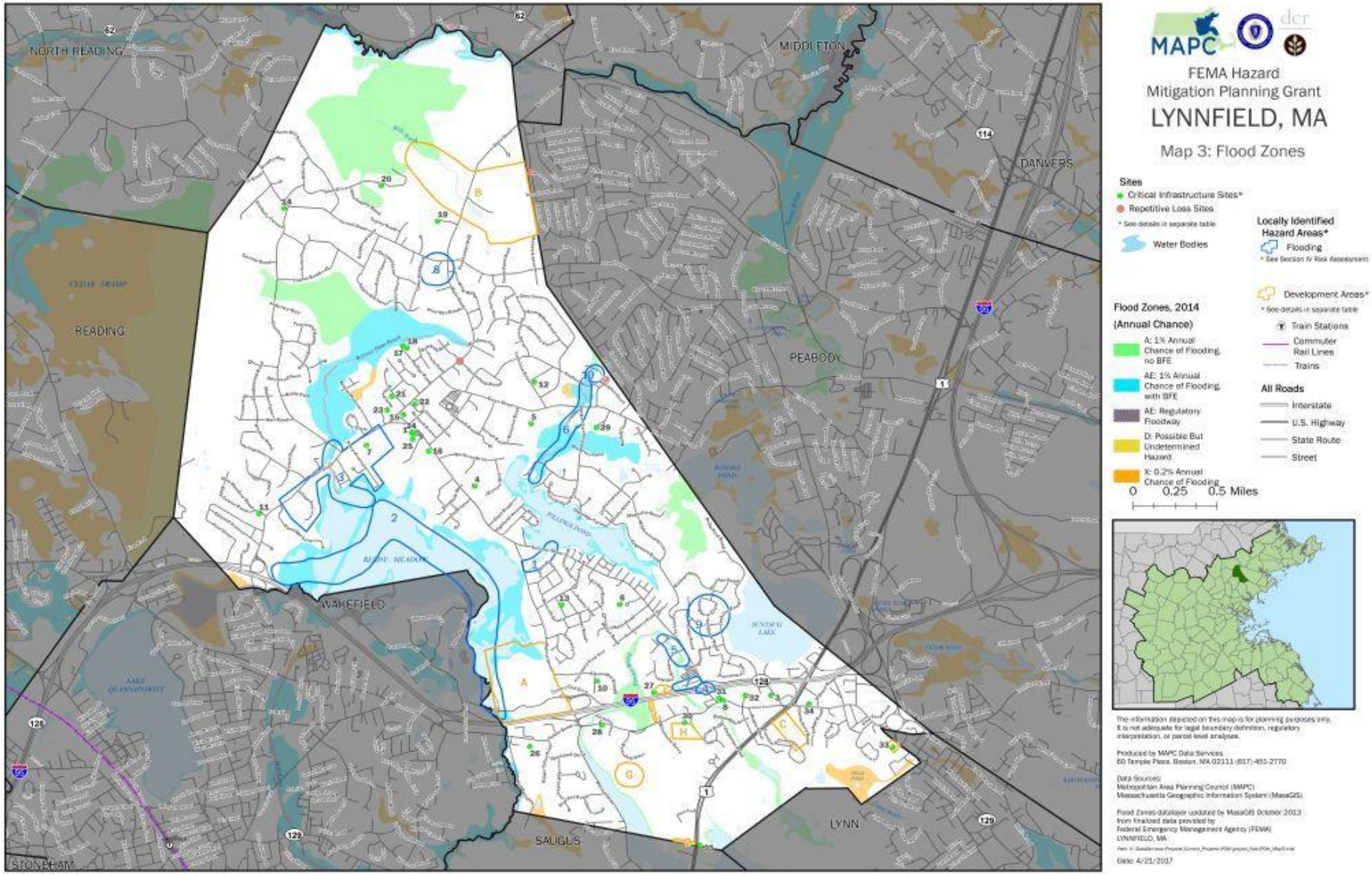
Map 6: Average Snowfall - - This map shows the average snowfall. It also shows storm tracks for nor'easters, if any storms tracked through the community.

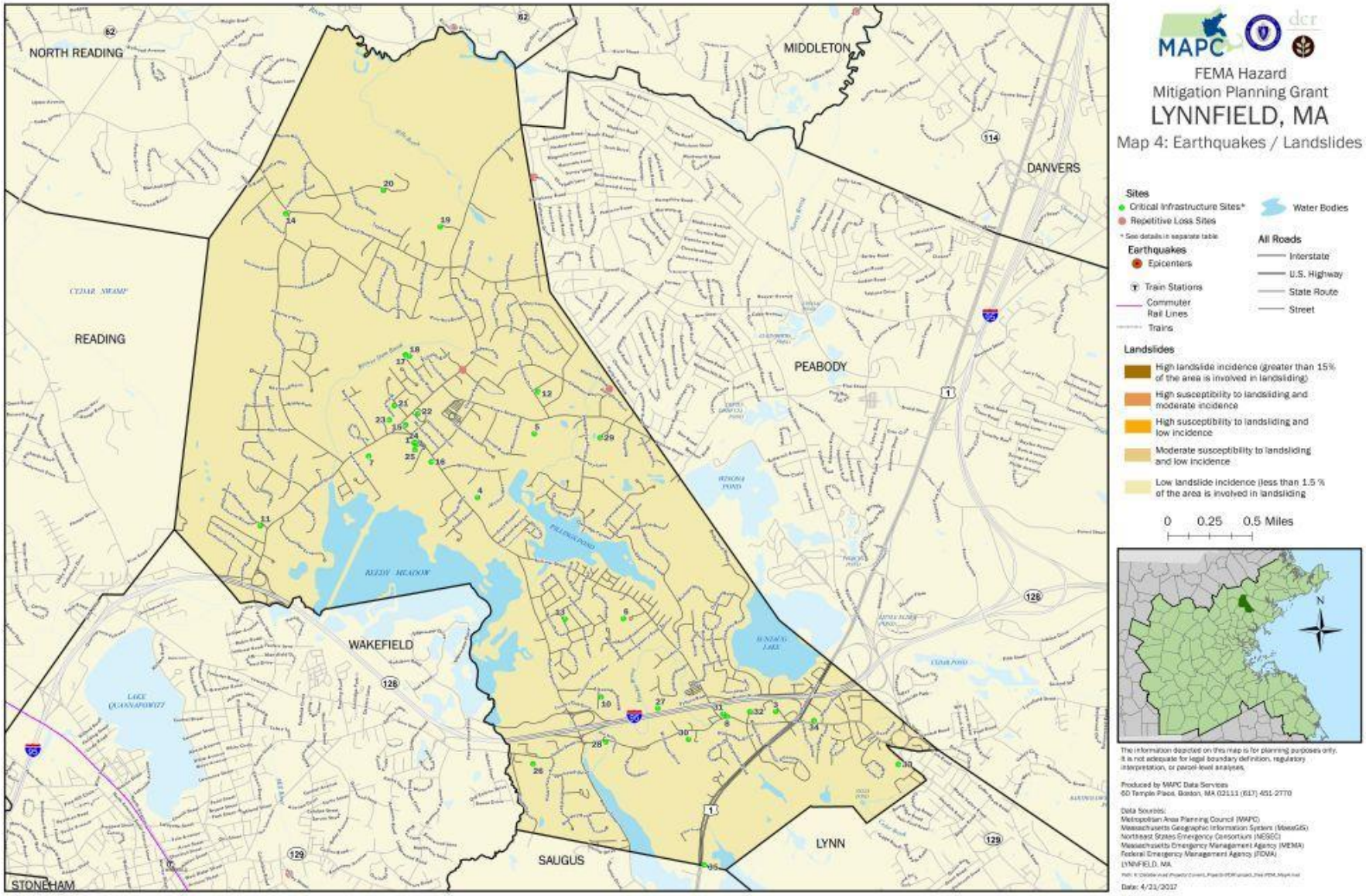
Map 7: Composite Natural Hazards - This map shows four categories of composite natural hazards for areas of existing development. The hazards included in this map are 100 year wind speeds of 110 mph or higher, low and moderate landslide risk, FEMA Q3 flood zones (100 year and 500 year) and hurricane 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.

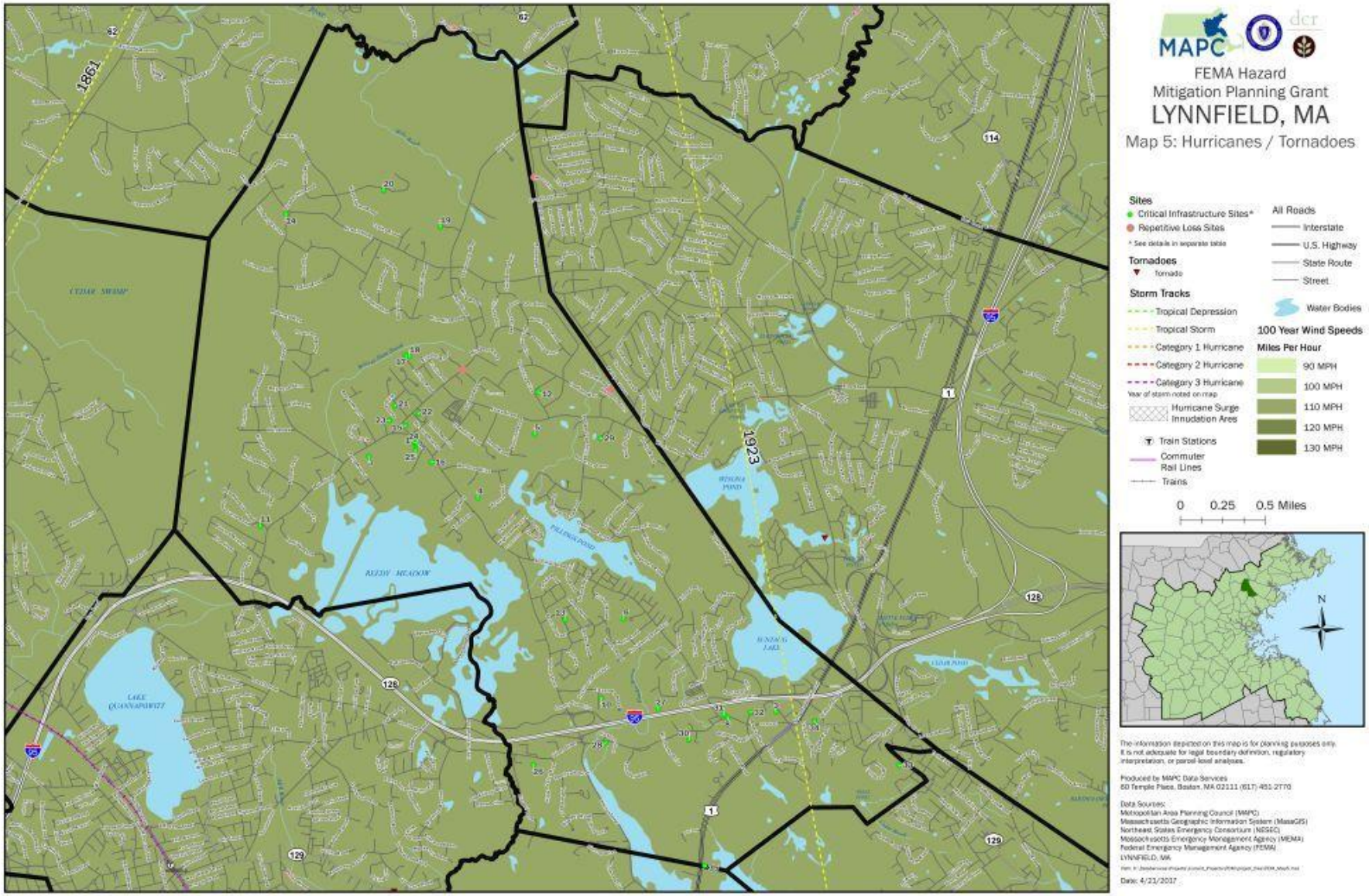
Map 8: Hazard Areas – For each community, locally identified hazard areas are overlaid on an aerial photograph dated April, 2010. The critical infrastructure sites are also shown. The source of the aerial photograph is Mass GIS.


MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
LYNNFIELD, MA
Map 1: Population Density
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Water Bodies
Train Stations
Commuter Rail Lines
Trains
All Roads
Interstate
U.S. Highway
State Route
Street
Population Density
2010 Census Blocks
People Per Acre
0 or No Data
0.1 - 5.0
5.1 - 15.0
15.1 - 30.0
More than 30
0 0.25 0.5 Miles
N
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analysis.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
LYNNFIELD, MA
Date: 4/21/2017
MIDDLETON
NORTH READING
DANVERS
PEABODY
READING
WAKEFIELD
SAUGUS
LYNN


NORTH READING
MIDDLETON
BEVERLY
READING
PEABODY
WAKEFIELD
SAUGUS
LYNN
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
LYNNFIELD, MA
Map 2: Land Use
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Development Areas
* See details in separate table
Land Use (2005)
High Density Residential
Medium Density Residential
Low Density Residential
Non-Residential Developed
Commercial
Industrial
Transportation
Agriculture
Undeveloped
Undeveloped Wetlands
Train Stations
Commuter Rail Lines
Trains
All Roads
Interstate
U.S. Highway
State Route
Street
Water Bodies
0 0.25 0.5 Miles
N
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
LYNNFIELD, MA
Date: 4/21/2017


NORTH READING
MIDDLETON
DANVERS
READING
PEABODY
WAKEFIELD
SAUGUS
LYNN
STONEHAM
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
LYNNFIELD, MA
Map 3: Flood Zones
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Water Bodies
Locally Identified Hazard Areas*
Flooding
* See Section IV Risk Assessment
Development Areas*
* See details in separate table
Train Stations
Commuter Rail Lines
Trains
All Roads
Interstate
U.S. Highway
State Route
Street
Flood Zones, 2014
(Annual Chance)
A: 1% Annual Chance of Flooding, no BFE
AE: 1% Annual Chance of Flooding, with BFE
AE: Regulatory Floodway
D: Possible But Undetermined Hazard
X: 0.2% Annual Chance of Flooding
0 0.25 0.5 Miles
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Flood Zones dataset updated by MassGIS October 2013 from finalized data provided by Federal Emergency Management Agency (FEMA)
LYNNFIELD, MA
Date: 4/21/2017


NORTH READING
MIDDLETON
DANVERS
READING
PEABODY
WAKEFIELD
SAUGUS
LYNN
STONEHAM
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
LYNNFIELD, MA
Map 4: Earthquakes / Landslides
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Earthquakes
Epicenters
Train Stations
Commuter Rail Lines
Trains
Water Bodies
All Roads
Interstate
U.S. Highway
State Route
Street
Landslides
High landslide incidence (greater than 15% of the area is involved in landsliding)
High susceptibility to landsliding and moderate incidence
High susceptibility to landsliding and low incidence
Moderate susceptibility to landsliding and low incidence
Low landslide incidence (less than 1.5 % of the area is involved in landsliding
0 0.25 0.5 Miles
N
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
LYNNFIELD, MA
Date: 4/21/2017


MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
LYNNFIELD, MA
Map 5: Hurricanes / Tornadoes
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Tornadoes
Tornado
Storm Tracks
Tropical Depression
Tropical Storm
Category 1 Hurricane
Category 2 Hurricane
Category 3 Hurricane
Year of storm noted on map
Hurricane Surge Innudation Area
Train Stations
Commuter Rail Lines
Trains
All Roads
Interstate
U.S. Highway
State Route
Street
Water Bodies
100 Year Wind Speeds
Miles Per Hour
90 MPH
100 MPH
110 MPH
120 MPH
130 MPH
0 0.25 0.5 Miles
N
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Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
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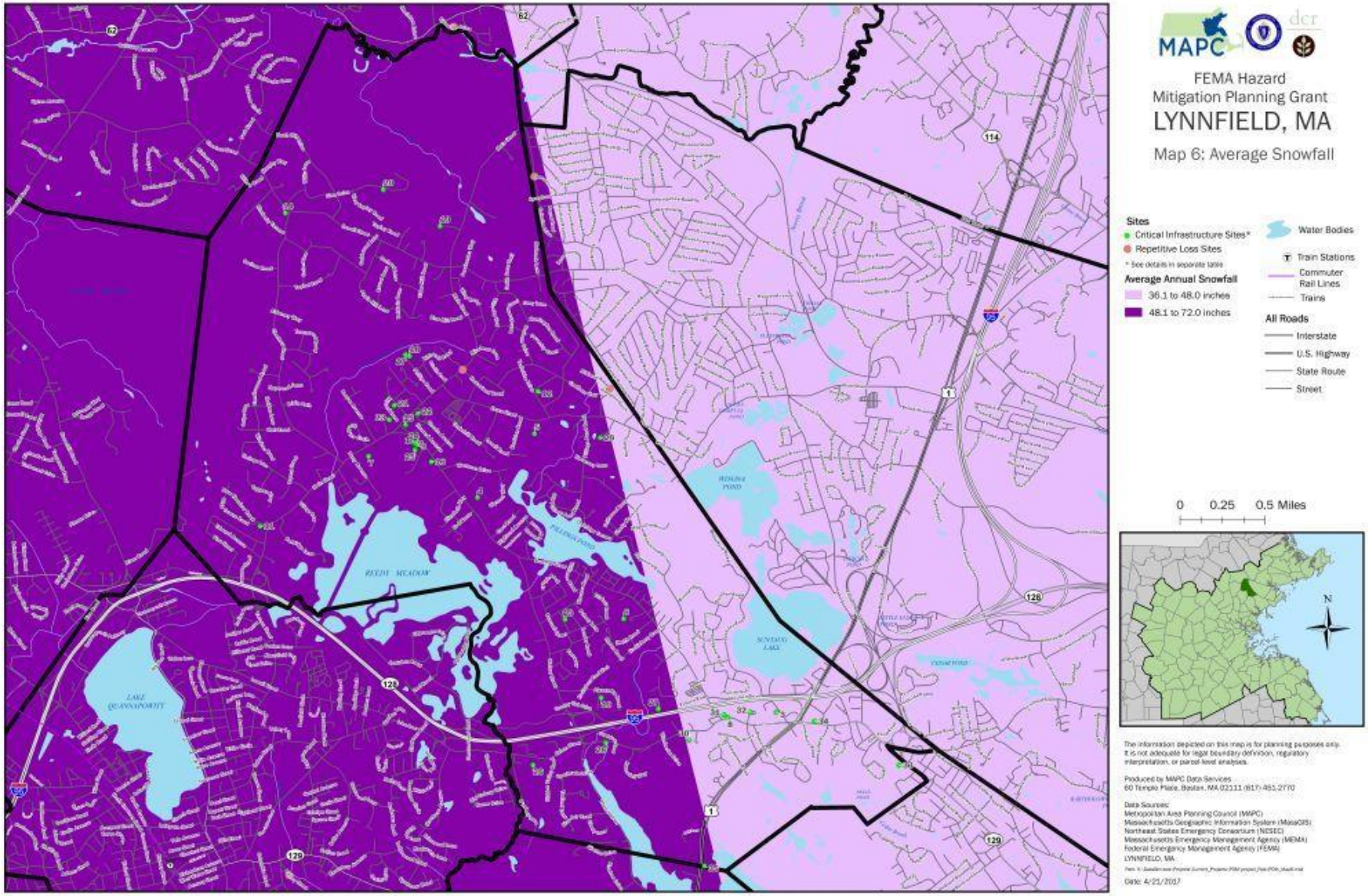
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
LYNNFIELD, MA
Date: 4/21/2017
1861
1923
LAKE QUANNAPOWITT
SUCCY MEADOW
PILLSBURY POND
SUNDAY LAKE


MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
LYNNFIELD, MA
Map 6: Average Snowfall
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Average Annual Snowfall
36.1 to 48.0 inches
48.1 to 72.0 inches
Water Bodies
Train Stations
Commuter Rail Lines
Trains
All Roads
Interstate
U.S. Highway
State Route
Street
0 0.25 0.5 Miles
N
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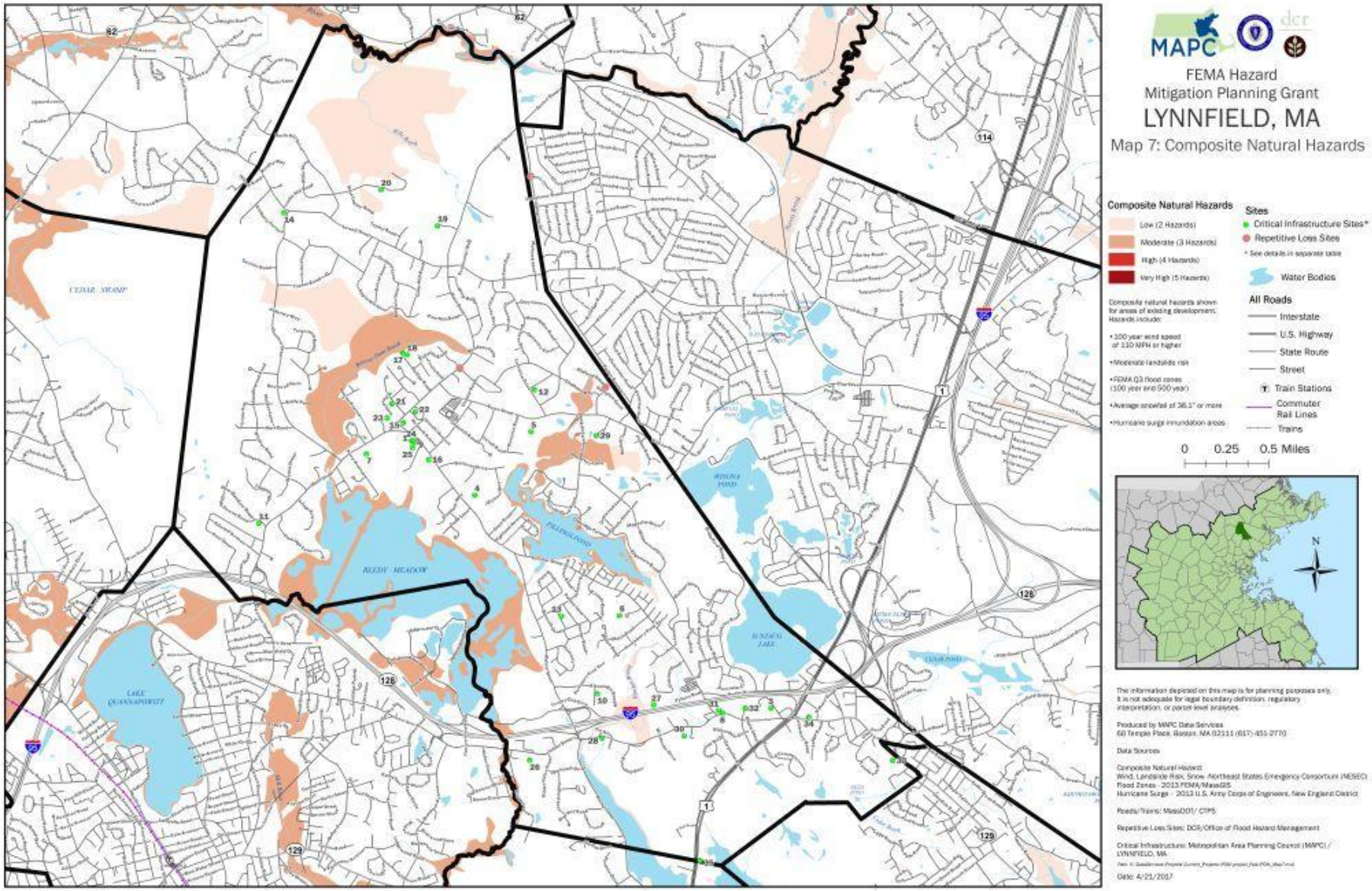
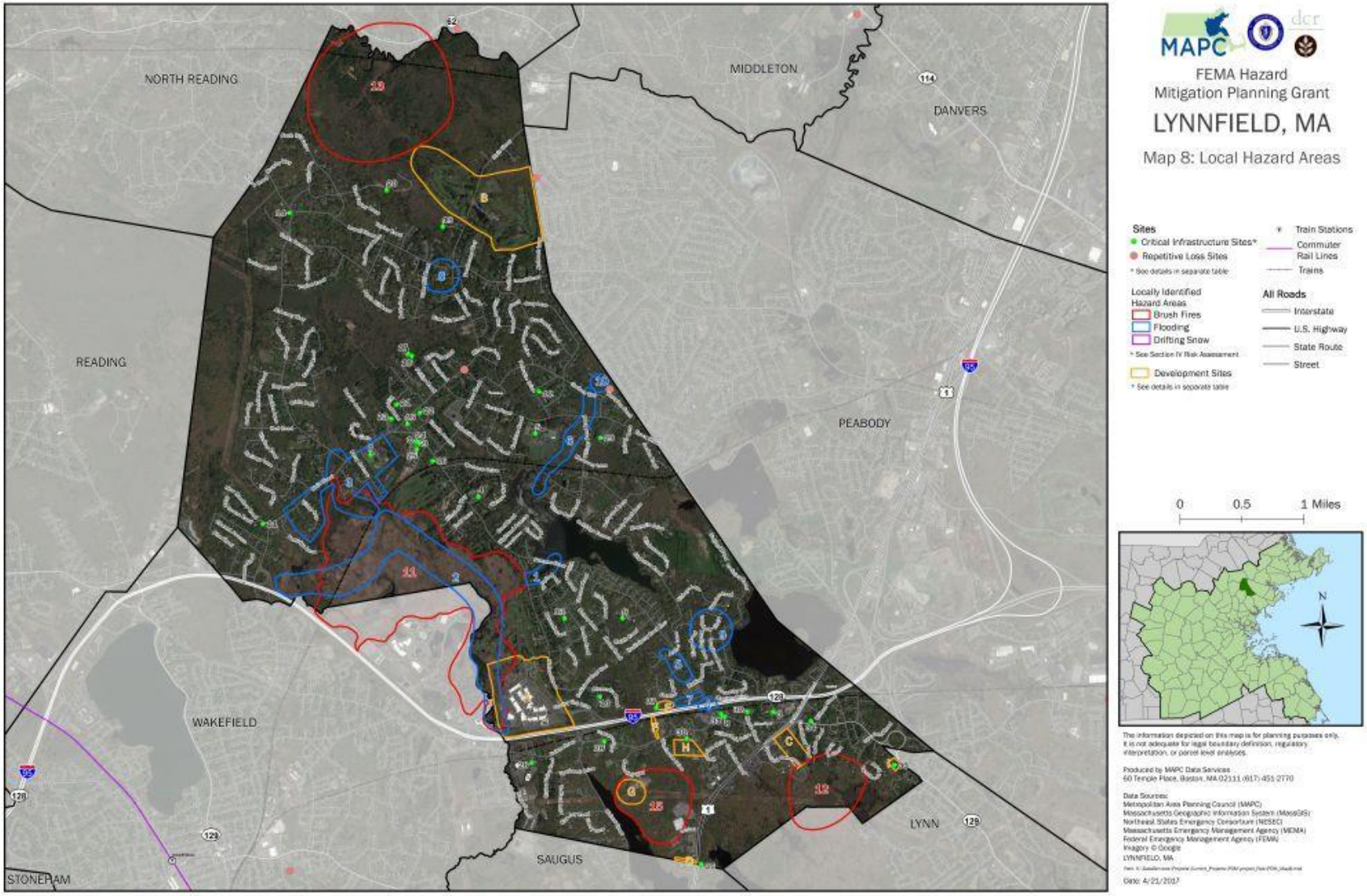
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
LYNNFIELD, MA
Date: 4/21/2017


MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
LYNNFIELD, MA
Map 7: Composite Natural Hazards
Composite Natural Hazards
Low (2 Hazards)
Moderate (3 Hazards)
High (4 Hazards)
Very High (5 Hazards)
Composite natural hazards shown for areas of existing development. Hazards include:
• 100 year wind speed of 110 MPH or higher
• Moderate landslide risk
• FEMA Q3 flood zones (100 year and 500 year)
• Average snowfall of 36.1" or more
• Hurricane surge inundation areas
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Water Bodies
All Roads
Interstate
U.S. Highway
State Route
Street
Train Stations
Commuter Rail Lines
Trains
0 0.25 0.5 Miles
N
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources
Composite Natural Hazard:
Wind, Landslide Risk, Snow -Northeast States Emergency Consortium (NESEC)
Flood Zones - 2013 FEMA/MassGIS
Hurricane Surge - 2013 U.S. Army Corps of Engineers, New England District
Roads/Trains: MassDOT/ CTPS
Repetitive Loss Sites: DCR/Office of Flood Hazard Management
Critical Infrastructure: Metropolitan Area Planning Council (MAPC) / LYNNFIELD, MA
Date: 4/21/2017
CEDAR SWAMP
REEDY MEADOW
LAKE QUANNAPOWITT
SUNDAY LAKE
62
114
128
129
1
95


NORTH READING
MIDDLETON
DANVERS
READING
PEABODY
WAKEFIELD
LYNN
SAUGUS
STONEHAM
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
LYNNFIELD, MA
Map 8: Local Hazard Areas
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Locally Identified
Hazard Areas
Brush Fires
Flooding
Drifting Snow
* See Section IV Risk Assessment
Development Sites
* See details in separate table
Train Stations
Commuter
Rail Lines
Trains
All Roads
Interstate
U.S. Highway
State Route
Street
0
0.5
1 Miles
N
The information depicted on this map is for planning purposes only.
It is not adequate for legal boundary definition, regulatory
interpretation, or parcel level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
Imagery © Google
LYNNFIELD, MA
Date: 4/21/2017

APPENDIX C
DOCUMENTATION OF PUBLIC PARTICIPATION

Amanda Linehan, Communications Manager, Metropolitan Area Planning Council
617-933-0705, alinehan@mapc.org

CALENDAR LISTING / MEDIA ADVISORY

LYNNFIELD'S NATURAL HAZARDS PLAN UPDATE IS FOCUS OF APRIL 26 PUBLIC MEETING

Meeting to present an overview of the update of Lynnfield's Natural Hazards Mitigation Plan and solicit public comments

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

What: The Lynnfield Emergency Management Team (EMT) will hold a public meeting to present an overview of the pending update of the Town of Lynnfield's Natural Hazards Mitigation Plan. The Metropolitan Area Planning Council (MAPC) is assisting the Town on the plan update, and a representative of MAPC will present an overview of the plan update.

The Town of Lynnfield adopted its first Hazard Mitigation Plan in 2008, which was approved by the Federal Emergency Management Agency (FEMA). The plan identifies natural hazards affecting Lynnfield such as floods, hurricanes, winter storms, and earthquakes, as well as actions that the Town can take to reduce the impacts of these hazards. FEMA requires that plans be updated regularly, so MAPC is assisting the Town prepare an updated plan.

When: April 26, 2016, 7:00 PM

Where: Lynnfield Town Hall, 55 Summer St, Selectmen's Meeting Room

MAPC is the regional planning agency for 101 communities in the metropolitan Boston area, promoting smart growth and regional collaboration. More information about MAPC is available at www.mapc.org.

Amanda Linehan, Communications Manager, Metropolitan Area Planning Council
617-933-0705, alinehan@mapc.org

CALENDAR LISTING / MEDIA ADVISORY

LYNNFIELD'S DRAFT HAZARD MITIGATION PLAN TO BE PRESENTED AT NOVEMBER 29 PUBLIC MEETING

Meeting to present the update of Lynnfield's Hazard Mitigation Plan and solicit public comments

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

What: The Lynnfield Planning Board and Emergency Management Team (EMT) will hold a public meeting to present an overview of the draft Lynnfield Hazard Mitigation Plan Update . The Metropolitan Area Planning Council (MAPC) is assisting the Town on the plan update, and a representative of MAPC will present an overview of the plan update.

The Town of Lynnfield adopted its first Hazard Mitigation Plan in 2008, which was approved by the Federal Emergency Management Agency (FEMA). The plan identifies natural hazards affecting Lynnfield such as floods, hurricanes, winter storms, and earthquakes, as well as actions that the Town can take to reduce the impacts of these hazards. FEMA requires that plans be updated regularly, so MAPC is assisting the Town prepare an updated plan.

When: November 29, 2017, 7:00 PM

Where: Lynnfield Town Hall, 55 Summer St, Selectmen's Meeting Room

MAPC is the regional planning agency for 101 communities in the metropolitan Boston area, promoting smart growth and regional collaboration. More information about MAPC is available at www.mapc.org.

LYNNFIELD HAZARD MITIGATION PLAN – NEIGHBORING COMMUNITIES OF LYNNFIELD, MA
Notification / Email

North Reading-Danielle McKnight –dmcknight@northLynnfieldma.gov

Middleton-Katrina O'Leary-**katrina.oleary@middletonma.gov**

Peabody- Brendan.Callahan@peabody-ma.gov

Lynn-James Marsh- jmarsh@lynnma.gov

Saugus-Bob Shannon bshannon@saugusma.gov

Wakefield-Paul Reavis –preavis@wakefield-ma.gov

Reading- Julie Mercier-jmercier@ci.reading.ma.us

Additional Organizations:
Lynn Area Chamber of Commerce

Lynnfield Conservation Commission

Lynnfield Department Directors – DPW, PUBLIC BUILDINGS, FIRE, POLICE, TOWN CLERK, RECREATION AND BOARD OF HEALTH.

Lynnfield Patch

What is the Hazard Mitigation Plan Update?
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.

Why is this plan important?
The Federal Disaster Mitigation Act of 2000 requires that a city or town have an approved hazard mitigation plan in order to qualify for federal funding from the following grant programs:

- Pre-Disaster Mitigation Competitive (PDM-C)
- Hazard Mitigation Grant Program (HMGP)
- Flood Mitigation Assistance (FMA)

Additionally, the plan provides a municipality the opportunity to review potential vulnerabilities to natural hazards and develop measures that can reduce or mitigate these vulnerabilities and be included in the local planning process.

What goes into a hazard mitigation plan?
A hazard mitigation plan assesses the municipality's risks and vulnerabilities to natural hazard events such as flooding, hurricanes, winter storms, and earthquakes. MAPC uses statewide data and information directly from the community to make this assessment.

The plan includes a set of goals related to the overall goal of hazard mitigation planning, an assessment of existing mitigation measures, and a set of new mitigation measures that will serve to advance the plan goals. The plan update will also look at implementation progress that has been made on mitigation measures from the previous plan.

What is the Local Hazard Mitigation Committee?
The Local Hazard Mitigation Committee includes and coordinates with representatives from a number of different Town departments including Public Works, Engineering, Health, Community Development, Emergency Management and Fire. This committee provides the local on-the-ground knowledge necessary to write this plan including information on local hazard areas and current mitigation measures. This committee also identifies and prioritizes mitigation measures to be included in the plan.

How can the public become involved in the Hazard Mitigation planning process?
Public participation is very important to the hazard mitigation planning process. FEMA requires a minimum of two public meetings. When the first draft of the plan is developed, the Town will provide an online link where the plan can be viewed and comments may be provided by the public.

60 Temple Place, Boston, MA 02111 • 617 451 2770 • Fax 617 482 7185 • www.mapc.org

APPENDIX D
DOCUMENTATION OF PLAN ADOPTION

Town of
LYNNFIELD

BOARD OF SELECTMEN

CHRISTOPHER J. BARRETT
PHILIP B. CRAWFORD
RICHARD P. DALTON

JAMES M. BOUDREAU
Town Administrator

CERTIFICATE OF ADOPTION
BOARD OF SELECTMEN
TOWN OF LYNNFIELD, MASSACHUSETTS

A RESOLUTION ADOPTING THE
TOWN OF LYNNFIELD HAZARD MITIGATION PLAN 2018 UPDATE

WHEREAS, the Town of Lynnfield established a Committee to prepare the *Town of Lynnfield Hazard Mitigation Plan 2018 Update*; and

WHEREAS, the *Town of Lynnfield Hazard Mitigation Plan 2018 Update* contains several potential future projects to mitigate potential impacts from natural hazards in the Town of Lynnfield, and

WHEREAS, duly noticed public meetings were held by the EMERGENCY MANAGEMENT TEAM on April 26, 2017, and November 29, 2017

WHEREAS, the Town of Lynnfield authorizes responsible departments and/or agencies to execute their responsibilities demonstrated in the plan, and

NOW, THEREFORE BE IT RESOLVED that the Town of Lynnfield BOARD OF SELECTMEN adopts the *Town of Lynnfield Hazard Mitigation Plan 2018 Update*, in accordance with M.G.L. 40 §4 or the charter and bylaws of the Town of Lynnfield.

ADOPTED AND SIGNED this Date. June 18, 2018

LYNNFIELD BOARD of SELECTMEN

Names:	Richard P. Dalton	Philip B. Crawford	Christopher J. Barrett
Titles	Chairman	Vice Chairman	Clerk
Signatures			

ATTEST:

TOWN HALL
55 SUMMER ST., LYNNFIELD, MA 01940-1823

781-334-9410 781-334-9412 FAX: 781-334-9419
e-mail: jboudreau@town.lynnfield.ma.us