



# 2014 TOWN OF GREENFIELD LOCAL MULTI-HAZARD MITIGATION PLAN



## **Multi-Hazard Mitigation Planning Committee:**

Robert Strahan, Emergency Management Director, Fire Department

Eric Twarog, Director, Department of Planning & Development

Nicole Zabko, Public Health Director

Roxann Wedegartner, Planning Board Chair

Lt. William Gordan, Police Department

Alan Twarog, Department of Public Works

Marcia Starkey, Historical Commission

and

## **The Franklin Regional Council of Governments:**

Peggy Sloan, Director of Planning & Development

Kimberly Noake MacPhee, P.G., Land Use & Natural Resources Program Manager

Mary Praus, Land Use Planner

Ryan Clary, Senior GIS Specialist

Alyssa Larose, Land Use Planner

Whit Sanford, Assistant Land Use Planner

*This project was funded by a grant received from the Massachusetts Emergency Management Agency*

*Cover: Eunice Williams Covered Bridge knocked from its footings during Hurricane Irene*

# Table of Contents

|  |            |
|--|------------|
| <i>1- INTRODUCTION</i> .....   | <i>1</i>   |
| Hazard Mitigation.....   | 1          |
| Plan Updates and Changes.....  | 3          |
| <br>   |            |
| <i>2 – LOCAL PROFILE</i> .....   | <i>5</i>   |
| Community Setting.....   | 5          |
| Infrastructure.....  | 6          |
| Natural Resources.....   | 7          |
| Cultural and historic Resources.....                                     | 9          |
| <br>   |            |
| <i>3 - RISK ASSESSMENT</i> .....   | <i>13</i>  |
| Multi-Hazard Identification and Profile.....                             | 13         |
| Risk Assessment Methodology.....   | 59         |
| Vulnerability Assessment.....  | 64         |
| Development Trends Analysis.....   | 94         |
| <br>   |            |
| <i>4 – MITIGATION STRATEGIES</i> .....                                   | <i>98</i>  |
| Current Mitigation Strategies.....                                       | 98         |
| Future Mitigation Strategies.....  | 129        |
| National Flood Insurance Program Compliance.....                         | 143        |
| <br>   |            |
| <i>5 – PLAN ADOPTION AND MAINTENANCE</i> .....                           | <i>147</i> |
| Plan Adoption.....   | 147        |
| Plan Maintenance Process.....  | 147        |
| <br>   |            |
| <i>6 – APPENDICES</i> .....  | <i>153</i> |
| Appendix A: Zoning Bylaws and Subdivision Regulations.....               | 153        |
| Appendix B: Massachusetts Cultural Resource Information System.....      | 163        |
| Appendix C: In the News.....   | 175        |
| Appendix D: Town Correspondence, Public Outreach, Sign Ins, Agendas..... | 188        |
| Appendix E: Plan Approval and Adoption.....                              | 197        |



# 1- INTRODUCTION

## Hazard Mitigation

---

The Federal Emergency Management Agency (FEMA) and the Massachusetts Emergency Management Agency (MEMA) define Hazard Mitigation as any sustained action taken to reduce or eliminate long-term risk to people and property from natural hazards such as flooding, storms, high winds, hurricanes, wildfires, earthquakes, and other disasters. Mitigation efforts undertaken by communities will help to minimize damages to buildings and infrastructure, such as water supplies, sewers, and utility transmission lines, as well as natural, cultural and historic resources.

Planning efforts, like the one undertaken by the Town of Greenfield and the Franklin Regional Council of Governments, make mitigation a proactive process. Pre-disaster planning emphasizes actions that can be taken before a natural disaster occurs. Future property damage and loss of life can be reduced or prevented by a mitigation program that addresses the unique geography, demography, economy, and land use of a community within the context of each of the specific potential natural hazards that may threaten a community.

Preparing a Local Multi-Hazard Mitigation Plan before a disaster occurs can save the community money and will facilitate post-disaster funding. Costly repairs or replacement of buildings and infrastructure, as well as the high cost of providing emergency services and rescue/recovery operations, can be avoided or significantly lessened if a community implements the mitigation measures detailed in the Plan. Many disaster assistance agencies and programs, including FEMA, require that a community have adopted a pre-disaster mitigation plan as a condition for both mitigation funding and for disaster relief funding. For example, the Hazard Mitigation Grant Program (HMGP), the Flood Mitigation Assistance Program (FMA) and the Community Rating System (CRS), are programs with this requirement.

## Planning Process

The hazard mitigation planning process for the Town of Greenfield included the following tasks:

- Review of the Greenfield 2005 Local Multi-Hazard Mitigation Plan, assessment of relevancy of existing materials, status of action items and addition of new materials based upon MEMA recommendations and Committee input.
- Identification of the hazards that may impact the community, and past occurrences of hazards at the local or regional level.
- Performance of a Vulnerability/Risk Assessment to identify the infrastructure (i.e., critical facilities, public buildings, roads, homes, businesses, etc.) at the highest risk for being damaged by the identified hazards, particularly flooding.
- Identification and assessment of the policies, programs, and regulations a community is currently implementing to protect against future disaster damages. Examples of such strategies include:

- Preventing or limiting development in hazard areas like floodplains, wetlands, drinking water recharge areas, and conservation land;
  - Implementing recommendations in planning documents including Stormwater Management Plans, Master (Comprehensive) Plans, Open Space and Recreation Plans, Emergency/Evacuation Plans that address the impacts of hazards; and
  - Requiring or encouraging the use of specific structural requirements for new buildings such as buried utilities, flood-proofed structures, and lightning grounding systems.
- Identification of deficiencies in the current strategies and establish goals for updating, revising or adopting new strategies.
  - Identification of specific projects that will mitigate the risk to public safety and damages to infrastructure from hazards.
  - Adoption and implementation of the Final Multi-Hazard Mitigation Plan.

Additionally, the Town of Greenfield and FRCOG:

- Provided an opportunity for the public to comment on the plan during the drafting and prior to the approval of the plan. Publicity was done with a press release in the Greenfield Recorder as well as through flyers posted in town throughout the planning process. A copy of the draft plan was available to the public at the Greenfield Planning Department. Two Public Meetings were held – one each on August 18, 2010 and August 30, 2011.
- Provided an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities and agencies that have the authority to regulate development, and businesses, academia and other private and nonprofit organization to be involved in the planning process. Some stakeholders include the Towns of Deerfield, Bernardston, Gill and Montague as well as the Greenfield School System, Baystate Franklin Medical Center, Stonely Burnham School, Greenfield Community College, and FirstLight Power. See Appendix D for a copy of the stakeholder invitation to participate letter that was sent to stakeholders on October 24, 2011.
- Reviewed and incorporated, if appropriate, existing plans, studies, reports and technical information. Plans reviewed and incorporated include the 2009 Greenfield Reconnaissance Report, 2002 Greenfield Downtown Master Plan, the 2006 Greenfield Open Space and Recreation Plan, 2002 Mohawk Trail West Action Plan, Bank Row Urban Renewal Plan of 2005 and data sources cited in footnotes throughout this Plan.
- Documented the planning process, including preparation and public participation.

This work was carried out by the staff of the FRCOG Planning Department with the assistance of the Greenfield Multi-Hazard Mitigation Planning Committee, which includes representatives of the Fire Department, Health Department, Department of Planning and Development, Police Department, Planning Board, Department of Public Works, and Historical Commission. See the cover page of this plan for a list of Committee members and their titles and affiliations.

## Plan Updates and Changes

---

As indicated in the Planning Process section, changes and updates were made to this Plan based upon MEMA recommendations and committee input. The following sections of the 2011 plan were added to and/or substantially updated:

- **Section 2: Local Profile**
  - Cultural and Historic Resources section added ..... 11-12
  
- **Section 3: Risk Assessment**
  - Multi-Hazard Identification and Profile
    - Drought and Extreme Temperatures added .....13
    - Location and Extent for Each Hazard added ..... 13-39
    - Microbursts and Wind Storms are separate categories, per the committee’s request
    - Beaver Dams (Sub-Category of Dam Failure) added ..... 28-30
    - Landslides added..... 31-33
    - Ice Jams added ..... 33-35
    - Manmade Hazards added ..... 35-39
  
  - Risk Assessment Methodology
    - All Hazards Risk Assessment Methodology expanded ..... 41-43
    - Table 3-21: All Hazards Vulnerability Assessment Table added .....44
  
  - Vulnerability Assessment
    - Environmental Justice text and map added..... 45-47
    - Assessment by Hazard – detailed section for each hazard added ..... 46-71
      - Exposure
      - Damages
      - Loss estimates
      - Population impacts
      - Data deficiencies
    - Zoning Map added .....75
    - Critical Facilities and Infrastructure Map added .....76
  
- **Section 4: Mitigation Strategy**
  - Current Mitigation Strategies were added for new hazards
    - Landslides .....106
    - Ice Jams.....107
    - Manmade Hazards .....108
  - Future Mitigation Strategies .....129
    - Prioritization of Hazards added .....129
    - Identification of Most Important Hazards added .....130
    - Goal Statements and Action Items updated .....131
    - 2005 Action Items Completed added.....131

Prioritization of Action Items added.....131  
Prioritized Action Plan in new table format with Potential Funding Sources added.....134  
Preparedness and Response Action Plan added.....140  
NFIP Community Rating System (CRS) and additional NFIP info added....143

- **Section 5: Plan Implementation**

New Potential Funding Sources Table 5-1 added.....149

## 2 – LOCAL PROFILE<sup>1</sup>

### Community Setting

---

The Town of Greenfield is located in the middle of Franklin County and is bisected by two major transportation routes in the county; Interstate 91 which travels north/south and State Route 2 which travels east/west. Greenfield is the largest community in the county with a recorded population of 17,537 people (2009 Census) or approximately 25% of the total population for Franklin County. Greenfield's downtown area is densely developed and people from Franklin County and beyond travel to the Town to take advantage of the employment opportunities, cultural and recreational offerings, retail shops, and restaurants.



Greenfield lies between the Rocky Mountain Ridge to the east and the hills of Shelburne to the West.  
*Photo courtesy of Creative Commons.*

In the late 17<sup>th</sup> Century, the Town of Greenfield was known as the Green River District of the Town of Deerfield, an agricultural community populated by settlers looking for land to farm.

---

<sup>1</sup> The majority of the information for this section was obtained from the Town of Greenfield's Open Space and Recreation Plan 2000 and from various websites including: [www.townofgreenfield.org](http://www.townofgreenfield.org) and [www.mass.info/greenfield.ma/description](http://www.mass.info/greenfield.ma/description), and the 2008 U.S. Census Population Estimates Program.

However, due to the location of this new settlement at the confluence of three major rivers – the Connecticut, Deerfield and Green Rivers – the community rapidly evolved into a trading hub.

In 1753, the Town of Greenfield was officially incorporated. In 1811, Greenfield was named the official County Seat in the newly established Franklin County. With its abundant water resources, Greenfield attracted industrial development that could be powered by water-generated electricity. Many mills and factories were built in Greenfield during the Industrial Revolution in clusters along the many large rivers running through town. The growth of the rest of the town was characterized by a compact downtown area with two- and three-storied brick and wood buildings surrounded by densely developed residential neighborhoods.

Today, the town's densest development is concentrated in the southeastern part of town which is bounded by Interstate 91 and Route 2. Outside this major transportation corridor, the town is characterized by larger residential lots and agricultural uses in the rural areas. According to 2005 land use data provided by MassGIS, the total land area of the Town of Greenfield is approximately 15,624 acres with approximately 29.2% or 4,103 of those acres developed land. The remaining 9,934 acres of land are classified as undeveloped with Forest as the largest category with 6,721 acres (47.9%). Cropland and pastureland represent the second and third largest amount of undeveloped land in the town with a total of 1,936 acres. Crop and pasture land can be particularly vulnerable to development pressures because they tend to be flat and cleared with few environmental constraints.

## **Infrastructure**

---

Since its incorporation as a town in 1753, Greenfield has been a major east/west and north/south transportation crossroads, first for river traffic on the Connecticut, then as a major stagecoach stop, and later for the transport of passengers and goods via railroad. Today, with the intersection of Interstate 91 and Route 2 located in the middle of town, Greenfield continues to be a transportation crossroads and is often referred to as the “Gateway to the Berkshires.”

### **Roads and Highways**

Greenfield has a total of approximately 124 miles of roadway within its borders, including the major transportation arteries Interstate 91 and Route 2. Interstate 91 connects Greenfield and Franklin County with Vermont and New Hampshire to the north and to the south, the larger communities of Northampton, Holyoke and Springfield, Massachusetts and the states of Connecticut and New York. Route 2 is the major east-west route in northern Massachusetts. This road links Greenfield and Franklin County with Boston and other metropolitan areas to the east and the Berkshires and New York State to the west.

### **Rail**

Since the 1840's, railroads have moved people and freight through Greenfield. The Boston and Maine Railroad has two important lines that converge in town, one that runs from Boston to New

York State and the other that runs from Springfield, Massachusetts in to Vermont. Currently, rail service in Greenfield is only for the transportation of freight.<sup>2</sup>

### **Public Transportation**

The Franklin Regional Transit Authority (FRTA) has ten fixed bus routes that all originate at Court Square in front of the Greenfield Town Hall. Buses run regularly throughout the day and provide a vital service to many area residents, particularly elderly residents. The Franklin Regional Transit Center is currently under construction and is slated for completion in December of 2011. This Leed certified, net-zero energy building will serve as the hub of public transportation in and around Greenfield.

### **Public Drinking Water Supply**

Approximately 95% of the town's residents receive their drinking water from the municipal water supply system. The town currently relies on both groundwater pumped from wells and surface waters for its drinking water supply. The three Millbrook wells, which are located in the northeastern section of town near the Bernardston border, provide groundwater. Known as the Leary Wells site, the town has identified a potential well site located in an area between Leyden and Green River Roads. The Leyden Glen Reservoir in Leyden is a 45 million gallon impoundment that supplies approximately 26% of Greenfield's water supply. The Green River also provides drinking water for the town during periods of peak demand in the summer. Water is withdrawn from the river behind the dam off of Eunice Williams Drive.

### **Sewer Service**

Located in the flood plain of the Green River, Greenfield's municipal sewer system services the town's central, urbanized area and approximately 75% of the residential dwelling units in town. One main interceptor and four trunk sewers feed the Wastewater Treatment Plant located on the Green River at the very southern end of town. This facility has been expanded and upgraded to comply with a 1987 DEP Administrative Order. The plant discharges its effluent into the Deerfield River. This facility underwent a \$9.2 million dollar upgrade – including flood proofing – in 2000.

## **Natural Resources**

---

Greenfield is located in the Connecticut River Valley lowland physiographic region, which is characterized by gently rolling hills and large expanses of flat land bordered by steep, forested hills and ridges. Rocky Mountain, on the town's eastern border, rises to an elevation of 490 feet and separates the center of town from the Connecticut River. To the northeast, the topography is characterized by small, rounded hills with elevations that range from 500 to 550 feet and the steep slopes and flat, narrow valley of the Fall River. The remaining land in the town is open and relatively flat with the exception of the area adjacent to the Green and Deerfield Rivers in the southwestern part of town.

---

<sup>2</sup> In addition to bus service. Greenfield will have a new Franklin Regional Transit Center (2011), which could become a major hub for improved passenger and freight rail proposed for the Connecticut to Vermont and Boston, Massachusetts to Albany, New York rail lines.

## **Hydrology**

Rivers and streams are prevalent in Greenfield. Also, there are a few small ponds within the town's borders, mostly in the northeastern section of town.

Though more densely populated than other towns in Franklin County, Greenfield has a wealth of natural resources. Four rivers flow through town, namely the Fall, Green, Deerfield, and Connecticut Rivers. The Connecticut River separates Greenfield from the Town of Montague to the east while the Fall River marks the northeastern limits of the Town of Greenfield and forms the border with the neighboring town of Gill. To the south, the Deerfield River separates Greenfield from the Town of Deerfield. The Green River, which flows in a southerly direction through the middle of the town, provides both drinking water and recreational opportunities for residents.

### ***Connecticut River Watershed***

The Connecticut River watershed consists of approximately 11,260 square miles and includes portions of Massachusetts, New Hampshire, Vermont and Connecticut. The Connecticut River flows for 410 miles, beginning at the Canadian border and emptying into the Long Island Sound. Approximately 80% of the watershed is forested, 12% is agricultural, 3% is developed and 5% is water. The Connecticut River Watershed Council is located on Bank Row in Greenfield and advocates for the health and vitality of the Connecticut River Watershed and its sub-watersheds.

### ***Deerfield River Watershed***

The Deerfield River watershed is a sub-watershed of the Connecticut River watershed and consists of approximately 665 square miles in the Southern Green Mountains in Vermont and the Northern Berkshires in Massachusetts. The Deerfield River flows approximately seventy miles from Stratton Mountain in Vermont to the Berkshire Mountains where it flows into the Connecticut River. Approximately 78% of the basin is forested and about 3% is urbanized.

### ***Green River Watershed***<sup>3</sup>

The Green River is the second largest tributary to the Deerfield River; therefore its watershed is a sub-basin of the Deerfield River watershed. The Green River watershed is comprised of approximately 88.9 square miles; the river begins in Marlboro, Vermont and ends as it flows into the Deerfield River in the Town of Greenfield. About 8.5 miles of the River are in Greenfield (<http://www.deerfieldriver.org/GreenRiver/index.htm>).

The Green River travels the entire length of Greenfield, starting in the northwest, continuing between Leyden and Plain Roads until it reaches Greenfield Meadows, an area known for its rich agricultural soils. Traveling south, the river enters into the Municipal Swimming Area where a dam allows a small storage capacity. The River then flows under Route 2A, and parallels Routes 5 and 10, Deerfield Street, before it discharges into the Deerfield River.

The Green River has four dams in Greenfield. From North to South the dams are located at the Eunice Williams Bridge, Green River Municipal Swimming Area, Mill Street, and Meridian Street. The Green River serves multiple purposes for the town. North of Greenfield in the Town

---

<sup>3</sup> Text from the 2006 Greenfield Open Space and Recreation Plan, Town of Greenfield Planning Department.

of Leyden, the Green River provides part of Greenfield's municipal water supply at the Leyden Glen Reservoir, and again further downstream just before the dam at the Eunice Williams Bridge. The river is used more heavily in the summer months to assist with peak water demands. The Town's pattern of seasonal use emphasizes the importance to maintain the high water quality of the Green River for the town's municipal water needs.

The Army Corps of Engineers has proposed removing the two lower dams, the Mill Street and Meridian Street dams. There is currently discussion around how removal of the dams may affect the ecosystems that have adapted to the current habitats and what types of mitigation can be put into place to minimize impacts to those organisms while still facilitating the dam removals.

### ***Fall River***

The Fall River forms the remainder of Greenfield's eastern boundary to the north. This river, with its valley bottom and steep adjacent land, has high potential for conservation and recreation use.

### **Forest**

Greenfield is fortunate to have forested open space/conservation lands located throughout the Town. Approximately 48 percent of Greenfield is forested. The public forest lands are used for walking, snowshoeing, and nature study along with being an important habitat for wildlife. While forest quality is generally good, it does require ongoing management efforts.

## **Cultural and historic Resources**

---

The importance of integrating cultural resource and historic property considerations into hazard mitigation planning is demonstrated by disasters that have occurred in recent years, such as the Northridge earthquake in California, Hurricane Katrina in New Orleans, or floods in the Midwest. Closer to home, the June 1, 2011 tornado, which ripped through Springfield, Monson and other towns in Hamden and Worcester Counties, caused injuries, loss of life and widespread damages to historic properties. See pages 20-21 for details and photos of this storm's aftermath. The effects of a disaster can be extensive—from human casualty to property and crop damage to the disruption of governmental, social, and economic activity. Often not measured, however, are the possibly devastating impacts of disasters on historic properties and cultural resources. Historic structures, artwork, monuments, family heirlooms, and historic documents are often irreplaceable, and may be lost forever in a disaster if not considered in the mitigation planning process. The loss of these resources is all the more painful and ironic considering how often residents rely on their presence after a disaster, to reinforce connections with neighbors and the larger community, and to seek comfort in the aftermath of a disaster.<sup>4</sup>

Even more recently, Tropical Storm Irene devastated many Franklin County Towns and nearby Southern Vermont. An inventory of cultural and historic resources impacted by Irene was not

---

<sup>4</sup> Integrating Historic Property and Cultural Resource Considerations Into Hazard Mitigation Planning, State and Local Mitigation Planning How-To Guide, FEMA 386-6 / May 2005.

available at the time of writing. More details on Tropical Storm Irene can be found on pages 28-29.

Historic properties and cultural resources can be important economic assets, often increasing property values and attracting businesses and tourists to a community. While preservation of historic and cultural assets can require funding, it can also stimulate economic development and revitalization. Hazard mitigation planning can help forecast and plan for the protection of historic properties and cultural resources.

Cultural and historic resources help define the character of a community and reflect its past. These resources may be vulnerable to natural hazards due to their location in a potential hazard area, such as a river corridor, or because of old or unstable structures. For instance, as described on pages 41-43, the Green River Cemetery, a cultural and historic resource has been impacted by recurring instances of erosion and by a significant mudslide in 2011.

In 2009, Massachusetts Department of Conservation and Recreation (DCR) and the Franklin Regional Council of Governments (FRCOG) assisted the Town of Greenfield in a Heritage Landscape Inventory Program. The purpose of the final Greenfield Reconnaissance Report was to help communities identify a wide range of landscape resources - including cultural and historic resources - particularly those that are significant and unprotected, and to provide communities with strategies for preserving heritage landscapes. As a result of this plan, several Priority Landscape areas were identified and mapped, as shown on the next page. They include:

- Town Common area
- Franklin County
- Fairgrounds
- Mohawk Trail
- Rocky Mountain area
- The Meadows

Within these areas, specific cultural and historic sites, buildings and other resources have been identified. As Greenfield continues to refine its priorities in protecting its community from natural and manmade hazards, the Heritage Landscape Inventory is an excellent resource.

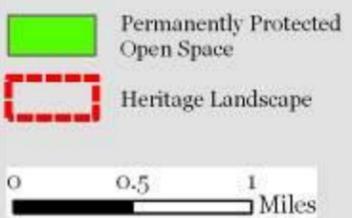
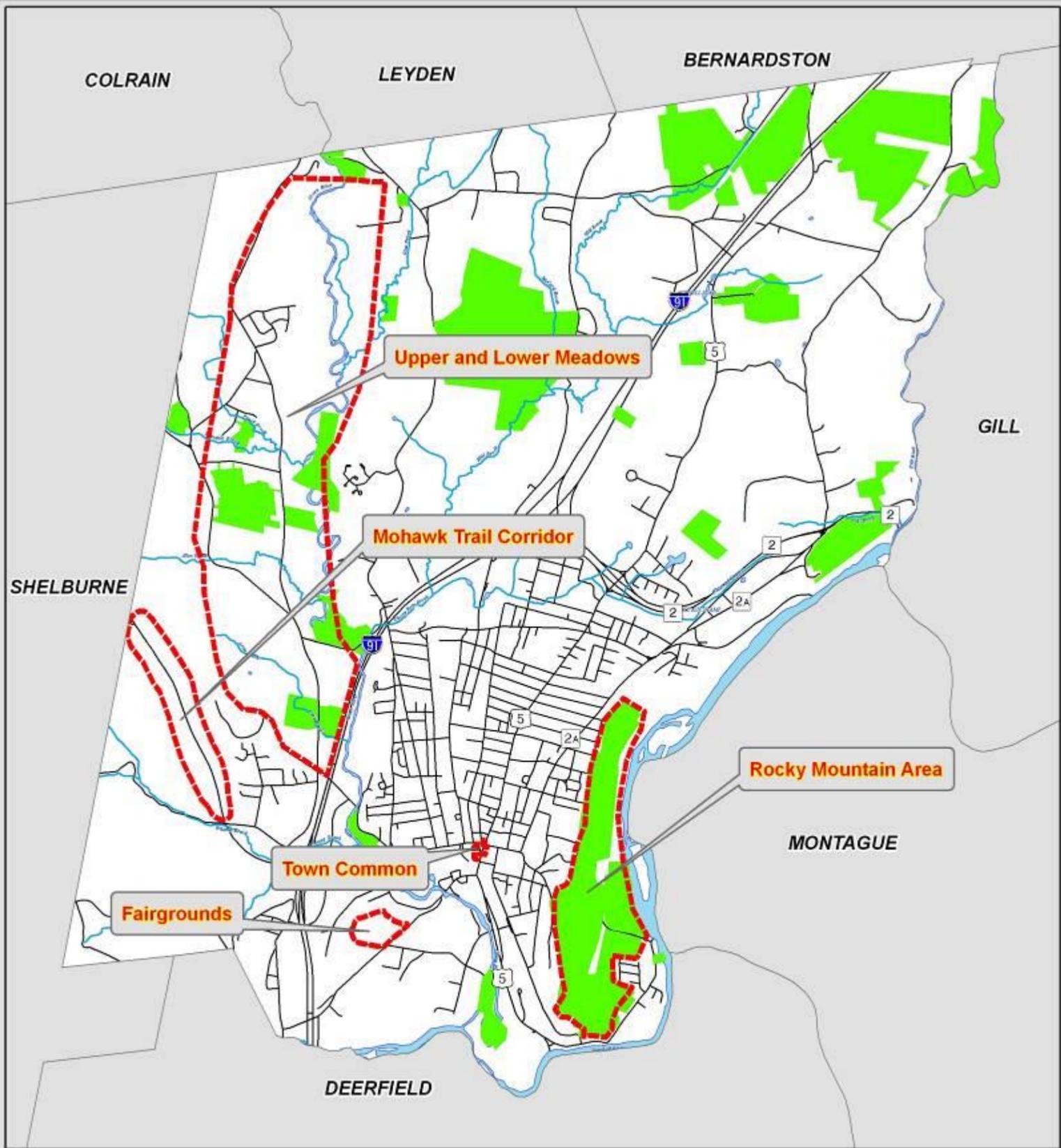
Additionally, the Massachusetts Cultural Resource Information System (MACRIS)<sup>5</sup> lists a total of 462 areas, buildings, burial grounds, objects, and structures of cultural and/or historic significance in Greenfield. Some of these include Greenfield's Main Street Historic District, Green River Cemetery, Greenfield Tap and Die Plant #1, Beacon Field, and Guiding Star Guild, to name just a few. A complete list is located in the Appendix of this document. Designation on this list does not provide any protective measures for the historic resources but designated sites may qualify for federal and state funding if damaged during a natural or manmade hazard. The Greenfield Historical Commission noted that many of the buildings on the list are located on or

---

<sup>5</sup> <http://mhc-macris.net/Results.aspx>

in the floodplain or in areas subject to occasional flooding and that much of Greenfield has a high water table, subjected building to – at the minimum – flooding of cellars.

Another resource for identifying cultural resources is the Greenfield Comprehensive Emergency Management Plan, which resides with the director of Emergency Management in the Town.



# City of Greenfield

Heritage Landscape Inventory Project,  
Franklin County



**FRANKLIN REGIONAL COUNCIL OF GOVERNMENTS**  
Main Office: 413-774-3167  
425 Main Street  
Greenfield, Massachusetts 01301



Map Sources:  
Franklin Regional Council of Governments, 2006.  
Massachusetts Executive Office of Transportation, Massachusetts Highway Department  
and the Massachusetts Executive Office of Energy and the Environment, MassGIS.

Funding:  
The Massachusetts Executive Office of Energy and the Environment  
Department of Conservation Resources.

## 3 - RISK ASSESSMENT

### Multi-Hazard Identification and Profile

---

Historical research, conversations with local officials and emergency management personnel, available hazard mapping and other weather-related databases were used to identify the hazards which are most likely to have an impact on the Town of Greenfield.

It should be noted that because different sources of data are used for various hazards, the year of most recent information available may vary from one hazard to another. In all cases the most recent information available at the time that work was done on this plan was used.

Two hazards, drought and temperature extremes, historically have not been significant hazards for Greenfield. These hazards are no more likely to occur in Greenfield than elsewhere in the state. Therefore, drought and extreme temperatures were not covered in detail in this plan, other than a summary of these two hazards, which is presented, below.<sup>6</sup> For more information on these hazards, please refer to the recently updated Massachusetts State Hazard Mitigation Plan (2013).<sup>7</sup>

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. The Commonwealth of Massachusetts is often considered a ‘water-rich’ state. Abundant precipitation results from frontal systems or storms that move across the continent and exit through the Northeast. Under normal conditions, regions across the state annually receive between 44 and 47 inches of precipitation.

There is no universal definition for extreme temperatures. The term is relative to the usual weather in the region based on climatic averages. Extreme heat, for this climatic region, is usually defined as a period of 3 or more consecutive days above 90 °F, but more generally a prolonged period of excessively hot weather, which may be accompanied by high humidity. Extreme cold, again, is 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. Massachusetts 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 that are far outside of the normal ranges for Massachusetts.

---

<sup>6</sup> Adapted from the 2010 Massachusetts State Hazard Mitigation Plan.

<sup>7</sup> <http://www.mass.gov/eopss/agencies/mema/hazard-mitigation/planning/planning-and-the-state-hazard-mitigation-plan.html>

## Floods

### *General Description*

The average annual precipitation for Greenfield and surrounding areas in northwestern Massachusetts is 44 inches.<sup>8</sup> There are three major types of storms that bring precipitation to Greenfield. Continental storms that originate from the west continually move across the region. These storms are typically low pressure systems that may be slow-moving frontal systems or more intense, fast-moving storms. The second major storm type are coastal storms; there are two kinds that bring major precipitation and wind – nor'easters and hurricanes. Nor'easters bring heavy rain, high winds, ice storms or blizzards into New England from the coast of Maine and Canada. In late summer or early fall, hurricanes may reach Massachusetts from the tropics and result in significant amounts of rainfall and wind. The third type of storm is the result of local convective action. Thunderstorms that form on warm, humid summer days can cause locally significant rainfall.

Floods are classified as either *flash floods*, which are the product of heavy, localized precipitation in a short time period over a given location or *general floods*, which are caused by precipitation over a longer time period in a particular river basin. Since the town is located at the confluence of three major rivers, Greenfield has also experienced what is known locally as *backwater flooding* due to ice jams on the Connecticut and Deerfield Rivers. There are several local factors that determine the severity of a flooding event, including: stream and river basin topography, precipitation and weather patterns, recent soil moisture conditions, amount of impervious surface area, and the degree of vegetative clearing. Floods occur more frequently and are the most costly natural hazard in the United States.

*Flash flooding* events typically occur within minutes or hours after a period of heavy precipitation, after a dam or levee failure, or from a sudden release of water from an ice jam. Most often, flash flooding is the result of a slow-moving thunderstorm or the heavy rains from a hurricane. In rural areas, flash flooding often occurs when small streams spill over their banks. However, in urbanized areas, flash flooding is often the result of clogged storm drains (leaves and other debris) and the higher amount of impervious surface area.

In contrast, *general flooding* events may last for several days. Excessive precipitation within a watershed of a stream or river can result in flooding particularly when development in the floodplain has obstructed the natural flow of the water and/or decreased the natural ability of the groundcover to absorb and retain surface water runoff (e.g., loss of wetlands and higher amounts of impervious surface area in urban areas).

A floodplain is the relatively flat, lowland area adjacent to a river, lake or stream. Floodplains serve an important function, acting like large “sponges” to absorb and slowly release floodwaters back to surface waters and groundwater. Over time, sediments that are deposited in floodplains develop into fertile, productive farmland like that found in the Connecticut River Valley. In the

---

<sup>8</sup> Massachusetts Department of Conservation and Recreation 2009 precipitation data, <http://www.mass.gov/dcr/watersupply/rainfall/index.htm>.

past, floodplain areas were also often seen as prime locations for development. Industries were located on the banks of rivers for access to hydropower. Residential and commercial development occurred in floodplains because of their scenic qualities and proximity to the water. Although periodic flooding of a floodplain area is a natural occurrence, past and current development and alteration of these areas ensures that flooding will continue to be a costly and frequent hazard.

Fluvial erosion hazard (FEH) zones are areas along rivers and streams that are susceptible to bank erosion caused by flash flooding. Any area within a mapped FEH zone is considered susceptible to bank erosion during a single severe flood or after many years of slow channel migration. While the areas of the FEH zones often overlap with areas mapped within the 100-year floodplain on Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs), the FIRMs only show areas that are likely to be inundated by floodwaters that overtop the riverbanks during a severe flood. However, much flood-related property damage and injuries is the result of bank erosion that can undermine roads, bridges, building foundations and other infrastructure. Consequently, FEH zones are sometimes outside of the 100-year floodplain shown on FIRMs. FEH zones can be mapped using fluvial geomorphic assessment data as well as historic data on past flood events. Both the FIRMs and FEH maps should be used in concert to understand and avoid both inundation and erosion hazards, respectively.<sup>9</sup> Areas of chronic erosion and flooding are shown on the Town of Greenfield Critical Facilities and Infrastructure Map on page 99.

### ***Location and Extent***

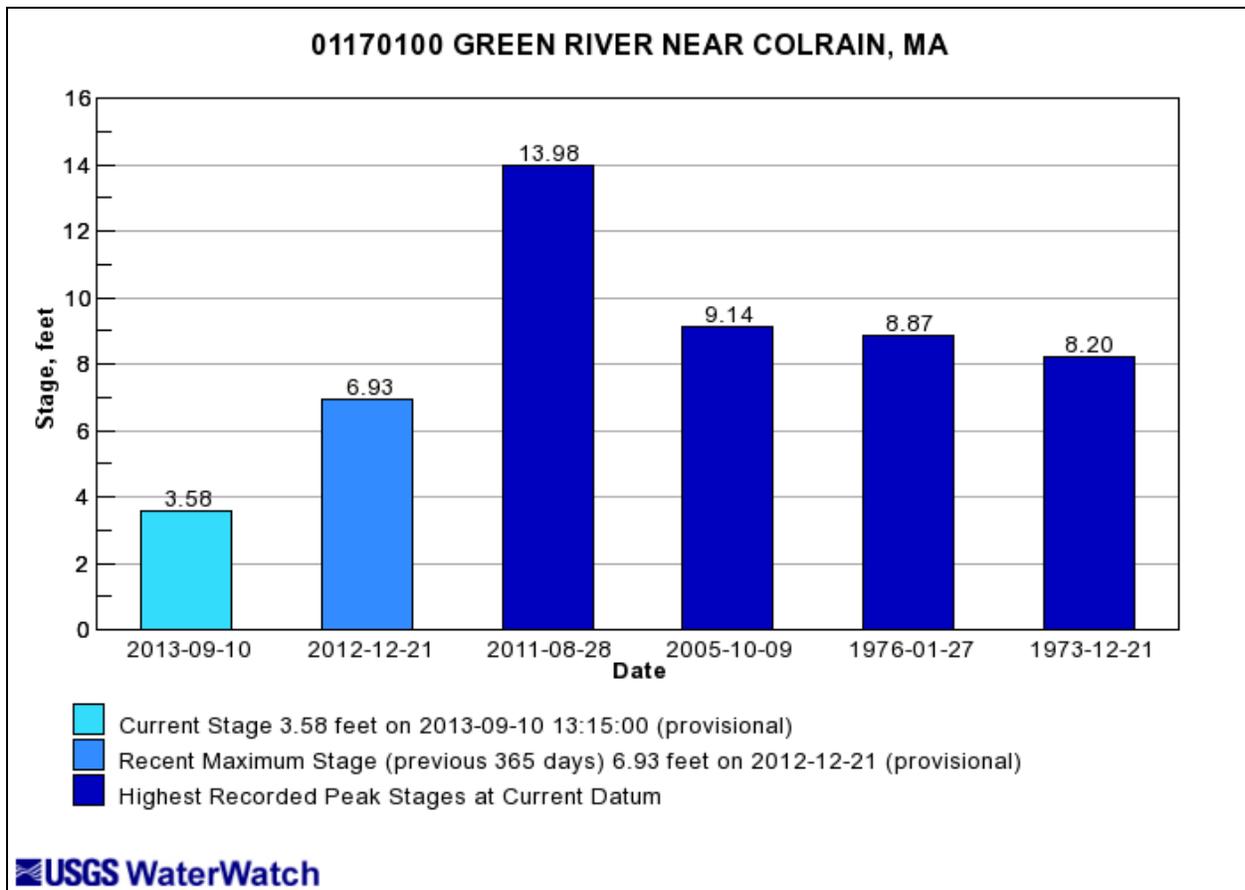
Franklin County has several major rivers and numerous tributaries which are susceptible to flood events. The major rivers in the region include the Connecticut, the Deerfield, and the Millers. Some of the tributaries to these rivers which are prone to flooding include the Green River and the Sawmill River. The Green River flows through Greenfield. Flooding poses a significant threat to life and public health and can cause severe property damage.



One river prone to flooding in Greenfield, the Green River, rushes past low-lying structures on River Street.

---

<sup>9</sup> *Ammonoosuc River Fluvial Erosion Hazard Map for Littleton, NH*. Field Geology Services, 2010.



Data from the USGS gage on the Green River near Colrain, MA is shown above. This gage is upstream of the Town of Greenfield. No flood stage data is available but the graph shows the highest recorded peak stages, which include the flooding associated with Tropical Storm Irene, the October 2005 floods and three other high flow events.

Table 3-1 shows occurrences of flooding in Franklin County since 1993 and Table 3-2 shows occurrences of flooding specific to Greenfield, both taken from NOAA data that is current through 2013.

**Table 3-1: Flood Events in Franklin County Since 1993**

| Year | # of Flood Events | Annual Property Damage | Annual Crop Damage |
|------|-------------------|------------------------|--------------------|
| 2013 | 0                 | \$0                    | \$0                |
| 2012 | 2                 | \$0                    | \$0                |
| 2011 | 8                 | \$22,275,000           | \$0                |
| 2010 | 1                 | \$150,000              | \$0                |
| 2009 | 0                 | \$0                    | \$0                |
| 2008 | 3                 | \$38,000               | \$0                |
| 2007 | 1                 | \$250,000              | \$0                |

| Year                    | # of Flood Events              | Annual Property Damage                | Annual Crop Damage                |
|-------------------------|--------------------------------|---------------------------------------|-----------------------------------|
| 2006                    | 0                              | \$0                                   | \$0                               |
| 2005                    | 5                              | \$11,435,000                          | \$0                               |
| 2004                    | 2                              | \$10,000                              | \$0                               |
| 2003                    | 1                              | \$10,000                              | \$0                               |
| 2002                    | 0                              | \$0                                   | \$0                               |
| 2001                    | 1                              | \$0                                   | \$0                               |
| 2000                    | 1                              | \$0                                   | \$0                               |
| 1999                    | 0                              | \$0                                   | \$0                               |
| 1998                    | 4                              | \$75,000                              | \$0                               |
| 1997                    | 0                              | \$0                                   | \$0                               |
| 1996                    | 11                             | \$1,800,000                           | \$0                               |
| 1995                    | 3                              | \$0                                   | \$0                               |
| 1994                    | 2                              | \$0                                   | \$0                               |
| 1993                    | 5                              | \$0                                   | \$0                               |
| <b>Total # of Years</b> | <b>Total # of Flood Events</b> | <b>Average Annual Property Damage</b> | <b>Average Annual Crop Damage</b> |
| <b>21</b>               | <b>50</b>                      | <b>\$720,860</b>                      | <b>\$0</b>                        |

Source: <http://www4.ncdc.noaa.gov>  
[http://www.ncdc.noaa.gov/stormevents/listevents.jsp?beginDate\\_mm=01&beginDate\\_dd=01&beginDate\\_yyyy=1996&endDate\\_mm=06&endDate\\_dd=30&endDate\\_yyyy=2013&eventType=%28C%29+Flood&county=FRANKLIN&zone=ALL&submitbutton=Search&statefips=25%2CMASSACHUSETTS#](http://www.ncdc.noaa.gov/stormevents/listevents.jsp?beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1996&endDate_mm=06&endDate_dd=30&endDate_yyyy=2013&eventType=%28C%29+Flood&county=FRANKLIN&zone=ALL&submitbutton=Search&statefips=25%2CMASSACHUSETTS#)

**Table 3-2: Flood Events in Greenfield Since 1993**

| Date      | Time    | Type                | Property Damage | Crop Damage | Excerpts from storm details for Greenfield only  |
|-----------|---------|---------------------|-----------------|-------------|--|
| 3/7/2011  | 2:00 PM | Flood/<br>Landslide | \$100,000       | \$0         | A water soaked ridge near the Green River Cemetery gave way resulting in a mudslide 13 inches deep that slid over Meridan and Water Streets. Three cars were buried and the mud was up to the foundations of three houses. This resulted in the evacuation of 17 people. These people were evacuated first to a shelter at Greenfield School run by the American Red Cross and then to family members houses (2 families) and a hotel (1 family) for the night while crews cleaned the mud from their houses. A portion of Meridian Street where it ends at Deerfield Road remained closed through the night of the 7th. |
| 2/13/2008 | 3:40 PM | Flood               | \$5,000         | \$0         | Several streets in Greenfield were flooded. A low pressure system developed off the Mid-Atlantic coast and moved up the east coast southeast of Nantucket producing snow, rain, and ice across Southern New England. Widespread two to four inch rainfall amounts resulted in small stream and poor drainage flooding as well as some minor river flooding. In addition, there was some minor wind damage from strong northeast winds, especially along the coast.   |

| Date      | Time     | Type                     | Property Damage | Crop Damage | Excerpts from storm details for Greenfield only  |
|-----------|----------|--------------------------|-----------------|-------------|--|
| 8/7/2008  | 5:00 PM  | Flood                    | \$8,000         | \$0         | Several thunderstorms with heavy rain moved through Greenfield resulting in flooding. Ten basements were flooded and there was some sewage backup on Silver Street. There was heavy rain associated with some of the storms.   |
| 7/18/2005 | 2:18 PM  | Flash Flood              | \$5,000         | \$0         | Slow moving (almost stationary) thunderstorms produced a significant flash flood event in north central Franklin County, Massachusetts. Two maximum rainfall totals of 9 inches were reported from Bernardston, where the worst flooding had been reported. In this town, the police station experienced flooding; and approximately 50 homes either experienced property damage or basement flooding. In addition, 30 roads were either washed out, closed or partially closed, or had culverts blown out due to flooding.                          |
| 9/18/2004 | 10:15 AM | Flash Flood              | \$10,000        | \$0         | Deerfield and Green Rivers Heavy rainfall associated with the remains of Ivan caused flash flooding in Franklin and Hampshire Counties in western Massachusetts. Storm totals of 3 to 5 inches were widely observed and caused rapid rises on the Deerfield and Green Rivers in Franklin County. The two rivers caused minor flooding of their respective low lying areas. In Hampshire County, a trained spotter reported several small brooks out of their banks which flooded low lying areas and caused minor damage. No injuries were reported. |
| 9/28/2003 | 2:00 PM  | Flash Flood              | \$10,000        | \$0         | Torrential rainfall caused flash flooding in the Connecticut River Valley. Nearly 4 inches of rain fell in a few hours, causing significant urban flooding from Agawam to Northampton. Several roads were closed in Westfield, Agawam, Chicopee, West Springfield, Easthampton, and Northampton where flood waters rose up to the doors of vehicles. In Greenfield, the Green River rose out of its banks and forced the closure of Nash's Mill Road between Colrain and Leyden Roads.   |
| 6/13/1996 | 4:00 PM  | Urban/Small Stream Flood | \$0             | \$0         |  |

Source: <http://www4.ncdc.noaa.gov/cgi-win/wcgi.dll?wwevent~ShowEvent~260419>  
[http://www.ncdc.noaa.gov/stormevents/listevents.jsp?beginDate\\_mm=01&beginDate\\_dd=01&beginDate\\_yyyy=1996&endDate\\_mm=06&endDate\\_dd=30&endDate\\_yyyy=2013&eventType=%28C%29+Flood&county=FRANKLIN&zone=ALL&submitbutton=Search&statefips=25%2CMASSACHUSETTS](http://www.ncdc.noaa.gov/stormevents/listevents.jsp?beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1996&endDate_mm=06&endDate_dd=30&endDate_yyyy=2013&eventType=%28C%29+Flood&county=FRANKLIN&zone=ALL&submitbutton=Search&statefips=25%2CMASSACHUSETTS)

### Tropical Storm Irene

The most recent – and dramatic – example of flooding occurred in the area during and after Tropical Storm Irene which struck Franklin County on August 28, 2011. Irene hit Western Massachusetts in a far more dramatic way than was anticipated. Given that the vast majority of damage caused by Irene was as a result of flooding, Irene is included in this section of the Plan.

According to the National Weather Service, up to 9.92 inches of rain fell during the storm, though amounts varied significantly across Franklin County. Rivers, streams and brooks throughout the County and parts of neighboring Hampshire County and Southern Vermont surpassed flood levels and rising water gathered debris that clogged culverts. Roads and bridges were washed out and homes and businesses were flooded and, in some cases, washed away altogether. About 140 Air National Guard members established a base of operations at nearby Mohawk Trail Regional High School in Buckland and were deployed to repair the damage left in Irene's wake. Damage to roads in Hawley was so severe that for several days travel was only possible by helicopter.



Tropical Storm Irene caused flooding to the Green River Swimming and Recreation Area

Two regional shelters were opened including one at Greenfield Middle School. At least 42,000 homes and businesses were initially without power. Governor Duval Patrick declared a state of emergency and President Barack Obama issued disaster decrees for Berkshire and Franklin Counties and FEMA opened disaster recovery assistance offices in two Franklin County towns. Despite the magnitude of damage, no deaths were reported as a result of Irene.



During flooding from Irene, the Green River's rushing waters cut new channels in the nearby land



Teams assessed damage to the Berkshire Gas Facility (left) and the Meridian Dam on the Green River (right)

Damage to Greenfield was widespread and some of the many instances are described as follows:

- Flooding caused damage to farm fields such as lost topsoil and contamination through washed up silt and trash.
- Flooding from the Green River impacted the Colrain Street Bridge area.
- Damage due to flooding was caused to the Green River Dam.
- River banks eroded downstream of the Green River Pump Station.
- A concrete retaining wall by the Leyden Glen dam on the Green River above the Eunice Williams Covered Bridge was knocked over and swept aside by flood waters. Water released from behind the wall washed away about 100 feet of the Leyden Road side of Eunice Williams Drive.
- Eunice Williams Covered Bridge knocked from one of its footings and was damaged.

- The drinking water supply pipe drawing from the Green River near Eunice Williams Covered Bridge was broken. Town is currently using alternate sources for drinking water. Drinking water quality was not impacted. Repairs to the water supply system are estimated at \$5 to \$6 as of early September 2011.
- Sewage treatment plant at the south end of Deerfield Street near the confluence of the Green and Deerfield rivers was flooded. Motors powering the pumps in the outlying pump station were destroyed. Costs for repairing the sewage plant were estimated at \$1 million and are estimated to take 18 to 24 months.
- Flooding to Colrain Street included businesses such as Davenport Trucking, whose offices were mud and silt filled. Computers and electrical wiring had to be replaced. It was estimated it would take about two months to recover from the damage. Total costs of damages were not available.
- Riverside and Greenfield Gardens apartments were evacuated and some were deemed uninhabitable due to flooding
- Interstate 91 southbound was closed in Deerfield, forcing traffic detours through Greenfield via Routes 5 and 10. Greenfield Police Department staffed detours for weeks with the highway reopening on September 5, 2011. Costs for overtime were not available at the time of writing.
- Damage occurred on Glen Road, an access route to the Town's water supply reservoir.
- The Green River Swimming and Recreation Area on Nash's Mill Road was closed for the season due to flooding and damages to buildings and structures including broken fences and a washed out bike path. The picnic areas, pavilions and lawns were covered with silt and sludge.
- Deerfield Street was flooded with sludge with houses and businesses impacted.
- A water impoundment wall on the Green River Dam was breached and is being repaired



After Irene, floodwaters begin to recede near the Wastewater Treatment Plant and golf course.

On September 22, 2011, the Franklin Regional Council of Governments released early estimates on storm damages and costs due to the impacts from Irene. FEMA's preliminary damage assessment totals \$27, 713,911 for municipal public damage. This number does not include state infrastructure damage.



Floodwaters from Irene were forceful enough to move large vehicles and structures.

Greenfield Department of Public Works provided cost estimates for public works and infrastructure-related projects that resulted from Tropical Storm Irene damage. As shown in Table 3-2A, estimated costs as of October 4, 2011 are \$12,495,354, with costs potentially rising even higher. In addition to DPW costs, other costs to the Town include those for Police and Fire as well as others such as the Board of Health and the building inspector. According to the DPW, two Action Items stemming from Irene include fortifying the Wastewater Treatment Plant to withstand a 144 foot elevation flooding (currently at elevation 140 feet) and repairing Glen Road and its drainage, essential for access to the Town's water supply reservoir.



Greenfield's Wastewater Treatment Plant was flood-proofed to elevation 140 feet but Irene's flooding topped elevation 142 ½ feet.

Table 3-2A: Greenfield DPW Irene Cost Estimates/Progress as of 10/4/11

| <b>Project:</b>  |                     |               | <b>Fund source</b> |   | <b>Status</b>       |
|--|---------------------|---------------|--------------------|---|---------------------|
| Green River Dam  | \$6,500,000         | estimate      | WF                 | Tighe & Bond retained 8/29; repair to start with cofferdam installation 10/11     | In progress         |
| Erosion downstream of Green River Pump Station                   | \$80,000            | estimate      | WF                 | Mitchell Construction apparent low bidder, waiting for quotes for rock            | work to start 10/11 |
| 8 in sewer crossing under Green River @2A bridge breeched        | \$1,300,000         | estimate      | SF                 | AECOM (nee Metcalf & Eddy) retained 8/30 ; surveying not complete due to hi water | In progress         |
| Bypass pumping at 2A bridge to stop raw sewage to river          | \$35,000            | Quote (8 mo)  | SF                 | Baker Pumps (equipment and setup) Set up & running 9/12/11                        | In operation        |
| Maple Brook (akA Solon St) Inceptor repair                       | \$176,354           | final invoice | SF                 | Davenport Construction retained 8/30; work complete 9/30/11                       | Done                |
| Water Pollution Control Plant                                    | \$750,000           | estimate      | SF                 | CRS, Aaron Assoc, AECOM and Elm Elec retained 8/29                                | In progress         |
| Misc road, bike path erosion (including Mead St& Leyden Glen Rd) | \$3,500             | estimate      | GF                 | Town doing work   | 75% done            |
| Removal covered bridge from river                                | \$78,000            | quoted price  | GF                 | RFQ issued 9/15/11; Work awarded to Northern Construction 10/4/11                 | In progress         |
| Replacement of bridge & road at Eunice Williams Drive            | \$3,000,000         | estimate      | GF                 | RFQ for engineering services to be let Nov 2011                                   | In progress         |
| Remove debris from Petty Plain Foot bridge/repair of bridge      | \$5,000             | estimate      | GF                 | Davenport retained 8/29; waiting for quotes on bridge repair                      | 25% complete        |
| Swimming Pool on Green River-Grounds, fence bldg &bldg contents  | \$65,000            | estimate      | GF                 | Elm Elec retained 8/29  | In progress         |
| North and southeasterly retaining walls at Swimming pool         | \$500,000           | estimate      | GF                 | Bid will be let in winter for work in spring (water too high now)                 | In progress         |
| Clean up of Green River Park, reseeding                          | \$2,500             | estimate      | GF                 | Work will be done by town crews   | In progress         |
| <b>Total</b>   | <b>\$12,495,354</b> |               |                    |   |                     |

Prior to Tropical Storm Irene, other recent examples of significant flooding in Greenfield occurred between October 8th and October 15th of 2005. During this time, the Connecticut River Valley received between 12-22 inches of rain from Tropical Storm Tammy and a subtropical depression. Greenfield experienced 100 year flood events in many areas throughout town. The majority of the flooding occurred along the Green River from Nash's Mill Road south to the mouth of the Deerfield River. Greenfield's Green River Recreational Swimming Area was severely affected with flood waters damaging the bath house and the public beach.

Areas of chronic localized flooding include:

- Green River Cemetery, where water has periodically pooled and then caused mudslides down hill.
- Factory Hollow Road along the Fall River has chronic flooding.
- Nash's Mill Road floods annually.
- The Meadow's Golf Course floods annually.
- Hastings, Heywood and Riddell Streets neighborhoods flood during heavy rain events when the Maple Brook Culvert backs up.
- Green River Park floods every few years.
- Green and Cooke Streets and Greenway Lane – this neighborhood floods during heavy rain events.



Greenfield mobile homes flooded in 2005. Courtesy of MassLive.

## Severe Winter Storms

### *General Description*

Severe winter storms can pose a significant risk to property and human life because the rain, freezing rain, ice, snow, cold temperatures and wind associated with these storms can disrupt utility service, phone service and make roadways extremely hazardous. Severe winter storms can be deceptive killers. The types of deaths that can occur as a result of a severe winter storm include: traffic accidents on icy or snow-covered roads, heart attacks while shoveling snow, and hypothermia from prolonged exposure to cold temperatures. Infrastructure and other property are also at risk from severe winter storms and the associated flooding that can occur following heavy snow melt. Power and telephone lines, trees, and telecommunications structures can be damaged by ice, wind, snow, and falling trees and tree limbs. Icy road conditions or roads blocked by fallen trees may make it difficult to respond promptly to medical emergencies or fires. Prolonged, extremely cold temperatures can also cause inadequately insulated potable water lines and fire sprinkler pipes to rupture and disrupt the delivery of drinking water and cause extensive property damage.

Severe winter storms can include blizzards, heavy snow, sleet, freezing rain and ice storms. A blizzard is a severe snowstorm characterized by strong winds and low temperatures. The difference between a blizzard and a snowstorm is the strength of the wind. To be a blizzard, a snow storm must have sustained winds or frequent gusts that are greater than or equal to 56 km/h (35 mph) with blowing or drifting snow which reduces visibility to 400 meters or a quarter mile or less and must last for a prolonged period of time — typically three hours or more.<sup>10</sup> Snowfall amounts do not have to be significant. A severe blizzard has winds over 72 km/h (45 mph), near zero visibility, and temperatures of  $-12^{\circ}\text{C}$  ( $10^{\circ}\text{F}$ ) or lower. A ground blizzard has snowdrifts and blowing snow near the ground, but no falling snow.<sup>11</sup> Blizzards can bring near-whiteout conditions, and can paralyze regions for days at a time, particularly where snowfall is unusual or rare. Freezing Rain is rain that falls as a liquid but freezes into glaze upon contact with the ground.<sup>12</sup> Heavy Snow generally means snowfall accumulating to 4" or more in depth in 12 hours or less; or snowfall accumulating to 6" or more in depth in 24 hours or less.<sup>13</sup> Sleet is defined as pellets of ice composed of frozen or mostly frozen raindrops or refrozen partially melted snowflakes. These pellets of ice usually bounce after hitting the ground or other hard surfaces. Heavy sleet is a relatively rare event defined as an accumulation of ice pellets covering the ground to a depth of approximately  $\frac{1}{2}$ " or more.<sup>14</sup> The term ice storm is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely

---

<sup>10</sup> <http://w1.weather.gov/glossary/index.php?letter=b>

<sup>11</sup> <http://www.britannica.com/EBchecked/topic/69478/blizzard>

<sup>12</sup> <http://w1.weather.gov/glossary/index.php?letter=f>

<sup>13</sup> <http://w1.weather.gov/glossary/index.php?letter=h>

<sup>14</sup> <http://w1.weather.gov/glossary/index.php?letter=s>

dangerous. Significant ice accumulations are usually accumulations of approximately ¼" or greater.<sup>15</sup>

***Location and Extent***

Franklin County regularly experiences severe winter storm events between the months of December and April. According to the National Climatic Data Center (NCDC), there have been a total of 115 snow and ice events reported in Franklin County between 1993 and 2013, including heavy snow, snow, ice storms, snow squalls, freezing rain and winter storms.<sup>16</sup> The NCDC web site has more detailed information about each of the listed storms. Eleven out of the 115 snow and ice events that impacted Franklin County (as well as other areas of Massachusetts) resulted in Presidential Disaster Declarations or Emergency Declarations, which then made the state, residents and businesses eligible for federal disaster relief funds. Table 3-3 lists the twelve recent severe winter disasters and other events that have led to Presidential Disaster or Emergency Declarations in Massachusetts.

**Table 3-3: Presidential Disaster Declarations Impacting Franklin County, 1993-2013**

| <b>Disaster Name</b>                      | <b>Date of Event</b> | <b>Declared Areas</b>   | <b>Disaster #/ Type of Assistance</b> | <b>Federal Share Disbursed</b> |
|---|----------------------|---|---------------------------------------|--------------------------------|
| Blizzards, High Winds and Record Snowfall | March 1993           | All 14 Counties   | FEMA-3103-EM (PA)                     | \$1,284,873                    |
| Blizzard                                  | January 1996         | All 14 Counties   | FEMA-1090-EM (PA)                     | \$16,177,860                   |
| Snowstorm                                 | March 2001           | Counties of Berkshire, Essex, Franklin, Hampshire, Middlesex, Norfolk, and Worcester. The cost share is 75% federal and 25% local.    | FEMA-3165-EM (PA)                     | \$21,065,441                   |
| Snowstorm                                 | February 2003        | All 14 Counties. The cost share is 75% federal and 25% local.   | FEMA-3175-EM (PA)                     | \$28,868,815                   |
| Snowstorm                                 | December 2003        | Counties of Barnstable, Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, Suffolk, and Worcester | FEMA-3191-EM (PA)                     | \$35,683,865                   |
| Snowstorm                                 | January              | All 14 Counties   | FEMA-3201-EM                          | \$49,945,087                   |

<sup>15</sup> <http://w1.weather.gov/glossary/index.php?letter=i>

<sup>16</sup> <http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms>

| Disaster Name                               | Date of Event      | Declared Areas   | Disaster #/ Type of Assistance | Federal Share Disbursed  |
|---|--------------------|--|--------------------------------|--------------------------|
|   | 2005               |  | (PA)                           |                          |
| Severe Winter Storm                         | December 2008      | Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Suffolk, and Worcester *(Figure as of 9/8/2009)        | FEMA-3296-EM-MA                | \$66,509,713             |
| Severe Storms and Flooding                  | December 2008      | 5 counties (Berkshire, Franklin, Hampden, Hampshire, and Worcester Counties)   | FEMA-1813-DR-MA(PA)            | \$32,058,172             |
| Severe Winter Storm and Snowstorm           | January 2011       | Berkshire, Essex, Hampshire, Middlesex, Norfolk, Suffolk and Hampden Counties  | FEMA-1959-DR (PA)              | \$1,050,102              |
| Tropical Storm Irene                        | August 27-29, 2011 | Berkshire, Franklin, Hampden, Hampshire, Norfolk, Bristol, Plymouth, Barnstable, Martha's Vineyard, and Nantucket Counties | FEMA-4028-DR                   | \$26,620,515             |
| Severe Storm and Snowstorm                  | October 2011       | Berkshire, Franklin, Hampden, Hampshire, Middlesex, and Worcester Counties   | FEMA-4051-DR (PA)              | \$71,927,443 (obligated) |
| Severe Winter Storm, Snowstorm and Flooding | February 8-9, 2013 | All 14 Counties  | FEMA-DR-4110                   | \$16,474,989 (obligated) |

Notes: Public Assistance (PA) Project grants. Supplemental disaster assistance to states, local governments, certain private non-profit organizations resulting from declared major disasters or emergencies. <http://www.fema.gov/disasters/grid/year> Accessed September 16, 2013.

Although ice storms occur much less frequently than snow storms (4 out of 115 in the NCDC database), the effects can be devastating. On December 11, 2008, Franklin County residents awoke to a landscape coated with ice. Half an inch of ice accumulated on exposed surfaces across Franklin County. This major ice storm affected interior Massachusetts and southern New Hampshire as well as much of northern New England. The ice buildup on exposed surfaces combined with breezy conditions resulted in numerous downed trees, branches, and power lines, which resulted in widespread power outages. More than 300,000 customers were reportedly without power in Massachusetts and an additional 300,000 were without power in the state of New Hampshire.



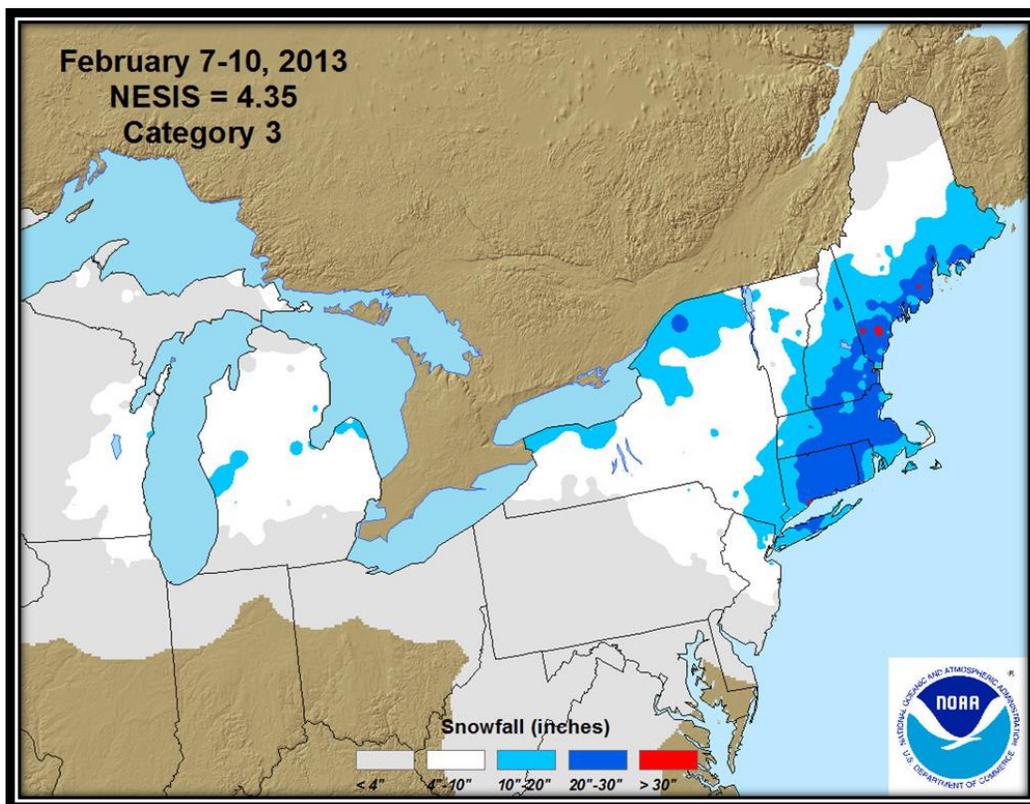
The ice storm of 2008 caused power outages in neighboring towns due to downed trees and power lines, as shown in this photo taken in Ashfield. *Photo courtesy of WMECO.*

Because of the breadth of this December 2008 storm (from Pennsylvania to Maine), extra crews to reinstate power were harder to come by. Power crews from states as far away as South Carolina, as well as local National Guard teams, were called in to help with power restoration and clean up. While most people had their power restored within a week, others were still without power at Christmas (nearly 2 weeks later). During this period, temperatures were mostly below normal and at least one major snowstorm affected the same area. At the time of the December 19th snowstorm, which dumped 7 – 12 inches of snow in eastern Franklin County and 9 – 14 inches of snow in western part of the county, over 100,000 customers were still without power in the two states combined. Two days later, on December 21<sup>st</sup>, 5 – 7 inches of new snow blanketed eastern Franklin County.

Greenfield was fortunate; the storm did not cause power outages in town. There was some property damage from the winds that required clean up and disposal of debris. However, because Greenfield did not lose power it became a refuge. Many residents from around Franklin County relied on the hospitality of Greenfield's hotels, motels and inns and restaurants, cafes, and coffee shops to weather the storm and power outages. More data and information related to Severe Winter Storms is located in the Vulnerability Assessment section of this plan.

Not all severe winter storms result in Presidential Disaster Declarations or Emergency Declarations although damage to property and infrastructure, fatalities, and interruptions to critical services and businesses can occur as a result of these events. The Northeast Snowfall

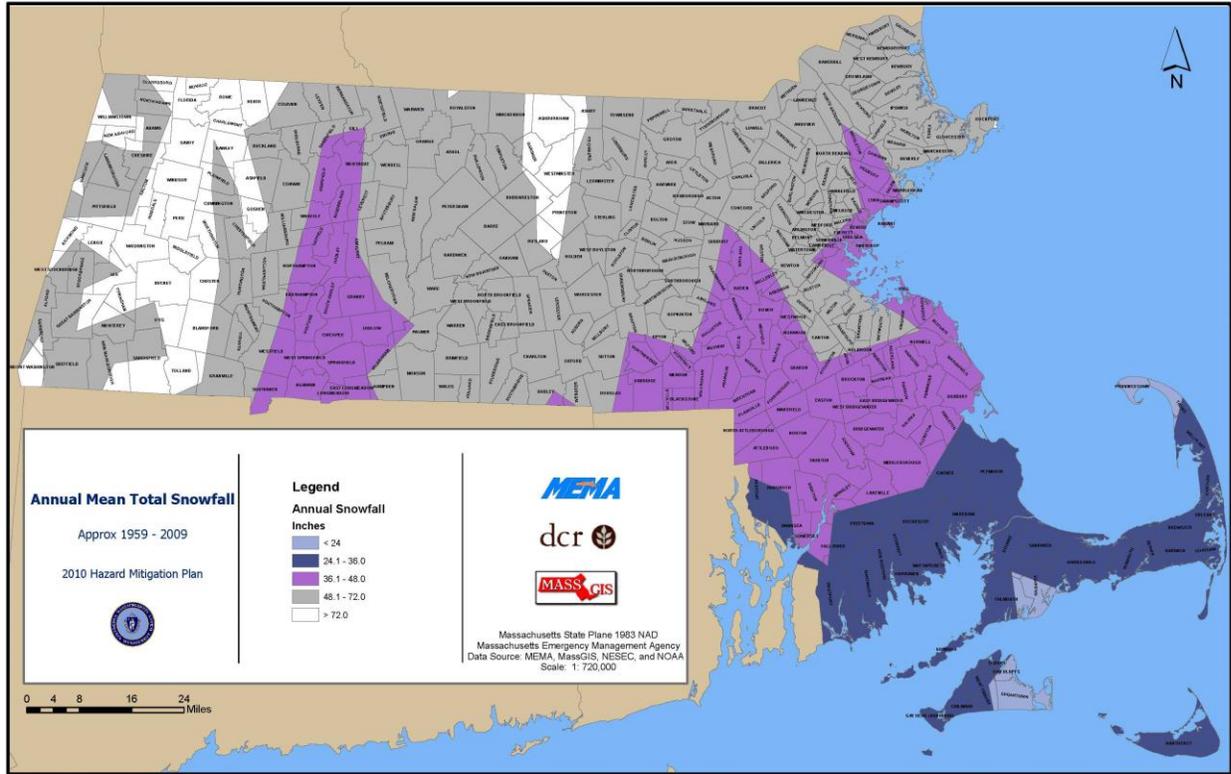
Impact Scale (NESIS) developed by Paul Kocin and Louis Uccellini of the National Weather Service (Kocin and Uccellini, 2004) characterizes and ranks Northeast snowstorms that have a large geographic impact. NESIS has five categories: Extreme, Crippling, Major, Significant, and Notable. The index differs from other meteorological indices in that it uses population information in addition to meteorological measurements. 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. Thus NESIS gives an indication of a storm's societal impacts. This scale was developed because of the impact Northeast snowstorms can have on the rest of the country in terms of transportation and economic impact.<sup>17</sup> The NESIS database includes 47 storms, many of which have dumped at least 10-20 inches on Franklin County towns. The database also includes maps of the affected areas.<sup>18</sup> Because of the rural nature of the county, a storm classified as Extreme or Crippling for the affected area may not have had as devastating an impact on the towns in Franklin County. However, the severity of these storms and their impact on Franklin County, neighboring counties and other New England states may affect the availability of disaster relief services.



<sup>17</sup> <http://www.ncdc.noaa.gov/snow-and-ice/nesis.php>

<sup>18</sup> <http://www.ncdc.noaa.gov/snow-and-ice/rsi/nesis>

The entire Town of Greenfield is at risk to the impacts of severe winter storms. The 2010 Massachusetts State Hazard Mitigation Plan includes a map of Mean Annual Snowfall for the period 1959-2009. This map shows that many of the towns in western Franklin County receive the greatest amount of annual snowfall in the state. The mean annual snowfall for the eastern portion of the Town of Greenfield in the Connecticut River valley is 36.1-48 inches while the higher elevations in the western part of the town receive 48.1-72 inches.



## Hurricanes and Tropical Storms

### General Description

Hurricanes are violent rainstorms associated with tropical storms with strong winds that can reach speeds of up to 200 miles per hour. Hurricanes generally occur between June and November and can result in flooding and wind damage to structures and above-ground utilities. August, September, and the first half of October are when most hurricanes occur in New England. The Saffir-Simpson Hurricane Wind Scale is a 1 to 5 rating based on a hurricane's sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous, however, and require

preventative measures.<sup>19</sup> Tropical storms, defined as having sustained winds from 34-73 mph, have also resulted in high winds and damages in Franklin County.

| Category     | Sustained Winds   | Types of Damage Due to Hurricane Winds   |
|--------------|---|--|
| 1            | 74-95 mph<br>64-82 kt<br>119-153 km/h                       | <b>Very dangerous winds will produce some damage:</b> Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.  |
| 2            | 96-110 mph<br>83-95 kt<br>154-177 km/h                      | <b>Extremely dangerous winds will cause extensive damage:</b> Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.  |
| 3<br>(major) | 111-129 mph<br>96-112 kt<br>178-208 km/h                    | <b>Devastating damage will occur:</b> Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.   |
| 4<br>(major) | 130-156 mph<br>113-136 kt<br>209-251 km/h                   | <b>Catastrophic damage will occur:</b> Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months. |
| 5<br>(major) | 157 mph or higher<br>137 kt or higher<br>252 km/h or higher | <b>Catastrophic damage will occur:</b> A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.  |

Source: <http://www.nhc.noaa.gov/aboutsshws.php>

### *Location and Extent*

In Massachusetts, major hurricanes occurred in 1904, 1938, 1954, 1955, 1960, 1976, 1985 and 1991.<sup>20</sup> The Great New England Hurricane of 1938, a Category 3 hurricane which occurred on September 21, 1938, was one of the most destructive and powerful storms ever to strike Southern New England. Sustained hurricane force winds occurred throughout most of Southern New England. Extensive damage occurred to roofs, trees and crops. Widespread power outages occurred, which in some areas lasted several weeks. Rainfall from this hurricane resulted in severe river flooding across sections of Massachusetts and Connecticut. The combined effects from a frontal system several days earlier and the hurricane produced rainfall of 10 to 17 inches across most of the Connecticut River Valley. This resulted in some of the worst flooding ever recorded in this area.<sup>21</sup> The last hurricane to make landfall in New England was Hurricane Bob, a weak category 2 hurricane, in August 1991. In Franklin County, Hurricane Bob caused

---

<sup>19</sup> National Weather Service National Hurricane Center:

<http://www.nhc.noaa.gov/aboutsshws.php> .

<sup>20</sup> <http://www.nhc.noaa.gov/aboutsshws.php>

<sup>21</sup> <http://www.erh.noaa.gov/box/hurricane/hurricane1938.shtml>

roughly \$5,555,556 in property and crop damages.<sup>22</sup> Between 1990 and 2008, 16 tropical storms impacted the County, causing almost \$600,000 in property damages.<sup>23</sup> Tropical Storm Irene hit Franklin County on August 28, 2011, resulting in over \$22 million in property damages from flooding and an additional \$3,050,000 in other, mostly wind-related, damage.<sup>24</sup> The entire Town of Greenfield is at risk to the effects of hurricanes and tropical storms.

Table 3-4 shows the occurrences of hurricanes and tropical storms in Franklin County in the last 24 years. This is the most current data available from the SHELDUS data base (accessed December 2013).

**Table 3-4: Damage from Hurricanes and Tropical Storms in Franklin County.**

| Begin Date | End Date   | Injuries | Fatalities | Property Damage | Crop Damage | Remarks         |
|------------|------------|----------|------------|-----------------|-------------|-----------------|
| 10/4/1990  | 10/4/1990  | 0        | 0          | \$3,571         | \$0         | High Winds      |
| 10/18/1990 | 10/19/1990 | 0.07     | 0          | \$3,571         | \$0         | High Winds      |
| 8/19/1991  | 8/19/1991  | 0.22     | 0          | \$ 5,555,556    | \$ 555,556  | Wind            |
| 12/23/1994 | 12/24/1994 | 0        | 0          | \$35,714        | \$0         | High Winds      |
| 10/28/1995 | 10/28/1995 | 0.2      | 0          | \$0             | \$0         | HIGH WINDS      |
| 10/1/1998  | 10/1/1998  | 0        | 0          | \$62,500        | \$0         | Strong Wind     |
| 12/1/1998  | 12/1/1998  | 0.23     | 0          | \$769           | \$0         | Strong Wind     |
| 3/22/1999  | 3/22/1999  | 0        | 0          | \$7,692         | \$0         | Strong Wind     |
| 10/15/2003 | 10/15/2003 | 0        | 0          | \$35,714        | \$0         |                 |
| 11/13/2003 | 11/14/2003 | 0        | 0          | \$91,667        | \$0         |                 |
| 12/1/2004  | 12/1/2004  | 0        | 0          | \$37,778        | \$0         | High Wind       |
| 9/29/2005  | 9/29/2005  | 0        | 0          | \$33,889        | \$0         | High Wind       |
| 1/15/2006  | 1/15/2006  | 0        | 0          | \$8,125         | \$0         | Strong Wind     |
| 2/17/2006  | 2/17/2006  | 0.33     | 0.11       | \$211,111       | \$0         | High Wind (G68) |
| 10/20/2006 | 10/20/2006 | 0.2      | 0          | \$43,000        | \$0         | High Wind (G50) |
| 10/29/2006 | 10/29/2006 | 0        | 0          | \$12,625        | \$0         | High Wind (G53) |
| 12/1/2006  | 12/1/2006  | 0        | 0          | \$3,000         | \$0         | High Wind (G55) |
| 8/28/2011  | 8/29/2011  | 0        | 0          | \$3,050,000     | \$0         | High Wind       |

Source: SHELDUS Database. Accessed December 2013. [www.sheldus.org](http://www.sheldus.org)

<sup>22</sup> Spatial Hazard Events and Losses Database (SHELDUS), <http://webra.cas.sc.edu/hvri/>

<sup>23</sup> Ibid.

<sup>24</sup> Hazards & Vulnerability Research Institute (2013). The Spatial Hazard Events and Losses Database for the United States, Version 12.0 [Online Database]. Columbia, SC: University of South Carolina. Available from <http://www.sheldus.org>

# Tornados

## General Description

Tornados are swirling columns of air that typically form in the spring and summer during severe thunderstorm events. In a relatively short period of time and with little or no advance warning, a tornado can attain rotational wind speeds in excess of 250 miles per hour and can cause severe devastation along a path that ranges from a few dozen yards to over a mile in width. The path of a tornado may be hard to predict because they can stall or change direction abruptly. Within Massachusetts, tornados have occurred most frequently in Worcester County and in communities west of Worcester. High wind speeds, hail, and debris generated by tornados can result in loss of life, downed trees and power lines, and damage to structures and other personal property (cars, etc.).

## Location and Extent

The Enhanced Fujita Scale, implemented in February 2007, is used by meteorologists to rate tornado damage on a scale from EF0 to EF5. The EF Scale incorporates more damage indicators and degrees of damage than the original Fujita Scale, allowing more detailed analysis and better correlation between damage and wind speed.

Since 1996, three tornados have been reported in Franklin County, in the towns of Heath (1997), Charlemont (1997), and Wendell (2006). See Table 3-4. The July 2006 tornado in Wendell was rated F2 (Strong) on the Fujita Scale with winds estimated near 155 mph.

“Gustnado” is a slang term for a short-lived, ground-based, shallow, vortex that develops on a gust front associated with either thunderstorms or showers. Gustnadoes have been known to cause damage in Franklin County. In 2009, a gustnado destroyed a tobacco barn and downed trees in the neighboring town of Sunderland. According to NOAA, a gustnado may only extend to 30 to 300 feet above the ground with no apparent connection to the convective cloud above. They may be accompanied by rain, but usually are 'wispy', or only visible as a debris cloud or dust whirl at or near the ground. Wind speeds can reach 60 to 80 mph, resulting in significant damage, similar to that of a F0 or F1 tornado. However, gustnadoes are not considered to be a tornado, and

in some cases, it may be difficult to distinguish a gustnado from a tornado. Gustnadoes are not associated with storm-scale rotation (i.e. mesocyclones) that is involved with true tornados; they

|   |  |
|---|--|
|  | F-0: (Light Damage) Chimneys are damaged, tree branches are broken, shallow-rooted trees are toppled.  |
|  | F-1: (Moderate Damage) Roof surfaces are peeled off, windows are broken, some tree trunks are snapped, unanchored manufactured homes are overturned, attached garages may be destroyed.            |
|  | F-2: (Considerable Damage) Roof structures are damaged, manufactured homes are destroyed, debris becomes airborne (missiles are generated), large trees are snapped or uprooted.                   |
|  | F-3: (Severe Damage) Roofs and some walls are torn from structures, some small buildings are destroyed, non-reinforced masonry buildings are destroyed, most trees in forest are uprooted.         |
|  | F-4: (Devastating Damage) Well-constructed houses are destroyed, some structures are lifted from foundations and blown some distance, cars are blown some distance, large debris becomes airborne. |
|  | F-5: (Incredible Damage) Strong frame houses are lifted from foundations, reinforced concrete structures are damaged, automobile-sized debris becomes airborne, trees are completely debarked.     |

are more likely to be associated visually with a shelf cloud that is found on the forward side of a thunderstorm.

On June 1, 2011, a tornado ripped through western and central Massachusetts, killing one person and injuring four others. In an area where tornados are rare, this event was a reminder that tornados do, in fact, impact the region. The fearsome storm downed trees, ripped roofs from hundreds of homes, and damaged many historic properties. On June 15, President Obama signed a disaster declaration for Hampden and Worcester counties which provided federal funds for affected residents and properties.

Preservation groups – including Preservation Massachusetts and the Springfield Preservation Trust – have assisted hardest hit communities, especially Springfield and Monson. In part, these preservation groups have helped to inventory properties and to encourage towns not to rush to demolish historic structures. The groups also offered a list of resources properties owners can consult to assist them in making decisions about repairing historic properties. MEMA also conducted a briefing for historic properties owners and encouraged representatives of Historical Commissions, Historical Societies, libraries, museums, and other non-profit organizations dedicated to preserving historic structures to communicate with town officials and FEMA and MEMA staff throughout the disaster recovery process.



Historic properties in Monson (left) and Springfield were hard hit by a June 1, 2011 tornado.

Prior to the June 2011 tornado, the most recent data on tornados is from the NOAA Database, Table 3-5, indicating 3 tornados that touched down in Franklin County since 1997. According to the NOAA database, no tornados have been observed directly in Greenfield, however, on July 11, 1958, a tornado was reported in nearby Erving and was ranked F2 (Significant Tornado) on the Fujita Scale of Tornado Intensity. The tornado touched down on the Connecticut River in an uninhabited area near Warner Road in Erving. The extent of damage it caused is unknown. A tornado could touch down at any location in the Town of Greenfield.

**Table 3-5: Tornado Events in Franklin County, 1997-2013**

| Date     | Location   | Hazard Type | Injuries | Fatalities | Property Damage | Crop Damage | Remarks |
|----------|------------|-------------|----------|------------|-----------------|-------------|---------|
| 7/3/1997 | Heath      | Tornado     | 0        | 0          | \$ 50,000       | \$0         |         |
| 7/3/1997 | Charlemont | Tornado     | 0        | 0          | \$ 50,000       | \$0         |         |

| Date      | Location | Hazard Type | Injuries | Fatalities | Property Damage | Crop Damage | Remarks      |
|-----------|----------|-------------|----------|------------|-----------------|-------------|--------------|
| 7/11/2006 | Wendell  | Tornado     | 0        | 0          | \$ 200,000      | \$0         | Tornado (F2) |

Source: NOAA National Climate Data Center

[http://www.ncdc.noaa.gov/stormevents/listevents.jsp?beginDate\\_mm=01&beginDate\\_dd=01&beginDate\\_yyyy=1996&endDate\\_mm=08&endDate\\_dd=31&endDate\\_yyyy=2013&eventType=%28C%29+Tornado&county=FRANKLIN&zone=ALL&submitButton=Search&statefips=25%2CMASSACHUSETTS](http://www.ncdc.noaa.gov/stormevents/listevents.jsp?beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1996&endDate_mm=08&endDate_dd=31&endDate_yyyy=2013&eventType=%28C%29+Tornado&county=FRANKLIN&zone=ALL&submitButton=Search&statefips=25%2CMASSACHUSETTS)

## Microbursts (Includes Thunderstorms and High Wind-Related Events)

### *General Description*

The category Microbursts includes thunderstorm events, and associated storm effects including wind storms, hail and lightning. Microbursts can often cause tornado-like damage and can be mistaken for tornadoes. In contrast to the upward rush of air in a tornado, air blasts rapidly downward from thunderstorms to create microbursts. Thunderstorms bring strong winds, rain and, at times, hail, potentially causing damage to property, crops and utilities and injuries or deaths to residents. Persistent rain can also cause flooding.

Damaging winds due to severe thunderstorms and microbursts are common in western Massachusetts and can cause significant damage. The National Weather Service defines a severe thunderstorm as having large hail, at least 3/4 inches (0.75 inches) in diameter, and/or damaging winds, at least 58 mph, or 50 knots.<sup>25</sup> A microburst is a downdraft (sinking air) in a thunderstorm that is less than 2.5 miles in scale. Some microbursts can pose a threat to life and property, but all microbursts pose a significant threat to aviation. Although microbursts are not as widely recognized as tornados, they can cause comparable, and in some cases, worse damage than some tornados produce. In fact, wind speeds as high as 150 mph are possible in extreme microburst cases. There are a handful of factors that cause microbursts to develop, including mid-level dry air entrainment, cooling beneath the thunderstorm cloud base, sublimation (occurs when the cloud base is above the freezing level), and the existence of rain and/or hail within the thunderstorm (i.e. precipitation loading).<sup>26</sup>

### *Location and Extent*

In July of 1994, a brief microburst in Greenfield caused a state disaster declaration and in nearly \$60 K of Public Assistance Project Grants to aid in storm recovery. A more recent microburst event in Greenfield, packed quite a punch. On May 26, 2010 as a result of being pummeled by storms that ripped through the region, Greenfield declared a state of emergency. All public schools were closed and many roads were closed to all but emergency vehicles. More than 100 reports of downed trees, utility poles, and wires were received. The storms left more than 27,000 Western Massachusetts Electric Co. customers in the region without power.<sup>27</sup> Assessment by the Greenfield DPW of total costs of the storm to the Town of Greenfield is approximately \$98,000

<sup>25</sup> <http://www.erh.noaa.gov/box/sevwxdef.html>

<sup>26</sup> <http://www.srh.noaa.gov/ama/?n=microbursts>

<sup>27</sup> [http://www.masslive.com/news/index.ssf/2010/05/storms\\_force\\_greenfield\\_to\\_dec.html](http://www.masslive.com/news/index.ssf/2010/05/storms_force_greenfield_to_dec.html)

while costs to private home owners are estimated to be about \$150,000, see Table 3-38 in the Vulnerability Assessment section of this plan for more information.



© 2010 The Republican Company. All rights reserved. Used with permission.

Damage such as this seen in Greenfield was common in the aftermath of the 2010 microburst.

Table 3-6 shows data supplied by the National Oceanic and Atmospheric Administration’s (NOAA) National Climatic Data Center for high wind events in Franklin County between 1993 and 2013. A “high wind” event is defined by NOAA as one with sustained wind speeds of 40 mph or greater lasting for 1 hour or longer, or winds of 58 mph or greater for any duration.

**Table 3-6: High Wind Events in Franklin County, 1993-2013<sup>28</sup>**

| Year | # of High Wind Events | Annual Property Damage | Annual Crop Damage |
|------|-----------------------|------------------------|--------------------|
| 2013 | 0                     | \$0                    | \$0                |
| 2012 | 0                     | \$0                    | \$0                |
| 2011 | 0                     | \$0                    | \$0                |
| 2010 | 0                     | \$0                    | \$0                |
| 2009 | 0                     | \$0                    | \$0                |

<sup>28</sup> The NOAA database was accessed on November 17, 2013 to update this information. The database has been undergoing upgrades and no longer has most of the older data listed. For Western Franklin County, 5 event(s) were reported between 01/01/1996 and 08/31/2013 (6453 days). These events are highlighted in the table. [http://www.ncdc.noaa.gov/stormevents/listevents.jsp?beginDate\\_mm=01&beginDate\\_dd=01&beginDate\\_yyyy=1996&endDate\\_mm=08&endDate\\_dd=31&endDate\\_yyyy=2013&eventType=%28Z%29+High+Wind&county=FRANKLIN&zone=WESTERN%20FRANKLIN&submitButton=Search&statefips=25%20MASSACHUSETTS](http://www.ncdc.noaa.gov/stormevents/listevents.jsp?beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1996&endDate_mm=08&endDate_dd=31&endDate_yyyy=2013&eventType=%28Z%29+High+Wind&county=FRANKLIN&zone=WESTERN%20FRANKLIN&submitButton=Search&statefips=25%20MASSACHUSETTS)

| Year       | # of High Wind Events | Annual Property Damage         | Annual Crop Damage         |
|------------|-----------------------|--------------------------------|----------------------------|
| 2008       | 0                     | \$0                            | \$0                        |
| 2007       | 0                     | \$0                            | \$0                        |
| 2006       | 5                     | \$1,928,000                    | \$0                        |
| 2005       | 1                     | \$305,000                      | \$0                        |
| 2004       | 1                     | \$340,000                      | \$0                        |
| 2003       | 2                     | \$1,350,000                    | \$0                        |
| 2002       | 0                     | \$0                            | \$0                        |
| 2001       | 0                     | \$0                            | \$0                        |
| 2000       | 0                     | \$0                            | \$0                        |
| 1999       | 1                     | \$0                            | \$0                        |
| 1998       | 0                     | \$0                            | \$0                        |
| 1997       | 0                     | \$0                            | \$0                        |
| 1996       | 2                     | \$0                            | \$0                        |
| 1995       | 5                     | \$0                            | \$0                        |
| 1994       | 4                     | \$5,050,000                    | \$0                        |
| 1993       | 3                     | \$550,000                      | \$0                        |
| <b>21</b>  |                       | <b>\$453,476</b>               | <b>\$0</b>                 |
| # of Years |                       | Average Annual Property Damage | Average Annual Crop Damage |

Thunderstorms are much more common in western Massachusetts than tornados and microbursts and can cause significant damage. While thunderstorms generally do not hit with the force of a tornado or microburst, their higher frequency and more widespread extent – and their associated hail and lightning – make them a hazard to be taken seriously. Existing and future mitigation efforts should continue to be developed and employed that will enable the Town to be prepared for these events. Microbursts, high winds and thunderstorms can occur at any location in the town.

## Wildfires/Brush Fires

### General Description

According to FEMA, there are three different classes of wildland fires: *surface fires*, *ground fires* and *crown fires*.<sup>29</sup> The most common type of wildland fire is a surface fire which burns slowly along the floor of a forest, killing or damaging trees. A ground fire burns on or below the forest floor and is usually started by lightning. Crown fires move quickly by jumping along the tops of trees. A crown fire may spread rapidly, especially under windy conditions.

While wildfires have not been a significant problem in Greenfield, there is always a possibility that changing land use patterns and weather conditions will increase a community’s vulnerability. For example, drought conditions can make forests and other open, vegetated areas

<sup>29</sup> FEMA, “Fact Sheet: Wildland Fires”, September 1993.

more vulnerable to ignition. Once the fire starts, it will burn hotter and be harder to extinguish. Soils and root systems starved for moisture are also vulnerable to fire. Residential growth in rural, forested areas increases the total area that is vulnerable to fire and places homes and neighborhoods closer to areas where wildfires are more likely to occur.

While moderate drought conditions were experienced in the western half of the state in July 2011, they were back to normal by October.<sup>30</sup> Historically, drought has not been a problem in the Town of Greenfield.

***Location and Extent***

The Town of Greenfield Fire Department responds to approximately 450 brush fires each year. Most of these fires are started on residential lots to clear grass, leaves, brush and other woody debris and become a problem when the homeowner can no longer control them. Franklin County is at a low fire risk, according to MEMA data, except for drought years when the risk may increase to moderate. Table 3-7 below shows that the number of brush fires in Greenfield between 2004 and 2010 was in the top tier of towns in Franklin County.

**Table 3-7: Massachusetts Fire Incident Reporting System – Brushfires 2004-2010 in Greenfield and Surrounding Towns**

| Department      | Total # of Brush Fires | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|-----------------|------------------------|------|------|------|------|------|------|------|
| Deerfield       | 26                     | 6    | 5    | 0    | 1    | 4    | 7    | 3    |
| Erving          | 10                     | 4    | 2    | 1    | 0    | 3    | 0    | 0    |
| Gill            | 17                     | 0    | 1    | 7    | 4    | 1    | 1    | 3    |
| Greenfield      | 51                     | 0    | 1    | 4    | 11   | 13   | 6    | 16   |
| Leverett        | 11                     | 1    | 1    | 3    | 5    | 0    | 1    | 0    |
| Montague Center | 49                     | 3    | 8    | 10   | 7    | 1    | 9    | 11   |
| South Deerfield | 21                     | 4    | 2    | 3    | 5    | 2    | 2    | 3    |
| Sunderland      | 22                     | 4    | 6    | 6    | 0    | 1    | 0    | 5    |
| Turners Falls   | 45                     | 8    | 5    | 4    | 7    | 1    | 4    | 16   |
| Whately         | 28                     | 6    | 7    | 6    | 1    | 3    | 0    | 5    |
| Franklin County | 498                    | 63   | 67   | 77   | 84   | 48   | 59   | 100  |

Source: Massachusetts Fire Incident Reporting System (MFIRS), Massachusetts Department of Fire Services.

There were no wildfires between 2010-2013, according to Emergency Management Director, Robert Strahan.

The Town issues approximately 430 burn permits annually. Education in the form of guidelines and rules are included in each burn permit issued and each applicant is required to read, understand and sign the permit.

<sup>30</sup> Massachusetts Department of Conservation and Recreation, *Current Water Conditions in Massachusetts*, August 9, 2012 and October 11, 2012, available on-line at [www.mass.gov/dcr/watersupply/rainfall/](http://www.mass.gov/dcr/watersupply/rainfall/).

Lightning can also be a cause of wildfires, brush fires, and structural fires. In June of 2005 severe thunderstorms accompanied by lightning affected portions of western Massachusetts, northeast Massachusetts, and southwest New Hampshire. During the storm, lightning struck the basement of a ranch style house in Deerfield, causing \$50,000 of structural damage to the house.<sup>31</sup>

## Dam Failures

### *General Description*

Although dams and their associated impoundments provide many benefits to a community, such as water supply, recreation, hydroelectric power generation, and flood control, they also pose a potential risk to lives and property. Dam failure is not a common occurrence but dams do represent a potentially disastrous hazard. When a dam fails, the potential energy of the stored water behind the dam is instantly released, oftentimes with catastrophic consequences, as the water rushes in a torrent downstream flooding an area engineers refer to as an “inundation area.” The number of casualties and the amount of property damage will depend upon the timing of the warning provided to downstream residents, the number of people living or working in the inundation area, and the number of structures in the inundation area.

Many dams in Massachusetts were built in the 19<sup>th</sup> Century without the benefit of modern engineering design and construction oversight. Dams can fail because of structural problems due to age and/or lack of proper maintenance. Dam failure can also be the result of structural damage caused by an earthquake or flooding brought on by severe storm events.

### *Location and Extent*

Greenfield is particularly susceptible to disastrous flooding because of its location at the confluence of the Connecticut and Deerfield Rivers. Both have major dams. The Connecticut has 16 large dams stretching from Holyoke Dam to the Moore Dam near Littleton New Hampshire. The Turners Falls Dam is just east of Greenfield.

### **Dams on the Connecticut River Mainstem:**

|                                 |                                  |
|---------------------------------|----------------------------------|
| 1. Holyoke, MA                  | 2. Cabot Station, MA             |
| 3. Turners Falls, MA            | 4. Vernon, VT-NH                 |
| 5. Bellows Falls, VT            | 6. Wilder, VT-NH                 |
| 7. Ryegate, VT-NH               | 8. McIndoes Station, VT-NH       |
| 9. Comerford Station, NH        | 10. Moore Reservoir, NH          |
| 11. Gilman Project, VT-NH       | 12. Lower, VT-NH                 |
| 13. Murphy, NH                  | 14. First Connecticut Lake, NH   |
| 15. Second Connecticut Lake, NH | 16. Moose Fall, NH <sup>32</sup> |

<sup>31</sup> NOAA National Climate Data Center, <http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms>

<sup>32</sup> Two other dams, Enfield Dam in Connecticut and Groverton Dam are breached.

There are 10 hydroelectric dams along the 73-mile length of the Deerfield River, earning it its nickname, "The Hardest Working River." Of particular note are the projects on the Deerfield River owned by TransCanada Corporation and licensed by the Federal Energy Regulatory Commission (FERC). These projects include the Somerset Dams and Harriman Dams (the two largest storage reservoirs), Sherman and Fife Brook Dams, and Bear Swamp Upper Reservoir, all of which are classified as High Hazard Dams. The Emergency Action Plans for these projects include a series of inundation maps for each dam which illustrate potential flooding conditions for downstream areas including portions of Greenfield adjacent to the Green, Deerfield and Connecticut Rivers.<sup>33</sup>

A catastrophic failure of any one of these High Hazard dams would likely result in the cascading failure of all the downstream dams (both High and Low Hazard dams), resulting in widespread flooding of downstream areas in a matter of hours. For example, on a sunny day (no additional precipitation added to released water), water from a catastrophic failure of the Harriman Dam would reach the Route 5 Bridge which spans the Deerfield River (67.6 miles from origin) in 4.6 hours and the confluence of the Deerfield and Connecticut Rivers (68.9 miles from origin) in 5 hours. Under "Probable Maximum Flood" (PMF) conditions, the worst-case scenario, floodwaters from a catastrophic failure of the Sherman Dam would reach the Route 5 Bridge in 3.2 hours. Both "Sunny Day" and PMF conditions are presented on the inundation maps for the five US GEN New England High Hazard Dams. According to inundation mapping for the Moore Dam, in the event of a catastrophic failure under PMF conditions, floodwaters would reach the Deerfield and Connecticut Rivers in approximately 25 hours.

The remaining five TransCanada dams on the Deerfield River are classified as Low Hazard Dams; therefore, no Emergency Action Plan or inundation mapping are required by FERC. Consultants hired by TransCanada examined a "Sunny Day" failure scenario for these dams to determine the downstream flooding hazard potential. Next, the incremental impact was determined for a dam failure that occurred at a flow equivalent to the 100-year frequency flood. For these two scenarios, the study indicates that the additional flooding above the 100-year flood stage was insignificant and therefore these projects do not present a significant hazard to life and property.<sup>34</sup> However, the cascading failure of one or more of these dams that would occur if one of the High Hazard dams failed would result in the catastrophic flooding shown on the inundation maps in the EAP.

The 100-year flood plain in Greenfield encompasses approximately 1,449 total acres. Of those acres, 63 acres are developed land, including an estimated 43 acres of developed residential land and 38 dwellings. The area inundated by a catastrophic failure of one of the TransCanada dams would cover substantially more acreage. Emergency responders should review inundation areas presented in the EAP and identify possible evacuation routes, since significant portions of Greenfield and neighboring communities such as Deerfield and Montague, including sections of Route 5/10, may be flooded.

---

<sup>33</sup> "Emergency Action Plans for the Deerfield River FERC Licensed Projects Nos. 2323 and 2669," prepared for US GEN New England, Inc., by Kleinschmidt Energy and Water Resource Consultants, November 2003.

<sup>34</sup> Ibid.

The Massachusetts Department of Conservation and Recreation (MA DCR) is the agency responsible for regulating dams in the state (M.G.L. Chapter 253, Section 44 and the implementing regulations 302 CMR 10.00). Until 2002, DCR was also responsible for conducting dam inspections when state law changed placing the burden of inspections on the owners of the dams. In accordance with the new regulations, which went into effect in 2005, dam owners must register, inspect and maintain dams in good operating condition. Owners of High Hazard Potential dams and certain Significant Hazard Potential dams are also required to prepare, maintain and update Emergency Action Plans. The state has three hazard classifications for dams:

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

The inspection schedule for dams is as follows:

- Low Hazard dams – 10 years
- Significant Hazard dams – 5 years
- High Hazard dams – 2 years

The time intervals represent the maximum time between inspections. More frequent inspections may be performed at the discretion of the state. Dams and reservoirs licensed and subject to inspection by the FERC are excluded from the provisions of the state regulations provided that all FERC-approved periodic inspection reports are provided to the DCR. All other dams are subject to the regulations unless exempted in writing by DCR. In 2005, the MA DCR Office of Dam Safety provided data for the 10 dams in Greenfield. Of these ten dams, seven were classified as *Significant Hazards*, two were classified as *Low Hazard* and one dam had no hazard classification. Four of the dams assigned to the Significant Hazard category were last inspected between June 1998 and May 1999. Two of these dams were found to be in good condition and the remaining two dams were found to be in fair condition. Of the three remaining dams classified as Significant Hazard dams, two have not been inspected since the mid 1970's and one has not been inspected since 1985. No current information is available on the condition of these dams. One of the Low Hazard dams was inspected in July 2003 and found to be in fair condition. The other Low Hazard dam was last inspected in June 2001 but its condition was not documented in the information received from DCR. The dam with no hazard classification was last inspected in January 1975. No information is available regarding the condition of this dam. In 2011, the MA DCR Office of Dam Safety's Legal Department provided updated data on dams in Greenfield. The data was generated using new software and a new reporting system, according to the Legal Department. The results are incomplete, with only 4 dams being reported in Greenfield. After attempts to clarify the data discrepancies were unsuccessful, MEMA advised using the information from the previous Hazard Mitigation plan and confirming the information directly with the town.

According to the Town Engineer, there are only nine dams in town rather than the ten reported by DCR in 2005. The Town of Greenfield is the Owner and Caretaker of record for six of these nine dams. According to DCR records, four of the dams the Town is responsible for are classified as Significant Hazards and the remaining two dams are Low Hazard. The remaining three dams in town are under private ownership. All three are classified as Significant Hazard dams.

### ***Beaver Dams***

Along with manmade dams, beaver dams can cause flooding as well. Alteration of the landscape by beavers is a natural process that creates habitat for shore birds, mammals and rare amphibians. However, beaver ponds can flood structures, roads and utilities, causing costly and potentially dangerous situations. Beaver activity can also pollute drinking water supplies. Mitigation measures suggested by Massachusetts Division of Fish and Wildlife (MassWildlife) and other agencies can help communities and homeowners deal with nature's master builders.

Until 1996, when a ballot initiative passed restricting the practice, Massachusetts residents were permitted to trap beavers. That change in policy caused a spike in the beaver population, which, in turn, led to a sharp increase in complaints about beaver activity and its effects. The law was modified in 2000 so that town Board of Health members could issue emergency trapping permission outside of the usual trapping season. State law makes it illegal for any person to disturb or tear open a beaver dam or beaver lodge without written permission from MassWildlife and the local Conservation Commission or Department of Environmental Protection. Permits are needed to disturb a beaver dam for any reason in Massachusetts. Even dams that cause flooding require permits to be breached.<sup>35</sup>

In 2011, a bill is under consideration with the State Legislators which would give individuals and towns an additional option when they are having issues with beavers. Under this new bill, a special permit could be obtained from the State Department of Fisheries and Wildlife. The bill does not aim to repeal the bill that bans trapping but rather allows the issuing of an emergency permit under the provisions allowed within the laws of the State. The proposed bill also calls for the State to begin keeping better records of all permits issued and how many beavers are trapped each year. An increased beaver population, combined with land development reducing beaver habitat, means that humans and beavers continue to clash. Several mitigation measures, when applied thoughtfully, legally and with maintenance measures in mind, can help with beavers' negative effects, while preserving beavers' positive impact on the land.<sup>36</sup>

While trapping beaver can have short-term benefits, the right conditions for beaver habitat will eventually lure new beavers. It may be best to combine trapping with measures that discourage beaver activity that's bad for humans. Techniques used to mitigate the flooding damage caused by beaver include breaching of beaver dams, protecting road culverts with fences or guards, and controlling water levels with water flow devices. All these techniques require a certain degree of effort and regular maintenance to insure water levels that can be tolerated (thereby preserving the

---

<sup>35</sup> Langlois, S.A. and T.A. Decker. 2004. *The Use of Water Flow Devices and Flooding Problems Caused by Beaver in Massachusetts* (Rev. Ed.). MA Division of Fisheries and Wildlife. 18pp.

<sup>36</sup> *Otsego County (NY) All Hazards Mitigation Plan*, 2010.

positive aspects of the associated wetland). See the MassWildlife publication *The Use of Water Flow Devices and Flooding Problems Caused by Beaver in Massachusetts* for details on these mitigation measures. The following techniques were adapted from that publication.

- Dam breaching is an immediate but very short-term solution to flooding problems caused by beaver. Good water control is possible if the breach is kept shallow and broad so that the water level falls slowly. Opening a deep breach creates a dangerous situation and may cause serious flooding and erosion downstream. Tractor- or truck-mounted excavators may be used by town, county or state highway employees to remove large amounts of material from beaver dams but care should be taken to avoid downstream flooding. Neighbors should be told where, when, and why a dam excavation is going to be done. If the method is justified and must be used, it is best done in mid-summer when the water level is low.
- Beavers build dams instinctively. When they sense running water, they start to build or repair dams. Beavers often block road culverts with sticks, mud and rocks. This can cause flooding upstream. Culverts blocked from the inside are difficult to clean and potentially dangerous. The use of meshes and grills, placed on both ends of the culvert, can prevent beavers from entering. Several mitigation strategies are listed in *The Use of Water Flow Devices and Flooding Problems Caused by Beaver in Massachusetts*.
- Water Level Control Devices (WLCDs) keep beavers away from an intake pipe that lowers the water level of the pond. It's been estimated that only 4.5% of beaver problems in Massachusetts will respond to these devices. Using and maintaining a WLCD in conjunction with trapping young beavers can allow coexistence for years. Several types of WLCDs are available. For construction details, see *The Use of Water Flow Devices and Flooding Problems Caused by Beaver in Massachusetts*.

Town of Greenfield Department of Public Works engineer, Alan Twarog, identified some sites where beaver dams are having an notable impact on the landscape. They include:

- Cherry Rum Brook behind Silvercrest Condominium project and behind Cherry Rum Plaza. These beaver dams have been breached several times.
- Allen Brook off Plain Road. The Town is currently working with landowner to address this issue.

On July 8, 2011, the DPW breached a beaver dam on the Cherry Rum Brook after obtaining the necessary permission to remove the beavers in the area of the dam. This year (2011) marks the third year in a row that Greenfield has breached a beaver dam in this same location. Town sewer lines run nearby the Cherry Rum Brook and, with the water level rising due to the dam, water was flowing into the sewer lines and the Town was spending money to process this water in their wastewater treatment plant.

The impoundment caused by this beaver dam is approximately one half mile long by approximately one tenth mile wide and contains a cattail marsh and offers habitat for many species – including the great blue heron, frogs, and red wing blackbirds which were observed the morning of the dam removal. Along with impacted the Town's sewer system, debris flowing from the beaver dam periodically causes flooding downstream at State Highway 5 and 10.

A letter from the Mayor of Greenfield (located in Appendix D) outlines the impacts and costs to the Town that beaver dams have had in recent years. There is also a newspaper article in Appendix C that describes work the DPW has done to deal with beaver dams.



The impoundment provides wildlife habitat but negatively impacts the Town's sewer system.



The DPW begins the work of breaching the beaver dam on July 8, 2011.



Water rushes through the newly breached beaver dam.



Once drained, the Cherry Rum Brook will return to a narrow waterbody – at least until the next beavers arrive to build a new dam.

## Earthquakes

### *General Description*

An earthquake is a sudden, rapid shaking of the ground that is caused by the breaking and shifting of rock beneath the Earth's surface. Earthquakes can occur suddenly, without warning, at any time of the year. The northeast states experience an average of 30 to 40 earthquakes each year although most are not noticed by people.<sup>37</sup> Ground shaking from earthquakes can rupture gas mains and disrupt other utility service, damage buildings, bridges and roads, and trigger other hazardous events such as landslides, avalanches, flash floods (dam failure) and fires. Unreinforced masonry buildings, buildings with foundations that rest on filled land or

<sup>37</sup> Northeast States Emergency Consortium web site: [www.nesec.org/hazards/earthquakes.cfm](http://www.nesec.org/hazards/earthquakes.cfm)

unconsolidated, unstable soil, and mobile homes not tied to their foundations are at risk during an earthquake.<sup>38</sup>

The Richter magnitude scale was developed in 1935 by Charles F. Richter of the California Institute of Technology as a mathematical device to compare the size of earthquakes. The magnitude of an earthquake is determined from the logarithm of the amplitude of waves recorded by seismographs. Adjustments are included for the variation in the distance between the various seismographs and the epicenter of the earthquakes. On the Richter Scale, magnitude is expressed in whole numbers and decimal fractions. For example, a magnitude 5.3 might be computed for a moderate earthquake, and a strong earthquake might be rated as magnitude 6.3. Because of the logarithmic basis of the scale, each whole number increase in magnitude represents a tenfold increase in measured amplitude; as an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Earthquakes with magnitude of about 2.0 or less are usually called microearthquakes; they are not commonly felt by people and are generally recorded only on local seismographs. Events with magnitudes of about 4.5 or greater - there are several thousand such shocks annually - are strong enough to be recorded by sensitive seismographs all over the world. Great earthquakes, such as the 1964 Good Friday earthquake in Alaska, have magnitudes of 8.0 or higher. On the average, one earthquake of such size occurs somewhere in the world each year. The Richter Scale has no upper limit.

It is important to note that the Richter Scale is not used to express damage. An earthquake in a densely populated area which results in many deaths and considerable damage may have the same magnitude as a shock in a remote area that does nothing more than frighten the wildlife. Large-magnitude earthquakes that occur beneath the oceans may not even be felt by humans.<sup>39</sup>

The effect of an earthquake on the Earth's surface is called the intensity. The intensity scale consists of a series of certain key responses such as people awakening, movement of furniture, damage to chimneys, and finally - total destruction. Although numerous *intensity scales* have been developed over the last several hundred years to evaluate the effects of earthquakes, the one currently used in the United States is the Modified Mercalli (MM) Intensity Scale. It was developed in 1931 by the American seismologists Harry Wood and Frank Neumann. This scale, composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, is designated by Roman numerals. It does not have a mathematical basis; instead it is an arbitrary ranking based on observed effects.

The Modified Mercalli Intensity value assigned to a specific site after an earthquake has a more meaningful measure of severity to the nonscientist than the magnitude because intensity refers to the effects actually experienced at that place.

---

<sup>38</sup> Federal Emergency Management Agency web site: [www.fema.gov/hazards/earthquakes/quake.shtm](http://www.fema.gov/hazards/earthquakes/quake.shtm)

<sup>39</sup> Adapted from <http://earthquake.usgs.gov/learn/topics/richter.php>

The **lower** numbers of the intensity scale generally deal with the manner in which the earthquake is felt by people. The **higher** numbers of the scale are based on observed structural damage. Structural engineers usually contribute information for assigning intensity values of VIII or above.<sup>40</sup> The figure below shows the Modified Mercalli Scale (far left column) and the corresponding Richter Scale magnitude rating (far right column).<sup>41</sup>

| Category             | Effects  | Richter Scale (approximate) |
|----------------------|--|-----------------------------|
| I. Instrumental      | Not felt   | 1-2                         |
| II. Just perceptible | Felt by only a few people, especially on upper floors of tall buildings  | 3                           |
| III. Slight          | Felt by people lying down, seated on a hard surface, or in the upper stories of tall buildings   | 3.5                         |
| IV. Perceptible      | Felt indoors by many, by few outside; dishes and windows rattle  | 4                           |
| V. Rather strong     | Generally felt by everyone; sleeping people may be awakened  | 4.5                         |
| VI. Strong           | Trees sway, chandeliers swing, bells ring, some damage from falling objects  | 5                           |
| VII. Very strong     | General alarm; walls and plaster crack   | 5.5                         |
| VIII. Destructive    | Felt in moving vehicles; chimneys collapse; poorly constructed buildings seriously damaged   | 6                           |
| IX. Ruinous          | Some houses collapse; pipes break  | 6.5                         |
| X. Disastrous        | Obvious ground cracks; railroad tracks bent; some landslides on steep hillsides  | 7                           |
| XI. Very disastrous  | Few buildings survive; bridges damaged or destroyed; all services interrupted (electrical, water, sewage, railroad); severe landslides | 7.5                         |
| XII. Catastrophic    | Total destruction; objects thrown into the air; river courses and topography altered   | 8                           |

### ***Location and Extent***

Tables 3-8 and 3-9 show historic occurrences of earthquakes in the Northeastern part of the United States. This Northeast States Emergency Consortium data is current as of December 2013. A NOAA data query for earthquake events in Franklin County between the years 1996 and 2013 turned up no events.<sup>42</sup>

**Table 3-8: Northeast Earthquakes with a Magnitude of 4.2 or more 1924 - 2007**

| Location           | Date              | Magnitude |
|--------------------|-------------------|-----------|
| Ossipee, NH        | December 20, 1940 | 5.5       |
| Ossipee, NH        | December 24, 1940 | 5.5       |
| Dover-Foxcroft, ME | December 28, 1947 | 4.5       |
| Kingston, RI       | June 10, 1951     | 4.6       |
| Portland, ME       | April 26, 1957    | 4.7       |

<sup>40</sup> Adapted from <http://earthquake.usgs.gov/learn/topics/mercalli.php>

<sup>41</sup> Adapted from <http://img.docstoccdn.com/thumb/orig/80153368.png>

<sup>42</sup> <http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=25%2CMASSACHUSETTS>

|                           |                |     |
|---------------------------|----------------|-----|
| Middlebury, VT            | April 10, 1962 | 4.2 |
| Near NH Quebec Border, NH | June 15, 1973  | 4.8 |
| West of Laconia, NH       | Jan. 19, 1982  | 4.5 |
| Plattsburg, NY            | April 20, 2002 | 5.1 |

Source: Northeast States Emergency Consortium: [www.nesec.org/hazards/earthquakes.cfm](http://www.nesec.org/hazards/earthquakes.cfm)

On June 22, 2010 there was a magnitude 5.8 earthquake in Canada which could be felt in Franklin County. No damage was reported, but residents stated they felt the quake and were unnerved by the experience. On August 23, 2011 an earthquake measuring 5.8 on the Richter scale centered in Virginia was felt throughout the northeast, prompting the evacuation of a number of multi-story buildings in the Franklin County region, but causing no property damage or personal injury.

Massachusetts introduced earthquake design requirements into their building code in 1975. However, these specifications apply only to new buildings or to extensively modified buildings. Existing buildings, bridges, water supply lines, electrical power lines and facilities, etc. have generally not been designed to withstand the forces of an earthquake.

**Table 3-9: Northeast States Record of Historic Earthquakes**

| State         | Years of Record | Number Of Earthquakes |
|---------------|-----------------|-----------------------|
| Connecticut   | 1668 - 2007     | 137                   |
| Maine         | 1766 - 2007     | 544                   |
| Massachusetts | 1668 - 2007     | 355                   |
| New Hampshire | 1638 - 2007     | 360                   |
| Rhode Island  | 1776 - 2007     | 38                    |
| Vermont       | 1843 - 2007     | 73                    |
| New York      | 1840 - 2007     | 755                   |

Source: Northeast States Emergency Consortium Web site: [www.nesec.org/hazards/earthquakes.cfm](http://www.nesec.org/hazards/earthquakes.cfm)

According to the United States Geological Survey, a fault line runs north-south to the east of Greenfield through the Towns of Erving, Montague and Leverett. The fault extends along the entire length of Franklin County, and was originally responsible for the creation of the Connecticut River. The entire town is equally at risk to the effects of an earthquake.

## Landslides

### *General Description*

Landslides are geological phenomena that include a wide range of ground movement, such as rock falls, failure of slopes and shallow debris flows. They can occur in coastal, mountain, and river edge environments.

Landslides occur when the stability of a slope changes from a stable to an unstable condition. A change in the stability of a slope can be caused by a number of factors, acting together or alone. Natural causes of landslides include:

- Groundwater pressure acting to destabilize the slope
- Loss or absence of vertical vegetative structure, soil nutrients, and soil structure (e.g. after a wildfire)
- Erosion of the toe of a slope by rivers
- Weakening of a slope through saturation by snowmelt or heavy rains
- Earthquakes adding loads to barely-stable slopes
- Earthquake-caused liquefaction destabilizing slopes
- Volcanic eruptions

Landslides are created by human activities as well, including deforestation, cultivation and construction, which destabilize already fragile slopes. These activities can include:

- Vibrations from machinery or traffic
- Blasting
- Earthwork which alters the shape of a slope, or which imposes new loads on an existing slope
- In shallow soils, the removal of deep-rooted vegetation that binds colluvium to bedrock
- Construction, agricultural or forestry activities (logging) which change the amount of water which infiltrates the soil.

### ***Location and Extent***

Landslides in New England occur along highways where rock cuts have been made or along river corridors where the river bank collapses due to erosion that undercuts the shore.

In recent years, relatively small landslides have been reported in Greenfield on Factory Hollow Road along the Fall River, on Mead Street and Wisdom Way, and Brook Road and Shelburne Road. Another incident of note affecting a cultural and historic resource involved the 90-acre Green River Cemetery. This cemetery contains the grave sites of many notable historical figures including a governor and state legislators. The site also includes exemplary funerary art and sculpture such as the Russell family monument carved by Daniel Chester French, one of America's foremost sculptors.<sup>43</sup>

In a recent landslide event, the Green River Cemetery's banks gave way again. In the early morning of March 7, 2011, torrential rains swept away a piece of cemetery into the backyards of homes and nearby streets, about 100 feet below the Cemetery. The landslide sent silt, mud, and debris from the Green River Cemetery down steep banks and into homes on Meridian Street. According to Robert Strahan, Emergency Management Director, three houses were damaged, three detached buildings destroyed, and six automobiles were totaled. The slide caused thousands of dollars in personal property damage and tens of thousands of dollars in clean-up costs to the Town.

---

<sup>43</sup> <http://www.jsrockwell.com/historic.htm>



Residential property in Greenfield, MA was inundated with mud due to a landslide from neighboring Green River Cemetery. Photo taken by Jeff Brown and courtesy of MassLive.com.

According to the Greenfield Recorder, state geologists estimated that about 1,500 to 3,000 cubic yards of mud and debris came down into the yards but that no graves were involved. Three inches of rain in Greenfield over a day and a half contributed to the disaster that caused thousands of dollars worth of damage.



The aftermath of the mudslide from the Green River Cemetery included cleanup on a nearby street and bridge..

The company called in to divert water away from homes below and help clear their yards of some of the mud found that a drainage system that had been installed in 1986 was been plugged and buried by the mudslide. The drainage system was cleaned out and was found to be in good shape. The company said that the drainage system, if maintained, should handle any future rains adequately. The Town indicated that it is the responsibility of the Cemetery board to make sure the system is evaluated and cleared of any silt accumulation on a regular basis. See Appendix C of this report for news articles related to this mudslide.

The Connecticut River Valley is given a Moderate landslide incidence rating (1.5% to 15% of the area involved) while the remainder of the state is listed as Low landslide incidence (less than 1.5% of the area involved).<sup>44</sup>

## **Ice Jams**

### ***General Description***

Ice jams (or ice dam) occurs when water builds up behind a blockage of ice. Ice dams can occur in various ways, but in New England they predominantly form on rivers and streams and mainly threaten infrastructure.

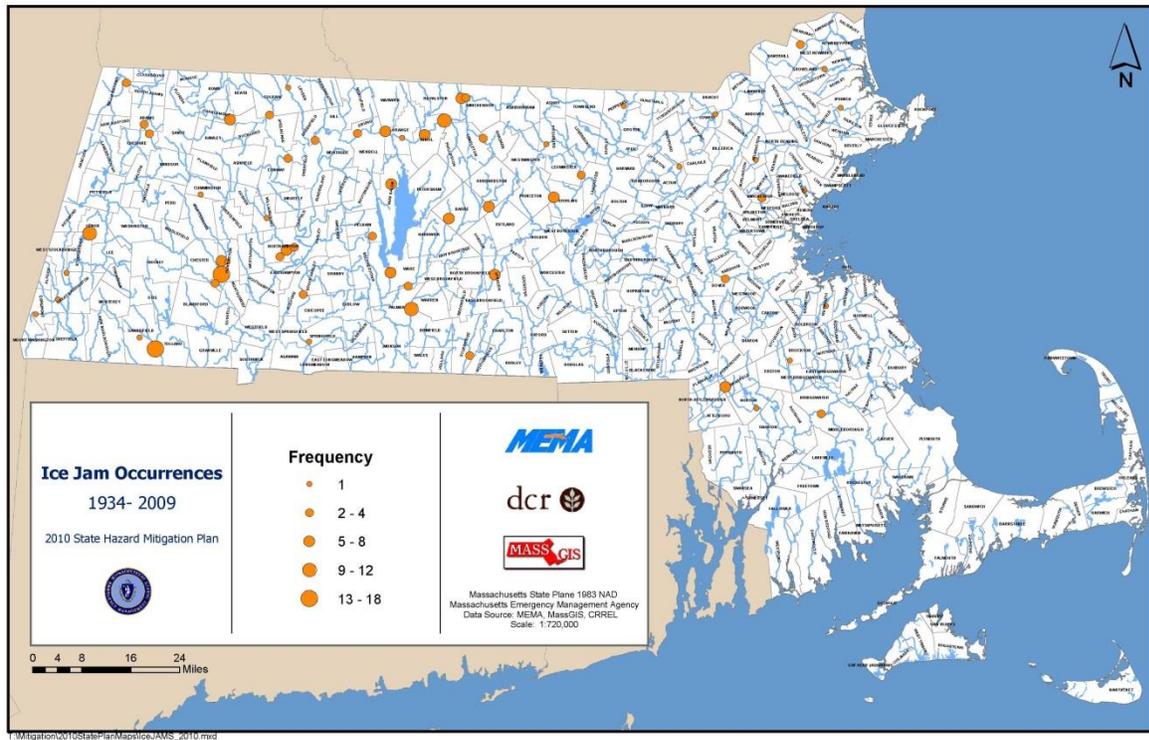
When the upstream part of a river thaws first and the ice is carried downstream into the still-frozen part of the watercourse, ice can form an ice dam and flood low lying areas upstream of the jam. Also, once an ice dam breaks apart, the sudden surge of water that breaks through the dam can flood areas downstream of the jam. Ice jams and flooding usually occur in spring; however, they can happen as winter sets in when the downstream reach of a river freezes first. Where floods threaten, the blockage can be removed mechanically.

### ***Location and Extent***

According to information in the 2010 Massachusetts State Hazard Mitigation Plan, ice jams have occurred with varying frequency on several rivers in Franklin County, including the Deerfield, Millers, Green, North and South Rivers between 1934-2009 (see map, below).

---

<sup>44</sup> U.S. Department of the Interior, U.S. Geological Survey. National Landslide Hazards Mitigation Strategy: A Framework for Loss Reduction. 2000.



According to the Committee, there have been only minor ice jams under a bridge by the intersection of Shelburne Road and Route 2. Ice jams occurring in and near Greenfield could have an impact similar to flooding or dam failure, depending upon the size and impoundment associated with the jam. Historical data from the U.S. Army Cold Regions Research and Engineering Laboratory<sup>45</sup> from 2008 show ice jams occurrences, located by river (most recent data available). Since recording began there have been no ice jams on the Connecticut River in Greenfield but there have been two in Turners Fall, just upstream from Greenfield. See Table 3-10. On the Deerfield River, no ice jams have been recorded since 1959 (Table 3-11) and on the Green River none have been recorded since 1970 (Table 3-12).

**Table 3-10: Ice Jam Occurrences on the Connecticut River in or near Greenfield**

| Date       | Type     | Latitude      | Longitude     | Town          | Description or other information  |
|------------|----------|---------------|---------------|---------------|---|
| 01/24/1957 | unknown  | 42° 34' 48" N | 72° 34' 43" W | Montague City | Maximum annual gage height of 23.78 feet. Discharge 36,000 cfs  |
| 03/01/1947 | Break-Up | 42° 6' 5" N   | 72° 35' 25" W | Springfield   | Weather Bureau reports ice jam upstream from gage Connecticut River at Springfield on March 1 (stage 4.5 ft) and 2, 1947 (stage 4.2 ft). Gage datum 37.3 ft MSL, flood stage 20 ft. |
| 03/10/1946 | unknown  | 42° 34' 48" N | 72° 34' 43" W | Montague City | Maximum annual gage height of 27.41. Discharge "about" 71,000 cfs   |

<sup>45</sup> [www.crrel.usace.army.mil](http://www.crrel.usace.army.mil) This is the most recent data available.

| Date       | Type     | Latitude      | Longitude     | Town        | Description or other information  |
|------------|----------|---------------|---------------|-------------|---|
| 03/01/1946 | Break-Up | 42° 19' 30" N | 72° 38' 30" W | Northampton | As reported by The Hartford Courant on 03/12/46, "The Connecticut River crested at the 18-foot level in Hartford about 7 p.m. Monday and by 8 p.m. had subsided to 17.5 feet as freeze-up gripped the whole Connecticut Valley and reduced the danger of a spring flood. Waters were receding at Northampton, Mass, despite an ice jam there.   |
| 12/21/1945 | unknown  | 42° 12' 50" N | 72° 36' 36" W | Holyoke     | Stage 2.7 ft. Gage datum 97.47 ft, flood stage 9 ft. NWSFO/NERFC flood stage 19 ft.   |
| 03/13/1936 | unknown  | 42° 19' 30" N | 72° 38' 30" W | Northampton | Gigantic ice jam in the Connecticut River, with ice piled 18 to 20 feet high at spots. This put terrific pressure on the Boston and Maine railroad embankment bordering the river and at one point a bulge was noticeable.  |
| 03/13/1936 | Break-Up | 42° 12' 15" N | 72° 37' 0" W  | Holyoke     | Nearly the entire flow of the swollen river was diverted across the inner part of the Hockanum Meadows, where it threatened to establish a new channel. This diverted stream returned to its normal channel near Mount Tom Junction when the huge ice barrier broke during the evening of March 15, floated downstream at a rate of more than 6 miles per hour, and passed over the Holyoke dam at a stage of 9.5 feet above the crest. |

**Table 3-11: Ice Jam Occurrences on the Deerfield River in or near Greenfield**

| Date       | Type    | Latitude      | Longitude     | Town           | Description or other information                                      |
|------------|---------|---------------|---------------|----------------|---|
| 01/22/1959 | unknown | 42° 32' 9" N  | 72° 39' 54" W | West Deerfield | Maximum annual gage height of 11.46 feet                              |
| 01/23/1957 | unknown | 42° 32' 9" N  | 72° 39' 54" W | West Deerfield | Maximum annual gage height of 7.49 feet. Discharge 9,570 cfs          |
| 02/08/1941 | unknown | 42° 32' 9" N  | 72° 39' 54" W | West Deerfield | Maximum annual gage height of 8.31 feet. Discharge "about" 10,000 cfs |
| 03/12/1936 | unknown | 42° 37' 33" N | 72° 51' 12" W | Charlemont     | Maximum annual gage height of 19.9 feet                               |
| 02/05/1934 | unknown | 42° 37' 33" N | 72° 51' 12" W | Charlemont     | Maximum annual gage height of 8.80 feet                               |
| 02/17/1930 | unknown | 42° 37' 33" N | 72° 51' 12" W | Charlemont     | Maximum annual gage height of 8.22 feet                               |
| 02/12/1925 | unknown | 42° 37' 33" N | 72° 51' 12" W | Charlemont     | Maximum annual gage height of 15.97 feet. Discharge 9,330 cfs         |
| 03/23/1923 | unknown | 42° 37' 33" N | 72° 51' 12" W | Charlemont     | Maximum annual gage height of 20.0 feet                               |
| 03/21/1918 | unknown | 42° 37' 33" N | 72° 51' 12" W | Charlemont     | Maximum annual gage height of 11.75 feet                              |

**Table 3-12: Ice Jam Occurrences on the Green River in or near Greenfield**

| Date       | Type    | Latitude      | Longitude    | Town    | Description or other information   |
|------------|---------|---------------|--------------|---------|--|
| 02/12/1970 | unknown | 42° 42' 12" N | 72° 40' 1" W | Colrain | Maximum annual gage height, 6.39 feet due to an ice jam. Discharge 300 cfs |

## Manmade Hazards<sup>46</sup>

### *General Description*

Most non-natural or manmade hazards fall into two general categories: intentional acts and accidental events, although these categories can overlap. Some of the hazards included in these two categories, as defined by MEMA, consist of intentional acts such as explosive devices, biological and radiological agents, arson and cyberterrorism and accidental events such as nuclear hazards, invasive species, infrastructure failure, industrial and transportation accidents. Accidental events can arise from human activities such as the manufacture, transportation, storage, and use of hazardous materials.

*Note: This plan does not address all manmade hazards that could affect Franklin County. A complete hazards vulnerability analysis was not within the scope of this update. For the purposes of the 2010 plan, FRCOG has evaluated those non-natural hazards that are of an accidental nature. They include industrial transportation accidents and industrial accidents in a fixed facility.*

Hazardous materials in various forms can cause death, serious injury, long-lasting health effects, and damage to buildings, homes, and other property. Many products are shipped daily on the nation's highways, railroads, waterways, and pipelines. Chemical manufacturers are one source of hazardous materials, but there are many others, including service stations, hospitals, and hazardous materials waste sites. Hazardous materials come in the form of explosives, flammable and combustible substances, poisons, and radioactive materials. These substances are most often released as a result of transportation accidents or because of chemical accidents in plants.

A release may occur at a fixed facility or in transit. Communities with a large industrial base may be more inclined to experience a hazardous materials release due to the number of facilities such materials in their manufacturing process. Communities with several major roadways may be at a greater risk due to the number and frequency of trucks transporting hazardous materials passing through.

### Industrial Accidents - Transportation

Franklin County transportation systems include road, rail, and air. Accessible and efficient freight transportation plays a vital function in the economy of the region. Most freight and goods being transported to and from Franklin County are by truck; however, a significant amount of freight that moves through the county is being hauled over the three main rail lines. Given that

---

<sup>46</sup> Content adapted from Commonwealth of Massachusetts State Hazard Mitigation Plan 2010

any freight shipped via air needs first to be trucked to an airport outside the region, air transportation is not being evaluated in this plan.

The major trucking corridors in Franklin County are Interstate 91, running north/south, and Route 2, running east/west, both of which travel through – and intersect in – Greenfield. These two highways also represent the busiest travel corridors in the region for non-commercial traffic. According to the Franklin County Hazardous Material Emergency Plan<sup>47</sup>, approximately 13 to 15 trucks per hour traveling through the region contain hazardous materials (Table 3-13). Interstate 91 and Route 2 carry approximately 12 per hour. Other major roadways passing through Greenfield include Routes 5/10 and 2A.

**Table 3-13: Estimated Levels of Hazardous Material Transported on Area Roadways**

| Roadway   | Number of Tank or Van Trucks Carrying Hazardous Materials per hour |
|---|--|
| Interstate 91   | 10   |
| Route 2   | 2  |
| Other major roadways ( <i>Routes 5/10, 63, 47, 116, 202, 8A, 78, 122, 142, and 2A</i> ) | 1 or 0   |

**Table 3-14: Estimated Level of Hazardous Material Transport on Area Train Lines**

| Train Line                               | Trains per Day (General Merchandise) | Average Number of Cars per Train | Average Number of Cars per Train with Hazardous Waste |
|--|--------------------------------------|----------------------------------|---|
| <b>Main Freight Line, Pan Am Systems</b> | <b>10 to 24</b>                      | <b>50</b>                        | <b>4</b>  |
| Connecticut River Line, Pan Am Systems   | 2 to 3                               | 30                               | 2   |
| East Deerfield Rail Yard, Pan Am Systems | 10 to 15 trains passing through yard | n/a                              | 2 to 5  |
| New England Central                      | 2                                    | 60                               | 5   |

Safe and efficient transportation routes for trucks to and through the region are important to the region’s economy to and to the safety of its citizens. The safer the transportation routes are, the less likely a transportation accident will occur. Some challenges to safe transportation routes were identified in the FRCOG 2007 Regional Transportation Plan and include:

- The lack of climbing and turning lanes on Route 2 East. Freight trucks are susceptible to the hazard of rapid stops, as they cannot slow the momentum of their vehicles quickly.
- The severity of the exit ramp curves impacts the safety of exiting for top-heavy vehicles such as freight trucks.
- Steep declines, including those on Route 2 eastbound west of Greenfield. The feasibility of adding runaway truck lanes is being evaluated.

---

<sup>47</sup> Franklin County Local Emergency Planning Committee, Franklin County Hazardous Material Emergency Plan and Maps, 2006. Based on a one-time survey conducted in 2003.

Ten to 24 trains per day travel on the Pan Am Systems Main Freight line which runs through Greenfield (Table 3-14). On each of these trains, an average of 4 cars carries hazardous waste. Additionally, the Deerfield Switch Yard is located just across the Connecticut River in Deerfield, close enough to Greenfield to have an impact, should a hazardous waste spill occur at that site.

On January 28th, U.S. Department of Transportation awarded of \$70 million for final design and construction of the "Knowledge Corridor" along the Connecticut River rail line in western Massachusetts. The Knowledge Corridor - Restore Vermonter Project will restore Amtrak's intercity passenger train service to its original route by relocating the Vermonter from the New England Central Railroad back to its former route on the Pan Am Southern Railroad. The Pan Am Southern route provides a shorter and more direct route for the Vermonter between Springfield and East Northfield, and improves access to densely populated areas along the Connecticut River. The Pan Am Southern route would include station stops at the former Amtrak station at Northampton and the new intermodal station at Greenfield.<sup>48</sup>

With these improvements to the rail line pending, additional trains are expected to run daily, possibly increasing risks to nearby neighborhoods. Speeds for freight trains are expected to increase from 10 to 40 mph with track improvements. These improvements may entice freight truckers to switch to rail. The EOT expects that by 2030, freight traffic will increase by 50-100% along the route.<sup>49</sup>

It must be noted that improvements to rail lines can have positive economic and social implications as well as the potentially negative discussed in this section.

Industrial Accidents – Fixed Facilities

An accidental hazardous material release can occur wherever hazardous materials are manufactured, stored, transported, or used. Such releases can affect nearby populations and contaminate critical or sensitive environmental areas. Those facilities using, manufacturing, or storing toxic chemicals are required to report their locations and the quantities of the chemicals stored on-site to state and local governments.

**Table 3-15: Toxics Release Inventory (TRI)**

| Facility Name         | Facility Address   | Chemical Name         | Date Updated |
|-----------------------|--------------------|-----------------------|--------------|
| Greenfield Armory     | 71 Hope Street     | Fuel Oil #2           | 2003         |
| Federal St. Sunoco    | 295 Federal Street | Diesel, Gasoline      | 2003         |
| Greenfield Industries | 34 Sanderson St    | Nitrogen, Fuel Oil #2 | 2003         |
| Greenfield Neighbors  | 223 Mohawk Trail   | Gasoline              | 2003         |
| Rogers, Lunt & Bowlen | 298 Federal St     | Petroleum Hydrocarbon | 2003         |
| Greenfield Mobil      | 486 Bernardston Rd | Gasoline              | 2003         |
| Mountain View Tire    | 109 Mohawk Trail   | Diesel, Gasoline      | 2003         |

<sup>48</sup> <http://www.massdot.state.ma.us/knowledgecorridor/>

<sup>49</sup> "Knowledge Corridor: Passenger Rail Study", Alyssa Larose, Robert Ratzenberger and Matthew Viens, December 2009 UMass Student Project

|                     |                     |  |      |
|---------------------|---------------------|--|------|
| Verizon-Greenfield  | 11 Church St.       | Battery Sulfuric Acid, Kerosene  | 2003 |
| Rice Oil Company    | 34 Montague City Rd | Fuel Oil #2, Kerosene, Propane   | 2003 |
| Rice Oil Company    | 400 Chapman St.     | Fuel Oil #2, Kerosene, Propane   | 2003 |
| A.R. Sandri         | 400 Chapman St      | Diesel, Gasoline   | 2003 |
| A.R. Sandri         | 191 Cleveland St    | Fuel oil #2, Kerosene, Motor/Lubricant Oils, Quenching Oils  | 2003 |
| Stop Smart Sunoco   | 416 Federal St      | Gasoline, Fuel Oil #2  | 2003 |
| WTE Recycling       | 75 Southern Ave     | Carbon Steel Scrap, Lead Alloy Scrap, Petroleum Hydrocarbon, Stainless Steel Scrap   | 2003 |
| J.K. Electronics    | 201 Munson St.      | Acetylene, Aluminum Foil, Canola Oil RBD, Carbon Blk, Blu Ink Tubes, Epic-Epoxy-Resin Titanium Dioxide, Copper Wire, Epoxies, Epoxy Resin, Polyamine, Epoxy-Hardener, Ethyl Acetate, Ethyl Alcohol, Ethylene Glycol Anti-Freeze, Aluminium, Tributyl Phosphate, Lead Chromate Ink, Lead Wire Foil, Mercury, Mineral Spirits, Molybdenum, Naphtha, VM+P Naphtha Paint, Tin, Trichloroethylene, Epoxy-Micars X1087-WE R20, Epoxy-Hardner Micars P980 | 2003 |
| Merriam Graves      | 1159 Bernardston Rd | Cryogenic Liquid Oxygen, Anhydrous Ammonia   | 2003 |
| Amerigas Propane LP | 44 Montague City Rd | Liquid Petroleum gas, Methanol   | 2003 |

Source: EPA Toxic Release Inventory, 2010. *Note: Table 3-9: Toxics Release Inventory (TRI) in no way indicates any issues with any of the sites but rather is an inventory of those facilities meeting TRI reporting requirements.*

The Greenfield CEM Plan identifies facilities that manufacture, store, transport or use hazardous materials in Greenfield. Because of their potentially sensitive nature, they are not listed in this report but can be accessed by the Emergency Management Director as needed. In addition, the Toxics Release Inventory (TRI) contains information about more than 650 toxic chemicals that are being used, manufactured, treated, transported, or released into the environment. Table 3-15 shows those facilities in Greenfield identified by TRI.

A bio-diesel plant slated to be built in the I-91 Industrial Park will also potentially house and use hazardous materials.

In addition to facilities potentially housing hazardous compounds, the Committee identified the transportation of hazardous materials through Greenfield as a potential manmade hazard. Route 2 and the Pan Am Systems Railroad both serve as primary routes for transportation of cargo, some of which is of a hazardous nature. According to the HMEP<sup>50</sup> Hazardous Materials Survey Results, the Pan Am Systems Railroad carries 5-12 freight trains in each direction daily with an

<sup>50</sup> [http://www.frcog.org/pubs/emergency/Franklin\\_County\\_HMEP.pdf](http://www.frcog.org/pubs/emergency/Franklin_County_HMEP.pdf)

average train length of 50 cars, an average of four of which carry hazardous materials. The hazardous materials regularly carried on these trains passing through Greenfield include:

- Hydrocyanic acid
- Sulfuric acid
- Liquified petroleum gas
- Hydrochloric acid
- Chlorine
- Caustic soda
- Methanol
- Sodium chloride

The same plan identifies hazardous materials being carried on highways. On Route 2, which runs through Greenfield, an average of 2 hazardous materials tank or van trucks travel per hour. The hazardous materials regularly carried on these trucks passing through Greenfield include:

- Gasoline
- Fuel oil
- Kerosene
- Liquified petroleum gas
- Propane
- Sodium aluminate
- Sulfuric acid
- NOS liquids 3082

Hazardous facilities located outside of town boundaries can potentially impact the Town as well. The Vermont Yankee nuclear power plant is located on the Connecticut River in Vernon, Vermont, near the Vermont/Massachusetts border and less than 20 miles from Greenfield. In January 2010, the facility notified the Vermont Department of Health that samples taken in November 2009 from a ground water monitoring well on site contained tritium. This finding signals an unintended release of radioactive material into the environment. Testing has shown that contaminated groundwater has leaked into the Connecticut River, though tritium levels in the river have remained below the lower limit of detection.[1]

More recently, the 2011 tsunami and earthquake in Japan that damaged a nuclear power plant demonstrates the potential vulnerability of these facilities to natural disasters, and the geographic extent that could be impacted by an accident. The future operation of the Vermont Yankee power plant is currently unclear. The future operation of the Vermont Yankee power plant is currently unclear. The Nuclear Regulatory Commission recently extended the plant's operating license for 20 more years, while the State of Vermont has denied an extension of the current license, which expires in March 2012. Nevertheless, Town officials should stay abreast of proper evacuation procedures in the event of an accident at the Vermont Yankee nuclear power plant.

---

[1] Vermont Department of Health. [http://healthvermont.gov/enviro/rad/vt\\_yankee.aspx](http://healthvermont.gov/enviro/rad/vt_yankee.aspx)

In preparation for a potential accident at Vermont Yankee – or other such potentially catastrophic event, on July 26th, 2011 twenty-eight officials and volunteers from a wide range of agencies, including public health, emergency response, housing, social services, and transit, gathered to discuss and exercise Greenfield’s emergency dispensing site (EDS) plan. The tabletop exercise was developed to (1) assess Greenfield and Franklin County agencies’ response to both a bioterrorism incident and an accident at the local nuclear power plant, and (2) to assess the updated EDS plan. This type of planning is ongoing in Greenfield.

## **Risk Assessment Methodology**

In updating Greenfield's Multi-Hazard Mitigation Plan, the Franklin Regional Council of Governments developed the All Hazards Risk Assessment methodology for assessing the risk of hazards. The All Hazards Risk Assessment is an interactive table that the Greenfield Committee completed with the FRCOG staff to evaluate all the hazards that can impact the town based on frequency of occurrence, severity of impacts, area of occurrence and preparedness. The methodology yields a Weighted Hazard Index, which is a measure of the likelihood of future occurrence for each hazard as well as the potential impacts each hazard may have on the built and natural environments, the population and the infrastructure. The methodology yields a Weighted Hazard Index, which is a measure of the likelihood of future occurrence for each hazard as well as the potential impacts each hazard may have on the built and natural environments, the population and the infrastructure.

The completed table also gives the town an overall understanding of the hazards, provides guidance on which hazards the Town may want to focus mitigation efforts on, reaffirms that Greenfield's planning and preparedness is on track, and shows residents that town departments and agencies are organized in case of a natural disaster. Note that the Assessment does not include manmade hazards, given lack of data assessed for this plan.

In rating the hazards, the committee considered the following issues for each category:

Issues considered when ranking probability of occurrence:

- 1) Known risk
- 2) Historical data (previous occurrences)

Issues considered when ranking severity of impacts:

- 1) Building stock
- 2) Critical facilities
- 3) Transportation systems
- 4) Lifeline utility systems
- 5) Communications systems and networks
- 6) High potential loss facilities
- 7) Hazardous material facilities
- 8) Economic elements
- 9) Special consideration areas
- 10) Historic, cultural, and natural resource areas
- 11) Natural resources

Issues considered when ranking preparedness:

- 1) Status of current plans
- 2) Training status
- 3) Availability of backup systems
- 4) Community resources (equipment, personnel, etc.)

The following rating charts were used to determine the rating for each event.

**Table 3-16: Probability of Occurrence Rating Chart**

| Classification | # | Probability of Occurrence  |
|----------------|---|--|
| Very High      | 5 | events that occur at least once each year (100% per year)                        |
| High           | 4 | events that occur from once in 2 years to once in 4 years (25% to 50% per year)  |
| Medium         | 3 | events that occur from once in 5 years to once in 50 years (2% to 20% per year)  |
| Low            | 2 | events that occur from once in 50 years to once in 100 years (1% to 2% per year) |
| Very Low       | 1 | events that occur less frequently than once in 100 years (less than 1% per year) |

**Table 3-17: Severity of Occurrence Rating Chart**

| Classification | # | Severity of Multiple Impacts   |
|----------------|---|--|
| Catastrophic   | 4 | Multiple deaths and injuries possible. More than 50% of property in affected area damaged or destroyed. Complete shutdown of facilities for 30 days or more. |
| Critical       | 3 | Multiple injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of facilities for more than 1 week.           |
| Limited        | 2 | Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of facilities for more than 1 day.                   |
| Minor          | 1 | Very few injuries, if any. Only minor property damage and minimal disruption on quality of life. Temporary shutdown of facilities.                           |

**Table 3-18: Severity of Impacts Definitions**

| Severity of Impact Category | Severity of Impact Category Definitions   |
|-----------------------------|---|
| Built                       | Building Stock includes residential, commercial, industrial, and institutional buildings.   |
| Built                       | Hazardous Material Facilities include facilities housing industrial/hazardous materials, such as corrosives, explosives, flammable materials, radioactive materials, and toxins.  |
| Built                       | Historic, Cultural, and Natural Resource Areas may include buildings, structures, objects, sites, national and local historic or significant districts, and historical archival storage facilities.   |
| Infrastructure              | Critical Facilities are essential to the health and welfare of the whole population and are especially important following hazard events. Since vulnerability is based on service losses as well as building structure integrity and content value, assess the effects on the service function interruption of critical facilities as well as their physical aspects. For purposes of this mitigation planning guidance, critical facilities may include emergency service facilities such as hospitals and other medical facilities, jails and juvenile detention centers, police and fire stations, emergency operations centers, public works facilities, evacuation shelters, schools, and other uses that house special needs populations. |
| Infrastructure              | Transportation Systems include airways (including airports, heliports, etc.), roadways (including highways, bridges, tunnels, roadbeds, overpasses, transfer centers, etc.), railways and public transit (including trackage, tunnels, bridges, rail yards, depots, etc.), and waterways (including canals, locks, seaports, ferries, harbors, dry-docks, piers, etc.).   |
| Infrastructure              | Lifeline Utility Systems such as potable water, wastewater, oil, natural gas, electric power, substations, power lines, etc.  |

| Severity of Impact Category | Severity of Impact Category Definitions   |
|-----------------------------|---|
| Infrastructure              | Communications Systems and Networks such as telephones, emergency service radio systems, repeater sites and base stations, television and radio stations, etc.  |
| Natural                     | Natural Resources include agricultural land, water supply lands, rivers.  |
| Population                  | High Potential Loss Facilities include facilities that would have a high loss associated with them, such as nuclear power plants or dams.   |
| Population                  | Economic Elements include major employers, financial centers, and other business or retail districts in the community that could significantly affect the local or regional economy if interrupted.                                     |
| Population                  | Special Consideration Areas include areas of high density residential, commercial, institutional, and industrial development that, if damaged, could result in economic and functional losses and in high death tolls and injury rates. |

**Table 3-19: Area of Occurrence Rating Chart**

| Classification | # | Percentage of Town Impacted         |
|----------------|---|-------------------------------------|
| Large          | 3 | More than 50% of the town affected. |
| Medium         | 2 | 10 to 50% of the town affected.     |
| Isolated       | 1 | Less than 10% of the town affected. |

**Table 3-20: Preparedness Rating Chart**

| Classification | # |
|----------------|---|
| Poor           | 3 |
| Fair           | 2 |
| Good           | 1 |

To determine the final hazard index for each hazard, each category was assigned a weight. Probability of Occurrence was given the most weight (45%), followed by Severity of Impacts (30%), Area of Occurrence (15%), and Preparedness (10%). Ratings were entered into a spreadsheet which calculated the weighted hazard index for each hazard. The Weighted Hazard Index represents the probability of occurrence of future events. Hazards with higher index scores represent the events most in need of organization focus and resources for emergency planning and mitigation projects.

The results of the All Hazards Vulnerability Assessment can be seen in Table 3-21. The hazards receiving a Weighted Hazard Index of 5 or more are – in order of vulnerability – Microbursts (including wind related events) (6.8), Hurricanes and Tornados (6.1), and Severe Winter Storms (5.2).

The committee evaluated microbursts and associated thunder and wind storms as particularly problematic, with issues such as power outages and debris removal common in the aftermath of such a storm. This is true of snow and ice storms as well. Given these issues and given the frequency of microbursts and wind-related storms, microbursts rated highest on the Weighted Hazard Index with a 6.8 rating. Hurricanes and severe winter storms rated next highest on the Index, with severe winter storms causing issues of power outages and debris removal, among other effects.

The hazards rated on the Weighted Hazard Index between 4 and 5 include floods, tornados, earthquakes and wildfires. In the case of floods, earthquakes and wildfires, there were all evaluated as having a high probability of occurrence but relatively low severity of impact and limited area of occurrence. The Committee acknowledged that earthquakes occur quite frequently in New England, but are rarely large enough to be felt. Landslides, ice dams and dam failures were rated lowest on the Weighted Hazard Index.

In terms of preparedness, the Committee rated the Town as being fair or good for all hazards, while acknowledging the need for improvements such a:

- Implementing Reverse 911 system
- Purchasing equipment for tree and debris removal
- Increasing debris disposal sites
- Sharing of equipment and sites on a multiple town or regional basis
- Conducting a hazardous tree assessment
- Purchasing emergency back-up generators for all emergency facilities
- Addressing animal control and sheltering during emergencies
- Inspecting the Mill and Meridian Street Dams

These needed improvements are included as action items in the Action Plan.

The Weighted Hazard Index is a crucial tool in helping the Committee and Town prioritize its action items. See the Future Mitigation Strategies section to understand how this information was applied to action item prioritization.

**Table 3-21: TOWN OF GREENFIELD All Hazards Vulnerability Assessment**

| EVENTS   | Probability of Occurrence (FOO)* | POC Weighted Value | Severity of Impacts* (SOI) |              |                 |                     | SOI Weighted Value | Area of Occurrence* | Add Weighted Value | Preparedness | Prep. Weighted Value | Weighted Hazard Index   |
|--|----------------------------------|--------------------|----------------------------|--------------|-----------------|---------------------|--------------------|---------------------|--------------------|--------------|----------------------|---|
| ASSIGNED WEIGHTING FACTOR                                    | 45%                              |                    | 30%                        |              |                 |                     |                    | 15%                 |                    | 10%          |                      |  |
| INDEX VALUE  | 1-5                              |                    | Built 1-4*                 | Natural 1-4* | Population 1-4* | Infrastructure 1-4* |                    | 1-3                 |                    | 1-3          |                      |   |
| <b>HAZARDS</b>   |                                  |                    |                            |              |                 |                     |                    |                     |                    |              |                      |   |
| Microbursts (Includes Thunderstorms and Wind Related Events) | 5                                | 2.25               | 3                          | 3            | 4               | 3                   | 3.9                | 3                   | 0.45               | 2            | 0.2                  | <b>6.8</b>  |
| Hurricanes/Tropical Storms                                   | 4                                | 1.8                | 3                          | 3            | 3               | 3                   | 3.6                | 3                   | 0.45               | 2            | 0.2                  | <b>6.1</b>  |
| Severe Winter Storms   | 5                                | 2.25               | 2                          | 2            | 2               | 2                   | 2.4                | 3                   | 0.45               | 1            | 0.1                  | <b>5.2</b>  |
| Floods   | 5                                | 2.25               | 2                          | 1            | 2               | 2                   | 2.1                | 1                   | 0.15               | 2            | 0.2                  | <b>4.7</b>  |
| Tornados   | 3                                | 1.35               | 2                          | 3            | 2               | 2                   | 2.7                | 1                   | 0.15               | 2            | 0.2                  | <b>4.4</b>  |
| Earthquakes  | 5                                | 2.25               | 1                          | 1            | 1               | 1                   | 1.2                | 3                   | 0.45               | 2            | 0.2                  | <b>4.1</b>  |
| Wildfires / Brush Fires                                      | 5                                | 2.25               | 1                          | 2            | 1               | 1                   | 1.5                | 1                   | 0.15               | 1            | 0.1                  | <b>4.0</b>  |
| Landslides   | 3                                | 1.35               | 2                          | 2            | 1               | 2                   | 2.1                | 1                   | 0.15               | 2            | 0.2                  | <b>3.8</b>  |
| Ice Jams   | 3                                | 1.35               | 1                          | 2            | 1               | 1                   | 1.5                | 1                   | 0.15               | 2            | 0.2                  | <b>3.2</b>  |
| Dam Failures   | 1                                | 0.45               | 2                          | 2            | 2               | 2                   | 2.4                | 1                   | 0.15               | 2            | 0.2                  | <b>3.2</b>  |

## **Vulnerability Assessment**

---

### **Vulnerability Overview**

This section presents exposure, damages, loss estimates, population impacts and data deficiencies for each of the hazards addressed in the Multi-Hazard Identification and Profile Section of the Plan. Additionally, an overall vulnerability assessment is provided for each hazard. This analysis is an in-depth look at each hazard in Greenfield. Coupled with the All Hazards Vulnerability Assessment from the previous section, these findings will support planning efforts based on a better understanding of the potential impacts associated with each hazard and provide a foundation for the mitigation strategy presented in Section 5.

### ***Vulnerability Assessment Methodology***

The Vulnerability Assessment is a series of tables that enabled FRCOG staff to determine the vulnerability of Greenfield to flooding and to calculate the potential costs of flooding to the town.<sup>51</sup> Estimated losses for all other hazard events were also determined, based on damages from past recorded events. The potential implications for vulnerable populations such as senior and low income populations in the event of a hazard are also assessed.

### ***Environmental Justice***

Identifying vulnerable populations in a town can be challenging. It can be assumed that senior populations may be more vulnerable—and thus might be more at risk for certain hazards—due to their possible loss of mobility and the increased likelihood that elderly people live alone and may have less access to information. People of low income may also face higher risks due in part to less access to information and the higher likelihood of living in undesirable or poor quality housing and/or locations, such as those adjacent to areas zoned industrial or in the floodplain, for example.

In 1994, President Clinton issued Executive Order 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,” directing federal agencies to address environmental injustices in their operations and in communities across the country. Since then, states and municipalities have developed policies and programs to proactively address environmental equity concerns to help ensure that minority and low-income communities are not disproportionately impacted by environmental hazards.<sup>52</sup>

There are many obstacles that make it challenging for Environmental Justice (EJ) populations to participate in such things as planning and development decisions in their communities. These residents are more likely to be unaware of environmental issues due to social issues including language barriers and limited access to educational resources. In addition, EJ populations are often unable to participate in environmental decision-making processes because they often must work longer hours to compensate for lower hourly wages.<sup>53</sup> Thus decisions that may directly impact where they live may be made by a town without their voices being heard.

---

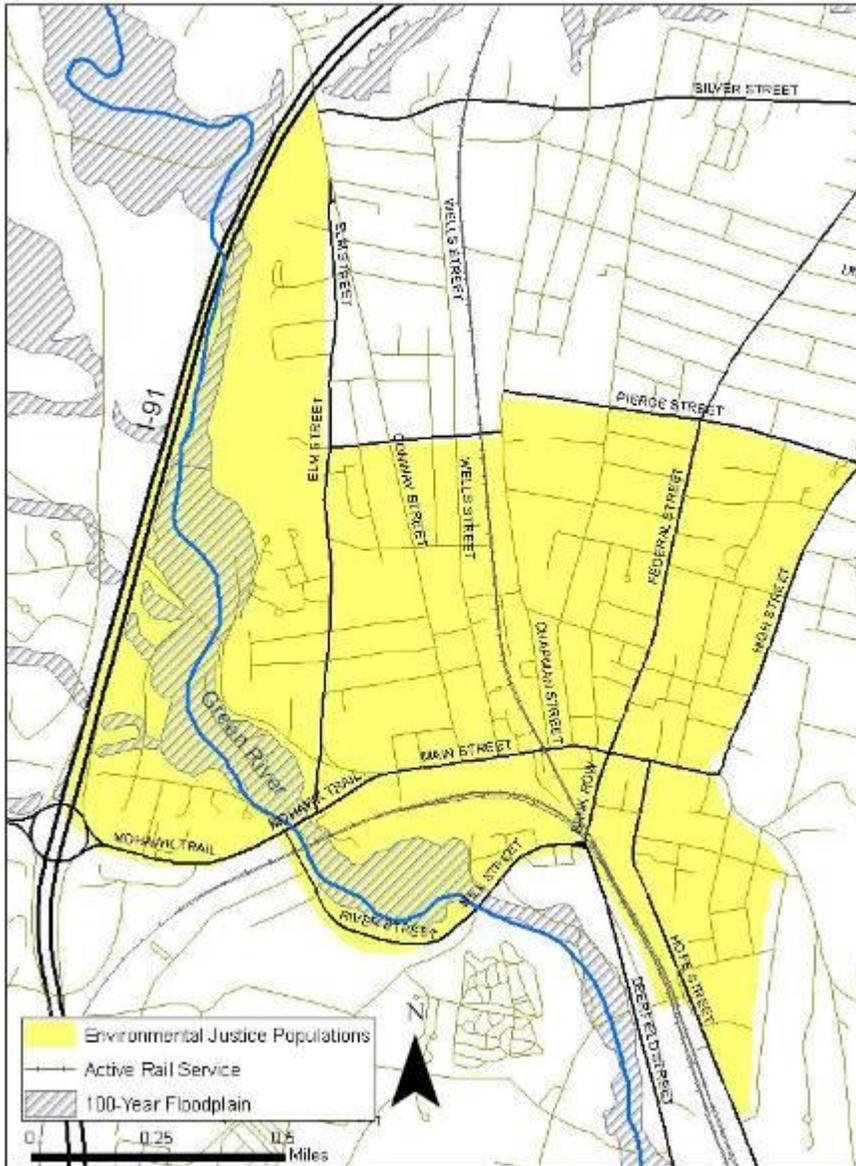
<sup>51</sup> These tables were developed to provide towns with a template for calculating and estimating potential losses and costs of flooding. They draw from and integrate the work of other Natural Hazard Mitigation Plans, specifically the Natural Hazard Mitigation Plan for Thurston County, Washington, September 2009, but the tables can be linked to the most recent demographic, land use, and infrastructure information (databases) and automatically calculate and estimate the cost of flooding to each town or region.

<sup>52</sup> <http://www.mass.gov>

<sup>53</sup> [http://www.mass.gov/envir/smart\\_growth\\_toolkit/pages/mod-ej.html](http://www.mass.gov/envir/smart_growth_toolkit/pages/mod-ej.html)

In 2003, based upon 2000 census data, MassGIS produced Environmental Justice Populations layers representing neighborhoods across the state with high minority, non-English speaking, low-income, and foreign-born populations.<sup>54</sup>

### Town of Greenfield Environmental Justice Populations



Source: Mass GIS Data

EJ Populations in Massachusetts are determined by the following criteria:

- Households earn 65% or less of the statewide household median income; or

<sup>54</sup> [http://www.mass.gov/mgis/cen2000\\_ej.htm](http://www.mass.gov/mgis/cen2000_ej.htm)

- 25% or more of the residents are minority; or
- 25% or more of the residents are foreign-born; or
- 25% or more of the residents are lacking English language proficiency

Based upon these criteria, the Franklin County towns with Environmental Justice populations are Greenfield, Montague and Orange. Sections of all three towns were categorized as such based on the low income criteria. In Greenfield, the EJ area is roughly bounded by Interstate 91 to the west, Pierce Street to the north, High Street to the east and River Street to the south, as shown in the map above. Some of the EJ area also overlaps with areas in the floodplain, is along the rail line, and/or is adjacent to areas zoned industrial. See Manmade Hazards for additional information on impacts to populations related to rail on pages 53-58.

As Greenfield works to mitigate hazards in Town, concentrating public education and outreach in the EJ area could be a priority. The Town could also evaluate action items to determine if their implementation could have a disproportionately high and adverse impact to Environmental Justice populations. Some hazard mitigation projects with the potential to cause these effects include flood control projects, and stormwater management projects.

## **Floods**

### ***Hazard Summary***

Flooding can be caused by severe storms, such as hurricanes, nor'easters, and microbursts, as well as ice jams and snow melt. To determine the vulnerability of the Town, properties within the flood hazard area were identified and damage assessments were then generated for the various classes of property — residential, commercial, industrial, public and institutional land uses. The damage estimates presented in the following tables are rough estimates and reflect a worst-case scenario. These estimates should be used only within the context of this Multi-Hazard Mitigation planning effort. Computing detailed damage assessments is a complex task and is the reason FRCOG developed the linked tables, which use town demographics and values.

In updating the Hazard Mitigation Plan for Greenfield, more detailed data was gathered and calculated for the value of residential, commercial, industrial and public/institutional properties as well as agricultural lands. Transportation and waste disposal land uses were beyond the scope of the assessment.

### ***Data Collected and Used***

National weather databases and Town of Greenfield data were collected and analyzed. Data on historic property damage and loss, and injuries and deaths, was collected for Franklin County from the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center website. This data was used to support an evaluation of exposure and potential impacts associated with this hazard. Available historic data were presented in Tables 3-1 and 3-2. The Commonwealth of Massachusetts State Hazard Mitigation Plan 2010 was also reviewed for information on flooding.

## ***Impact on the Community***

### **Exposure and Loss Estimation**

Flooding can cause a wide range of issues, from minor nuisance roadway flooding and basement flooding to major impacts such as roadway closures and residential evacuations. Specific damages associated with flooding events include the following primary concerns:

- Blockages of roadways or bridges vital to travel and emergency response
- Breaching of dams
- Damaged or destroyed buildings and vehicles
- Uprooted trees causing power and utility outages
- Drowning, especially people trapped in cars
- Contamination of drinking water
- Dispersion of hazardous materials
- Interruption of communications and/or transportation systems
- Debris management issues including debris removal and identification of disposal sites

### **Property Damage**

The following discussion and tables examine the potential cost of flooding to Greenfield for land uses and facilities located in the floodplain should catastrophic flooding occur resulting in a worst-case scenario. Of Greenfield's total of 14,037 acres, 1,449 acres – or about 10% – lie within the 100-year floodplain. Table 3-22 shows the number of dwelling units in the flood hazard area (floodplain) in Greenfield. The figures in the last two columns of the table are calculated using data from the U.S. Census and MassGIS. In Greenfield less than 1% of the population resides in the floodplain.

**Table 3-22: Number of Dwelling Units in the Flood Hazard Area**

| Total Town Population <sup>55</sup> | Average per household population <sup>56</sup> | Number of Dwelling Units in Flood Hazard Area <sup>57</sup> | Estimated population in Flood Hazard Area | % of total population that reside in the Flood Hazard Area |
|-------------------------------------|--|---|---|--|
| 17,456                              | 2.19   | 38  | 83  | 0.005%   |

Table 3-23 shows the total acreage of each type of land use – commercial, industrial and public/institutional – in Greenfield; the total acreage for each of the three types of land use in the floodplain in town; and the percentage of the total acreage for each type of land use in the floodplain in Greenfield.<sup>58</sup> In all, 2% of the land in the floodplain is used for commercial, industrial and public/institutional purposes.

---

<sup>55</sup> U.S. Census, 2010.

<sup>56</sup> U.S. Census, 2000.

<sup>57</sup> Mass GIS

<sup>58</sup> Mass GIS

**Table 3-23: Acres of Commercial, Industrial and Public/Institutional Land Uses in the Flood Hazard Area**

|                      | Total acres of land use in Town | Acres of land use in Flood Hazard Area | % of land use acres in the Flood Hazard Area of the Town |
|----------------------|---------------------------------|--|--|
| Commercial           | 402.98                          | 13.57                                  | 3%   |
| Industrial           | 183.13                          | 1.86                                   | 1%   |
| Public/Institutional | 239.31                          | 4.81                                   | 2%   |

Table 3-24 summarizes the average assessed value of the five types of land uses in Greenfield in the floodplain – residential, commercial, industrial, public/institutional and agricultural.<sup>59</sup> The total worth of lands in the floodplain is assessed at almost \$4.5 billion. This is of concern because should a catastrophic flooding event befall Greenfield, the assessed values of these structures and facilities would likely be significantly reduced which in turn would severely impact the town’s tax revenues.

**Table 3-24: Average Assessed Value of Land Use in Flood Hazard Area**

|                    | Total Acres in Town | Total Assessed Value | Average Assessed Value Per Acre | Acres in Floodplain | Average Assessed Value in Floodplain |
|--------------------|---------------------|----------------------|---------------------------------|---------------------|--------------------------------------|
| <b>Residential</b> | 2,598.51            | \$253,678,000        | \$97,624                        | 42.99               | \$4,196,873.29                       |
| <b>Commercial</b>  | 11.3                | \$1,992,179          | \$176,299                       | 0.49                | \$86,387                             |
| <b>Industrial</b>  | 2.7                 | \$793,900            | \$294,037                       | 0.48                | \$141,138                            |

Table 3-25 lists the estimated value of the contents of the different classes of buildings and facilities. The value is presented as a percentage of the replacement value of the building and the class of structure.<sup>60</sup> The percentages vary for certain classes because the replacement cost of the contents is different from institution to business to service.

**Table 3-25: Estimates of Building Contents by Class**

| Occupancy Class   | Contents Value % |
|---|------------------|
| Residential (including temporary lodging, dormitory, and nursing homes)                                 | 50%              |
| Commercial (including retail, wholesale, professional, services, financial, entertainment & recreation) | 100%             |
| Commercial (including hospital and medical office/clinic)   | 150%             |
| Commercial Parking  | 50%              |
| Industrial (including heavy, light technology)  | 150%             |
| Agriculture   | 100%             |
| Religion/Non-Profit   | 100%             |
| Government Emergency Response   | 150%             |
| Government General Services   | 100%             |
| Education Schools/Libraries   | 100%             |
| Education Colleges/Universities   | 150%             |

<sup>59</sup> Massachusetts Department of Revenue.

<sup>60</sup> Town of Clay Hazard Mitigation Plan

Table 3-26 shows the total value of replacing the structures and contents of buildings located in the floodplain in Greenfield. In total, the structures and building contents are valued in excess of \$5.7 million. It is evident that catastrophic flooding would cause significant economic, financial and environmental damage.

**Table 3-26: Total Building and Contents Value in Flood Hazard Area**

|                      | Building Structure Value in Flood Hazard Area | Building Contents Value in Flood Hazard Area | Total Building and Contents Value in Flood Hazard Area |
|----------------------|---|--|--|
| Commercial           | \$243,076,431                                 | 100%   | \$486,152,862  |
| Industrial           | \$33,819,460                                  | 150%   | \$84,548,650   |
| Public/Institutional | \$184,675                                     | 150%   | \$461,688  |

Table 3-27 identifies the average assessed value of all residential, commercial, and industrial land uses located in the floodplain in Greenfield, and the losses that would result from 1%, 5%, and 10% damage to this inventory as a result of a major flooding event

**Table 3-27: Potential Estimated Loss in Flood Hazard Area by Land Use**

| Land Use     | Average Assessed Value of Land in Floodplain | 1% Damage Loss Estimate | 5% Damage Loss Estimate | 10% Damage Loss Estimate |
|--------------|--|-------------------------|-------------------------|--------------------------|
| Residential  | \$17,460,450.61                              | \$174,605               | \$873,023               | \$1,746,045              |
| Commercial   | \$8,185,386.79                               | \$81,854                | \$409,269               | \$818,539                |
| Industrial   | \$343,494.76                                 | \$3,435                 | \$17,175                | \$34,349                 |
| <b>Total</b> | <b>\$25,989,332.17</b>                       | <b>\$259,893.32</b>     | <b>\$1,299,466.61</b>   | <b>\$2,598,933.22</b>    |

Source: Massachusetts Dept. of Revenue - Division of Local Services, Municipal Databank/Local Aid Section 2010.

Repetitive Loss Properties

Repetitive loss properties are those for which two or more losses of at least \$1000 each have been paid under the National Flood Insurance Program (NFIP) within any 10-year period since 1978. According to MEMA, as of June 2013, there are three repetitive loss structures in Franklin County, including one in Greenfield. See page 143 for more information on NFIP.

Population Impacts – Senior Citizens and People of Low Income

Certain segments of Greenfield’s population – seniors and people of low income and/or Environmental Justice populations– may be more vulnerable to flooding and other events (see Environmental Justice section, pages 64-66). The Town should be aware of the potential needs of these residents in the event of a hazard occurrence Table 3–28 displays the number of senior and people of low income residents in Greenfield. It should be noted that there may be overlap within the two categories, so that the total number of individuals exposed may be lower than what is shown in the table.

**Table 3-28: Senior and Low Income Populations in Greenfield Exposed to Hazards**

| Population Category           | Number of Persons Exposed | Percentage of Total Population |
|-------------------------------|---------------------------|--------------------------------|
| Senior (Over 65 years of age) | 3,178                     | 17.5%                          |

| Population Category  | Number of Persons Exposed | Percentage of Total Population |
|--|---------------------------|--------------------------------|
| Low Income (Persons with annual incomes less than \$25,000)* | 5,320                     | 29.3%                          |
| <b>Total</b>   | <b>8,498</b>              | <b>46.8%</b>                   |

\* Low income population was calculated by multiplying 2000 U.S. Census Households with Incomes of Less than \$25,000 (116) by 2000 U.S. Census Average Household Size (2.45). Source: 2000 U.S. Census.

### ***Overall Vulnerability Assessment***

Flooding is common in New England, and can cause significant impacts to the roads, structures, facilities, utilities, and populations, including Greenfield. Existing and future mitigation efforts should continue to be developed and employed that will enable Greenfield to be prepared for these events when they occur. Particular areas of vulnerability include Environmental Justice and elderly populations, trailer homes, and infrastructure, floodplain areas and those mapped on the Critical Facilities and Infrastructure Map (page 99). In addition, vulnerable areas include the low-lying areas that can be impacted by flooding related to ice jams, heavy rain events or rapid snow melt.

### ***Data Deficiencies***

In assessing the risks to Greenfield from flood hazards, the following data deficiencies were identified:

- The towns of Franklin County rely on farming for one of its income sources. Little data exists on localized crop damage due to flooding.
- Data for the location and condition of dams within Greenfield resides with the DCR Office of Dam Safety and with FERC. New software and reporting systems within the Office of Dam Safety has resulted in missing data and questions as to the status of some dams. Requests for additional information have been referred to the Office of Dam Safety's Legal Department, which charges for any requests for information.

## **Severe Winter Storms**

### ***Hazard Summary***

Severe snow and ice storms are common in Greenfield, often impacting the Towns' roads, structures, facilities, utilities, and population. Existing and future mitigation efforts should continue to be developed and employed that will enable the Town to be prepared for these events. Severe winter storms cause significant concern because they happen often and can be quite severe; they cost residents money; they require snow and ice removal, which can limit access to facilities and can cause health problems; they can cause utility failure and flooding from ice jams; and they put stress on community resources.

### ***Data Collected and Used***

National weather databases and Town of Greenfield data were collected and analyzed. Data on historic property damage and loss, and injuries and deaths, was collected for Franklin County from the National Oceanic and Atmospheric Administration's (NOAA) National Climactic Data Center website. This data was used to support an evaluation of exposure and potential impacts associated with this hazard. Available historic data are presented in Table 3-29. The

Commonwealth of Massachusetts State Hazard Mitigation Plan 2010 was also reviewed for information on severe winter storm hazard data and mitigation measures.

***Impact on the Community***

***Exposure and Loss Estimation***

Heavy snowfall coupled with low temperatures often results in increases in traffic accidents; disruptions in transportation, commerce, government, and education; utility outages due to falling trees, branches, and other objects; personal injuries associated with slippery surfaces and freezing temperatures; and numerous other problems. Specific damages associated with severe winter storm (snow) events include the following primary concerns:

- Injuries and fatalities associated with accidents, low temperatures, power loss, falling objects and accidents associated with slippery surfaces and snow accumulation
- Increases in the frequency and impact of traffic accidents, resulting in personal injuries
- Ice-related damage to trees, building and infrastructure inventory, and utilities (power lines, bridges, substations, etc.)
- Roads damaged through freeze and thaw processes
- Stress on the local shelters and emergency response infrastructure
- Lost productivity that occurs when people cannot go to work, school, or stores due to inclement conditions
- Debris management issues including debris removal and identification of disposal sites

New England’s climate offers no immunity to the potential damaging effects of severe winter storms. Some minimum damage is anticipated annually, with potential extensive damage occurring about once every 10 years.

***Property Damage***

According to the National Climatic Data Center (NCDC), there have been a total of 115 snow and ice events reported in Franklin County between 1993 and 2013, including heavy snow, snow, ice storms, snow squalls, freezing rain and winter storms. The NCDC web site has more detailed information about each of the listed storms. An average of 5 such events occurs each year. Over 21 years, winter storms have caused an average of \$3.9 million in damages per year in Franklin County.

**Table 3-29: Severe Winter Storms in Franklin County (Heavy Snow/Ice)**

| <b>Year</b> | <b># of Heavy Snow/Ice Events</b> | <b>Annual Property Damage</b> | <b>Annual Crop Damage</b> |
|-------------|-----------------------------------|-------------------------------|---------------------------|
| 2013        | 0                                 | \$0                           | \$0                       |
| 2012        | 2                                 | \$0                           | \$0                       |
| 2011        | 2                                 | \$1.01 million                | \$0                       |
| 2010        | 3                                 | \$30,000                      | \$0                       |
| 2009        | 5                                 | \$0                           | \$0                       |
| 2008        | 12                                | \$6,020,000                   | \$0                       |
| 2007        | 7                                 | \$10,000                      | \$0                       |
| 2006        | 0                                 | \$0                           | \$0                       |
| 2005        | 9                                 | \$625,000                     | \$0                       |

| Year       | # of Heavy Snow/Ice Events | Annual Property Damage         | Annual Crop Damage         |
|------------|----------------------------|--------------------------------|----------------------------|
| 2004       | 3                          | \$0                            | \$0                        |
| 2003       | 5                          | \$50,000                       | \$0                        |
| 2002       | 7                          | \$1,605,000                    | \$0                        |
| 2001       | 7                          | \$11,000,000                   | \$0                        |
| 2000       | 7                          | \$0                            | \$0                        |
| 1999       | 6                          | \$0                            | \$0                        |
| 1998       | 3                          | \$0                            | \$0                        |
| 1997       | 6                          | \$10,030,000                   | \$0                        |
| 1996       | 10                         | \$47,000,000                   | \$0                        |
| 1995       | 6                          | \$0                            | \$0                        |
| 1994       | 8                          | \$5,050,000                    | \$0                        |
| 1993       | 7                          | \$0                            | \$0                        |
| # of Years | Total # of Events          | Average Annual Property Damage | Average Annual Crop Damage |
| <b>21</b>  | <b>115</b>                 | <b>\$3,925,238</b>             | <b>\$0</b>                 |

Source: NOAA National Climatic Data Center. <http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms>.

As indicated in the Risk Assessment section of this plan, a winter storm in 2008 left residents in Franklin County without power for several days. Greenfield was fortunate; the storm did not cause power outages in town. There was some property damage from the winds that required clean up and disposal of debris. However, because Greenfield did not lose power it became a refuge. Many residents from around Franklin County relied on the hospitality of Greenfield's hotels, motels and inns and restaurants, cafes, and coffee shops to weather the storm and power outages. Total property damage from this storm total was not available. Estimated costs to the Town for storm response, including staffing shelters and providing food and water, were also not available.

### *Population Impacts*

Populations considered most vulnerable to severe winter storm impacts are identified based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Table 3-30 summarizes the population in Greenfield over the age of 65 or living in households with an income below \$25,000 per year. See also Environmental Justice section on pages 64-66.

**Table 3-30: Senior and Low Income Populations in Greenfield Exposed to Hazards**

| Population Category  | Number of Persons Exposed | Percentage of Total Population |
|--|---------------------------|--------------------------------|
| Senior (Over 65 years of age)                                | 3,178                     | 17.5%                          |
| Low Income (Persons with annual incomes less than \$25,000)* | 5,320                     | 29.3%                          |
| <b>Total</b>   | <b>8,498</b>              | <b>46.8%</b>                   |

\* Low income population was calculated by multiplying 2000 U.S. Census Households with Incomes of Less than \$25,000 (116) by 2000 U.S. Census Average Household Size (2.45). Source: 2000 U.S. Census.

The entire built environment of Greenfield is vulnerable to a severe winter storm. Table 3-31 identifies the assessed value of all residential, commercial, and industrial land uses in Town, and the losses that would result from 1%, 5%, and 10% damage to this inventory as a result of a severe winter storm.

**Table 3-31: Potential Estimated Loss by Land Use**

| Land Use           | Total Assessed Value   | 1% Damage Loss Estimate | 5% Damage Loss Estimate | 10% Damage Loss Estimate |
|--------------------|------------------------|-------------------------|-------------------------|--------------------------|
| <b>Residential</b> | \$1,055,388,591        | \$10,553,886            | \$52,769,430            | \$105,538,859            |
| <b>Commercial</b>  | \$243,076,431          | \$2,430,764             | \$12,153,822            | \$24,307,643             |
| <b>Industrial</b>  | \$33,819,460           | \$338,195               | \$1,690,973             | \$3,381,946              |
| <b>Total</b>       | <b>\$1,332,284,482</b> | <b>\$13,322,845</b>     | <b>\$66,614,224</b>     | <b>\$133,228,448</b>     |

Source: Massachusetts Department of Revenue - Division of Local Services, Municipal Databank/Local Aid Section 2010.

### ***Overall Vulnerability Assessment***

Severe winter storms are common in New England, often causing significant impacts to the roads, structures, facilities, utilities, and population of Greenfield. Existing and future mitigation efforts should continue to be developed and employed that will enable Greenfield to be prepared for these events when they occur. The cascade effects of severe winter storms include utility losses, transportation accidents, and flooding. Losses associated with flooding are discussed earlier in this section. Particular areas of vulnerability include low-income and elderly populations, trailer homes, and infrastructure such as roadways and utilities that can be damaged by such storms and the low-lying areas that can be impacted by flooding related to ice jams or rapid snow melt.

### ***Data Deficiencies***

In assessing the risks to Greenfield from severe snow and ice storms, the following data deficiencies were identified:

- The towns of Franklin County rely on farming for one of its income sources. Little data exists on localized crop damage due to these hazards.

## **Hurricanes**

### ***Hazard Summary***

Hurricanes and tropical storms can cause severe impacts such as flooding, power outages, flying debris, damage to property and injury and loss of life. Existing and future mitigation efforts should continue to be developed and employed that will enable the Town to be prepared for these events.

Hurricanes or tropical cyclones can spin off tornadoes and bring thunderstorms, high winds and, in coastal areas, storm surges in the sea, possibly resulting in beach erosion and loss or damage to property. (See Tornadoes and Microbursts Section) Inland, hurricanes mainly bring heavy rains that can cause flooding.

### ***Data Collected and Used***

National weather databases and Town of Greenfield data were collected and analyzed. Data on historic property damage and loss, and injuries and deaths, was collected for Franklin County from the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center website, and the Spatial Hazard Events and Losses Database (SHELDUS). This data was used to support an evaluation of exposure and potential impacts associated with this hazard. The Commonwealth of Massachusetts State Hazard Mitigation Plan 2010 was also reviewed for information on thunderstorms, hurricanes and tornadoes hazard data and mitigation measures.

### ***Impact on the Community***

#### ***Exposure and Loss Estimation***

High winds and heavy rain associated with hurricanes and tropical storms can cause damage to utilities, structures, roads, trees (potentially causing vehicle accidents) and injuries and death. Other issues associated with this type of hazard include debris management issues including debris removal and identification of disposal sites.

#### ***Property Damage***

As presented in Table 3-32, historic data for hurricane and tropical storm events indicate one hurricane and 17 tropical storms have been recorded in Franklin County. Hurricane Bob in 1991 caused over \$5.5 million in property damage in the county, and over \$500,000 in crop damage. In 2011, Tropical Storm Irene caused over \$25 million in property damage. Overall, tropical storms and hurricanes have caused an average annual property damage of just \$1.3 million over the last 24 years.

**Table 3-32: Hurricane and Tropical Storm Events in Franklin County**

| <b>Year</b> | <b># of Hurricane/Tropical Storm Events</b> | <b>Annual Property Damage</b> | <b>Annual Crop Damage</b> |
|-------------|---|-------------------------------|---------------------------|
| 2013        | 0   | \$0                           | \$0                       |
| 2012        | 0   | \$0                           | \$0                       |
| 2011        | 1   | \$25,325,000                  | \$0                       |
| 2010        | 0   | \$0                           | \$0                       |
| 2009        | 0   | \$0                           | \$0                       |
| 2008        | 0   | \$0                           | \$0                       |
| 2007        | 0   | \$0                           | \$0                       |
| 2006        | 5   | \$277,861                     | \$0                       |
| 2005        | 1   | \$33,889                      | \$0                       |
| 2004        | 1   | \$37,778                      | \$0                       |
| 2003        | 2   | \$127,381                     | \$0                       |
| 2002        | 0   | \$0                           | \$0                       |
| 2001        | 0   | \$0                           | \$0                       |
| 2000        | 0   | \$0                           | \$0                       |

| Year       | # of Hurricane/Tropical Storm Events | Annual Property Damage         | Annual Crop Damage         |
|------------|--------------------------------------|--------------------------------|----------------------------|
| 1999       | 1                                    | \$7,692                        | \$0                        |
| 1998       | 2                                    | \$63,269                       | \$0                        |
| 1997       | 0                                    | \$0                            | \$0                        |
| 1996       | 0                                    | \$0                            | \$0                        |
| 1995       | 1                                    | \$0                            | \$0                        |
| 1994       | 1                                    | \$35,714                       | \$0                        |
| 1993       | 0                                    | \$0                            | \$0                        |
| 1992       | 0                                    | \$0                            | \$0                        |
| 1991       | 1                                    | \$5,555,556                    | \$555,556                  |
| 1990       | 2                                    | \$7,142                        | \$0                        |
| # of Years | Total # of Events                    | Average Annual Property Damage | Average Annual Crop Damage |
| <b>24</b>  | <b>18</b>                            | <b>\$1,373,746</b>             | <b>\$26,455</b>            |

Source: Spatial Hazard Events and Losses Database for the United States (SHELDUS):

<http://webra.cas.sc.edu/hvri/products/sheldus.aspx>.

[http://www.ncdc.noaa.gov/stormevents/listevents.jsp?beginDate\\_mm=01&beginDate\\_dd=01&beginDate\\_yyyy=1996&endDate\\_mm=08&endDate\\_dd=31&endDate\\_yyyy=2013&eventType=%28Z%29+Tropical+Storm&county=FRANKLIN&zone=WESTERN%20FRANKLIN&submitButton=Search&statefips=25%20MASSACHUSETTS](http://www.ncdc.noaa.gov/stormevents/listevents.jsp?beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1996&endDate_mm=08&endDate_dd=31&endDate_yyyy=2013&eventType=%28Z%29+Tropical+Storm&county=FRANKLIN&zone=WESTERN%20FRANKLIN&submitButton=Search&statefips=25%20MASSACHUSETTS)

### ***Population Impacts***

As discussed above, some traffic accidents associated with storm events include injuries and deaths. However, the number of injuries and deaths reported for accidents is generally low.

Populations considered most vulnerable to hurricane and tropical storm impacts in Greenfield are identified based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Table 3-33 summarizes the population over the age of 65 or living in households with an annual income below \$25,000. See also Environmental Justice section on pages 64-66.

**Table 3-33: Senior and Low Income Populations in Greenfield Exposed to Hazards**

| Population Category  | Number of Persons Exposed | Percentage of Total Population |
|--|---------------------------|--------------------------------|
| Senior (Over 65 years of age)                                | 3,178                     | 17.5%                          |
| Low Income (Persons with annual incomes less than \$25,000)* | 5,320                     | 29.3%                          |
| <b>Total</b>   | <b>8,498</b>              | <b>46.8%</b>                   |

\* Low income population was calculated by multiplying 2000 U.S. Census Households with Incomes of Less than \$25,000 (116) by 2000 U.S. Census Average Household Size (2.45). Source: 2000 U.S. Census.

### ***Overall Vulnerability Assessment***

Hurricanes and tropical storms are uncommon in Franklin County, but when they do occur these storms can cause significant damage. Existing and future mitigation efforts should continue to be developed and employed that will enable Greenfield to be prepared for these events. The cascade effects of severe storms include utility losses and transportation accidents and flooding. Losses associated with the flood hazard are discussed earlier in this section. Particular areas of vulnerability include low-income and elderly populations, trailer homes, and infrastructure such as roadways and utilities that can be damaged by such storms and the low-lying areas that can be impacted by flooding.

### ***Data Deficiencies***

In assessing the risks to Greenfield from hurricanes and tropical storms, no data deficiencies were identified.

## **Tornados**

### ***Hazard Summary***

While uncommon in Greenfield, tornados could potentially cause severe wind-related damage, including downed trees and power lines, power outages and damage to the built and natural environment.

### ***Data Collected and Used***

National weather databases and Town of Greenfield data were collected and analyzed. Data on historic property damage and loss, and injuries and deaths, was collected for Franklin County from the National Oceanic and Atmospheric Administration's (NOAA) National Climactic Data Center website, and the Spatial Hazard Events and Losses Database (SHELDUS). This data was used to support an evaluation of exposure and potential impacts associated with this hazard. The Commonwealth of Massachusetts State Hazard Mitigation Plan 2010 was also reviewed for information on tornado hazard data and mitigation measures.

### ***Impact on the Community***

#### ***Exposure and Loss Estimation***

High winds and heavy rain and/or hail associated with tornados can cause damage to utilities, structures, roads, trees (potentially causing vehicle accidents) and injuries and death. Other issues associated with this type of hazard include debris management issues including debris removal and identification of disposal sites.

#### ***Property Damage***

As presented in Table 3-34, historic data for tornado events indicate that between 1991 and 2013, 4 tornados were recorded in Franklin County. Over 23 years, tornados have caused an average of \$14,130 in property damages yearly.

**Table 3-34: Tornado Events in Franklin County**

| Year              | # of Tornado Events      | Annual Property Damage                | Annual Crop Damage                |
|-------------------|--------------------------|---------------------------------------|-----------------------------------|
| 2013              | 0                        | \$0                                   | \$0                               |
| 2012              | 0                        | \$0                                   | \$0                               |
| 2011              | 0                        | \$0                                   | \$0                               |
| 2010              | 0                        | \$0                                   | \$0                               |
| 2009              | 0                        | \$0                                   | \$0                               |
| 2008              | 0                        | \$0                                   | \$0                               |
| 2007              | 0                        | \$0                                   | \$0                               |
| 2006              | 1                        | \$200,000                             | \$0                               |
| 2005              | 0                        | \$0                                   | \$0                               |
| 2004              | 0                        | \$0                                   | \$0                               |
| 2003              | 0                        | \$0                                   | \$0                               |
| 2002              | 0                        | \$0                                   | \$0                               |
| 2001              | 0                        | \$0                                   | \$0                               |
| 2000              | 0                        | \$0                                   | \$0                               |
| 1999              | 0                        | \$0                                   | \$0                               |
| 1998              | 0                        | \$0                                   | \$0                               |
| 1997              | 2                        | \$100,000                             | \$0                               |
| 1996              | 0                        | \$0                                   | \$0                               |
| 1995              | 0                        | \$0                                   | \$0                               |
| 1994              | 0                        | \$0                                   | \$0                               |
| 1993              | 0                        | \$0                                   | \$0                               |
| 1992              | 1                        | \$25,000                              | \$0                               |
| 1991              | 0                        | \$0                                   | \$0                               |
| <b># of Years</b> | <b>Total # of Events</b> | <b>Average Annual Property Damage</b> | <b>Average Annual Crop Damage</b> |
| <b>23</b>         | <b>4</b>                 | <b>\$14,130</b>                       | <b>\$0</b>                        |

**Source:** National Oceanic and Atmospheric Administration’s (NOAA) National Climatic Data Center Storm Events Database website: <http://www.ncdc.noaa.gov/stormevents/>.  
[http://www.ncdc.noaa.gov/stormevents/listevents.jsp?beginDate\\_mm=01&beginDate\\_dd=01&beginDate\\_yyyy=1996&endDate\\_mm=08&endDate\\_dd=31&endDate\\_yyyy=2013&eventType=%28C%29+Tornado&county=FRANKLIN&zone=WESTERN%2BFRANKLIN&submitbutton=Search&statefips=25%2CMASSACHUSETTS](http://www.ncdc.noaa.gov/stormevents/listevents.jsp?beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1996&endDate_mm=08&endDate_dd=31&endDate_yyyy=2013&eventType=%28C%29+Tornado&county=FRANKLIN&zone=WESTERN%2BFRANKLIN&submitbutton=Search&statefips=25%2CMASSACHUSETTS)

**Population Impacts**

As discussed above, some traffic accidents associated with tornado events can include injuries and deaths. However, the number of injuries and deaths reported for accidents is generally low. Populations assessed as being most vulnerable to tornado impacts in Greenfield are identified based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Table 3-35

summarizes the population over the age of 65 or living in households with an annual income below \$25,000. See also Environmental Justice section on pages 64-66.

**Table 3-35: Senior and Low Income Populations in Greenfield Exposed to Hazards**

| Population Category  | Number of Persons Exposed | Percentage of Total Population |
|--|---------------------------|--------------------------------|
| Senior (Over 65 years of age)                                | 3,178                     | 17.5%                          |
| Low Income (Persons with annual incomes less than \$25,000)* | 5,320                     | 29.3%                          |
| <b>Total</b>   | <b>8,498</b>              | <b>46.8%</b>                   |

\* Low income population was calculated by multiplying 2000 U.S. Census Households with Incomes of Less than \$25,000 (116) by 2000 U.S. Census Average Household Size (2.45). Source: 2000 U.S. Census.

The entire built environment of Greenfield is vulnerable to the high winds and/or flooding from a tornado. Table 3-36 identifies the assessed value of all residential, commercial, and industrial land uses in Greenfield, and the losses that would result from 1%, 5%, and 10% damage to this inventory as a result of a tornado.

**Table 3-36: Potential Estimated Loss by Land Use**

| Land Use     | Total Assessed Value   | 1% Damage Loss Estimate | 5% Damage Loss Estimate | 10% Damage Loss Estimate |
|--------------|------------------------|-------------------------|-------------------------|--------------------------|
| Residential  | \$1,055,388,591        | \$10,553,886            | \$52,769,430            | \$105,538,859            |
| Commercial   | \$243,076,431          | \$2,430,764             | \$12,153,822            | \$24,307,643             |
| Industrial   | \$33,819,460           | \$338,195               | \$1,690,973             | \$3,381,946              |
| <b>Total</b> | <b>\$1,332,284,482</b> | <b>\$13,322,845</b>     | <b>\$66,614,224</b>     | <b>\$133,228,448</b>     |

Source: Massachusetts Department of Revenue - Division of Local Services, Municipal Databank/Local Aid Section 2010.

***Overall Vulnerability Assessment***

Tornado are not at all common in Greenfield, however these and other wind-related storms such as hurricanes and microbursts could impact property, crops, utilities and the population of Greenfield. Existing and future mitigation efforts should continue to be developed and employed that will enable Greenfield to be prepared for these events. The cascade effects of severe storms include utility losses and transportation accidents and flooding. Losses associated with the flood hazard are discussed earlier in this section. Particular areas of vulnerability include low-income and elderly populations, trailer homes, and infrastructure such as roadways and utilities that can be damaged by such storms and the low-lying areas that can be impacted by flooding.

***Data Deficiencies***

In assessing the risks to Greenfield from tornados, no data deficiencies were identified.

## **Microbursts (Includes Thunderstorms and Wind Related Events)**

### ***Hazard Summary***

Microbursts are frequent enough in Greenfield to cause the Committee to suggest they be categorized separately from hurricanes and tornados. Their severe impacts include flooding, power outages, flying debris, damage to property, as Greenfield experienced in May of 2010. Existing and future mitigation efforts should continue to be developed and employed that will enable the Town to be prepared for these events. Thunderstorms, a sub-category of Microbursts, are common in western Massachusetts and can cause significant damage. Additional data were available for hail and lightning events, and are included in tables 3-29 and 3-30. Hail and lightning are events generally associated with thunderstorms.

### ***Data Collected and Used***

National weather databases and Town of Greenfield data were collected and analyzed. Data on historic property damage and loss, and injuries and deaths, was collected for Franklin County from the National Oceanic and Atmospheric Administration's (NOAA) National Climactic Data Center website, and the Spatial Hazard Events and Losses Database (SHELDUS). This data was used to support an evaluation of exposure and potential impacts associated with this hazard. The Commonwealth of Massachusetts State Hazard Mitigation Plan 2010 was also reviewed for information on thunderstorms, hurricanes and tornados hazard data and mitigation measures.

### ***Impact on the Community***

#### ***Exposure and Loss Estimation***

High winds and heavy rain and/or hail associated with microburst and wind-related storms can cause damage to utilities, structures, roads, trees (potentially causing vehicle accidents) and injuries and death. Other issues associated with this type of hazard include debris management issues including debris removal and identification of disposal sites. The Committee identified debris management and disposal as an ongoing concern.

#### ***Property Damage***

Severe thunderstorms, and their associated hail and lightning events brought about significant property wreckage in Franklin County in recent years. However, it is typically the winds from thunderstorms that consistently cause the worst property damage. Thunderstorms with associated wind damage, 169 of them in the last 24 years, caused an average annual property loss of more than \$81,938 and an average annual crop damage of \$5,208 (Table 3-37). It is important to note that each reported thunderstorm wind event is counted in the total, even if they occurred in multiple towns on the same date. Even taking that into consideration, the number of thunderstorms has increased in recent years. In the 1990s, there was an average of 3.8 storms per year, according to NOAA data. From 2000 to 2012, NOAA recorded an average of 9.5 storm events per year, 2.5 times the previous decade. Between 2007 and 2010, 72 storm events were recorded countywide for an average number of 18 storms for those four years. A very strong storm with strong winds moved through the communities of Whately and Sunderland on July 19, 2008, causing a substantial amount of property and crop damage, mostly in the form of fallen trees and downed power lines.

**Table 3-37: Thunderstorm Wind Events in Franklin County**

| <b>Year</b>       | <b># of Thunderstorm Events</b> | <b>Annual Property Damage</b>         | <b>Annual Crop Damage</b>         |
|-------------------|---------------------------------|---------------------------------------|-----------------------------------|
| 2013              | 8                               | \$149,000                             | \$0                               |
| 2012              | 8                               | \$34,000                              | \$0                               |
| 2011              | 9                               | \$77,000                              | \$0                               |
| 2010              | 30                              | \$590,500                             | \$0                               |
| 2009              | 2                               | \$17,000                              | \$0                               |
| 2008              | 21                              | \$602,000                             | \$1,250,000                       |
| 2007              | 19                              | \$0                                   | \$0                               |
| 2006              | 6                               | \$315,000                             | \$0                               |
| 2005              | 9                               | \$85,000                              | \$0                               |
| 2004              | 4                               | \$30,000                              | \$0                               |
| 2003              | 1                               | \$10,000                              | \$0                               |
| 2002              | 6                               | \$25,000                              | \$0                               |
| 2001              | 5                               | \$0                                   | \$0                               |
| 2000              | 3                               | \$20,000                              | \$0                               |
| 1999              | 5                               | \$0                                   | \$0                               |
| 1998              | 8                               | \$2,000                               | \$0                               |
| 1997              | 7                               | \$10,000                              | \$0                               |
| 1996              | 5                               | \$0                                   | \$0                               |
| 1995              | 3                               | \$0                                   | \$0                               |
| 1994              | 4                               | \$0                                   | \$0                               |
| 1993              | 0                               | \$0                                   | \$0                               |
| 1992              | 2                               | \$0                                   | \$0                               |
| 1991              | 3                               | \$0                                   | \$0                               |
| 1990              | 1                               | \$0                                   | \$0                               |
| <b># of Years</b> | <b>Total # of Events</b>        | <b>Average Annual Property Damage</b> | <b>Average Annual Crop Damage</b> |
| <b>24</b>         | <b>169</b>                      | <b>\$81,938</b>                       | <b>\$5,208</b>                    |

**Source:** National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center Storm Events Database website: <http://www.ncdc.noaa.gov/stormevents/>.  
[http://www.ncdc.noaa.gov/stormevents/listevents.jsp?beginDate\\_mm=01&beginDate\\_dd=01&beginDate\\_yyyy=1996&endDate\\_mm=08&endDate\\_dd=31&endDate\\_yyyy=2013&eventType=%28C%29+Thunderstorm+Wind&county=FRANKLIN&zone=WESTERN%2BFRANKLIN&submitButton=Search&statefips=25%2CMASSACHUSETTS](http://www.ncdc.noaa.gov/stormevents/listevents.jsp?beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1996&endDate_mm=08&endDate_dd=31&endDate_yyyy=2013&eventType=%28C%29+Thunderstorm+Wind&county=FRANKLIN&zone=WESTERN%2BFRANKLIN&submitButton=Search&statefips=25%2CMASSACHUSETTS)

As described in more detail in the Multi-Hazard Identification and Profile section, a brief microburst in 1994 in Greenfield caused a state disaster declaration and in nearly \$60 K of Public Assistance Project Grants to aid in storm recovery and a May 2010 microburst caused Greenfield to declare a state of emergency. Assessment by the Greenfield DPW of total costs of the storm to the Town of Greenfield is approximately \$98,000 while costs to private home owners are estimated to be about \$150,000 (Table 3-38).

**Table 3-38: Severe Microburst Events in Greenfield**

| Date      | Event      | Location of Event | Property Damage |
|-----------|------------|-------------------|-----------------|
| July 1994 | Microburst | Town-Wide         | \$60,000        |
| May 2010  | Microburst | Town-Wide         | \$248,000       |

As Table 3-39 shows, 84 hail storms in Franklin County between 1991 and 2013 have caused an average of approximately \$217 in property damage per year, and an average of \$2,174 of crop damage. The total amount of crop damage during this period resulted from a single incident on June 16, 2008 that caused \$50,000 in damage. Pea to marble size hail fell in a swath from Colrain to Shelburne damaging apple and peach orchards from Colrain to Shelburne to Deerfield. An estimated 45 acres of apples and two to three acres of peaches were damaged by the hail. This storm was also accompanied by lightning and thunderstorm winds. It is important to note that each reported hail event is counted in the total, even if they occurred in multiple towns on the same date.

**Table 3-39: Hail Events in Franklin County**

| Year | # of Hail Events | Annual Property Damage | Annual Crop Damage |
|------|------------------|------------------------|--------------------|
| 2013 | 7                | \$0                    | \$0                |
| 2012 | 2                | \$0                    | \$0                |
| 2011 | 9                | \$0                    | \$0                |
| 2010 | 4                | \$0                    | \$0                |
| 2009 | 2                | \$0                    | \$0                |
| 2008 | 14               | \$0                    | \$50,000           |
| 2007 | 15               | \$0                    | \$0                |
| 2006 | 0                | \$0                    | \$0                |
| 2005 | 3                | \$5,000                | \$0                |
| 2004 | 2                | \$0                    | \$0                |
| 2003 | 1                | \$0                    | \$0                |
| 2002 | 0                | \$0                    | \$0                |
| 2001 | 3                | \$0                    | \$0                |
| 2000 | 1                | \$0                    | \$0                |
| 1999 | 0                | \$0                    | \$0                |
| 1998 | 9                | \$0                    | \$0                |
| 1997 | 1                | \$0                    | \$0                |
| 1996 | 3                | \$0                    | \$0                |
| 1995 | 4                | \$0                    | \$0                |
| 1994 | 4                | \$0                    | \$0                |
| 1993 | 0                | \$0                    | \$0                |
| 1992 | 0                | \$0                    | \$0                |
| 1991 | 0                | \$0                    | \$0                |

| # of Years | Total # of Events | Average Annual Property Damage | Average Annual Crop Damage |
|------------|-------------------|--------------------------------|----------------------------|
| <b>23</b>  | <b>84</b>         | <b>\$217</b>                   | <b>\$2,174</b>             |

**Source:** National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center Storm Events Database website: <http://www.ncdc.noaa.gov/stormevents/>  
[http://www.ncdc.noaa.gov/stormevents/listevents.jsp?beginDate\\_mm=01&beginDate\\_dd=01&beginDate\\_yyyy=1996&endDate\\_mm=08&endDate\\_dd=31&endDate\\_yyyy=2013&event%28Type=%28C%29+Hail&county=FRANKLIN&zone=WESTERN%2BFRANKLIN&submitButton=Search&statefips=25%2CMASSACHUSETTS](http://www.ncdc.noaa.gov/stormevents/listevents.jsp?beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1996&endDate_mm=08&endDate_dd=31&endDate_yyyy=2013&event%28Type=%28C%29+Hail&county=FRANKLIN&zone=WESTERN%2BFRANKLIN&submitButton=Search&statefips=25%2CMASSACHUSETTS)

Fifteen (15) lightning events (Table 3-40) have caused an average of more than \$354,800 in property damage per year over the last 20 years in Franklin County. These events include the lightning strike that occurred in Rowe on August 4, 2012 that resulted in the complete destruction of the Rowe Elementary School, for a property loss with an insurance value of \$6,900,000. The average property damage per year during this period excluding that event in 2012 is \$9,800.

**Table 3-40: Lightning Events in Franklin County**

| Year              | # of Lightning Events    | Annual Property Damage                | Annual Crop Damage                |
|-------------------|--------------------------|---------------------------------------|-----------------------------------|
| 2013              | 3                        | \$48,000                              | \$0                               |
| 2012              | 1                        | \$6,900,000                           | \$0                               |
| 2011              | 0                        | \$0                                   | \$0                               |
| 2010              | 1                        | \$15,000                              | \$0                               |
| 2009              | 0                        | \$0                                   | \$0                               |
| 2008              | 1                        | \$10,000                              | \$0                               |
| 2007              | 0                        | \$0                                   | \$0                               |
| 2006              | 0                        | \$0                                   | \$0                               |
| 2005              | 1                        | \$50,000                              | \$0                               |
| 2004              | 1                        | \$35,000                              | \$0                               |
| 2003              | 0                        | \$0                                   | \$0                               |
| 2002              | 1                        | \$15,000                              | \$0                               |
| 2001              | 1                        | \$20,000                              | \$0                               |
| 2000              | 0                        | \$0                                   | \$0                               |
| 1999              | 0                        | \$0                                   | \$0                               |
| 1998              | 0                        | \$0                                   | \$0                               |
| 1997              | 1                        | \$3,000                               | \$0                               |
| 1996              | 0                        | \$0                                   | \$0                               |
| 1995              | 2                        | \$0                                   | \$0                               |
| 1994              | 2                        | \$0                                   | \$0                               |
| <b># of Years</b> | <b>Total # of Events</b> | <b>Average Annual Property Damage</b> | <b>Average Annual Crop Damage</b> |
| <b>20</b>         | <b>15</b>                | <b>\$354,800</b>                      | <b>\$0</b>                        |

**Source:** National Oceanic and Atmospheric Administration’s (NOAA) National Climatic Data Center Storm Events Database website: <http://www.ncdc.noaa.gov/stormevents/>.

**Population Impacts**

As discussed above, some traffic accidents associated with storm events include injuries and deaths. However, the number of injuries and deaths reported for accidents is generally low.

Populations considered most vulnerable to microburst and wind-related storm impacts in Greenfield are identified based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Table 3-41 summarizes the population over the age of 65 or living in households with an annual income below \$25,000. See also Environmental Justice section on pages 64-66.

**Table 3-41: Senior and Low Income Populations in Greenfield Exposed to Hazards**

| Population Category  | Number of Persons Exposed | Percentage of Total Population |
|--|---------------------------|--------------------------------|
| Senior (Over 65 years of age)                                | 3,178                     | 17.5%                          |
| Low Income (Persons with annual incomes less than \$25,000)* | 5,320                     | 29.3%                          |
| <b>Total</b>   | <b>8,498</b>              | <b>46.8%</b>                   |

\* Low income population was calculated by multiplying 2000 U.S. Census Households with Incomes of Less than \$25,000 (116) by 2000 U.S. Census Average Household Size (2.45). Source: 2000 U.S. Census.

The entire built environment of Greenfield is vulnerable to the high winds and/or flooding from a microburst and wind-related storm. Table 3-42 identifies the assessed value of all residential, commercial, and industrial land uses in Greenfield, and the losses that would result from 1%, 5%, and 10% damage to this inventory as a result of a microburst or wind-related storm.

**Table 3-42: Potential Estimated Loss by Land Use**

| Land Use           | Total Assessed Value   | 1% Damage Loss Estimate | 5% Damage Loss Estimate | 10% Damage Loss Estimate |
|--------------------|------------------------|-------------------------|-------------------------|--------------------------|
| <b>Residential</b> | \$1,055,388,591        | \$10,553,886            | \$52,769,430            | \$105,538,859            |
| <b>Commercial</b>  | \$243,076,431          | \$2,430,764             | \$12,153,822            | \$24,307,643             |
| <b>Industrial</b>  | \$33,819,460           | \$338,195               | \$1,690,973             | \$3,381,946              |
| <b>Total</b>       | <b>\$1,332,284,482</b> | <b>\$13,322,845</b>     | <b>\$66,614,224</b>     | <b>\$133,228,448</b>     |

Source: Massachusetts Department of Revenue - Division of Local Services, Municipal Databank/Local Aid Section 2010.

**Overall Vulnerability Assessment**

Microbursts have occurred with some frequency in Greenfield. These and other wind-related storms such as thunderstorms can impact property, crops, utilities and the population of Greenfield. Existing and future mitigation efforts should continue to be developed and employed that will enable Greenfield to be prepared for these events. The cascade effects of severe storms include utility losses and transportation accidents and flooding. Losses associated with the flood hazard are discussed earlier in this section. Particular areas of vulnerability include low-income and elderly populations, trailer homes, and infrastructure such as roadways and utilities that can be damaged by such storms and the low-lying areas that can be impacted by flooding.

### ***Data Deficiencies***

In assessing the risks to Greenfield from microbursts and other wind-related storms, the following data deficiencies were identified:

- The towns of Franklin County rely on farming for one of its income sources. Little data exists on localized crop damage due to these hazards.

## **Wildfires / Brush Fires**

### ***Hazard Summary***

According to data from Massachusetts Fire Incident Reporting System of the Massachusetts Department of Fire Services, the Greenfield Fire Department responded to 35 brushfires between 2004 and 2010. Wildfires can damage woodlands, homes, utilities and buildings, and could cause injuries or deaths. Existing and future mitigation efforts should continue to be developed and employed that will enable the Town to be prepared for these events. Burn piles that blaze out of control, lightning strikes in forested land, campfires improperly managed, and arson can cause wildfires. Greenfield is vulnerable to these conflagrations, especially in times of drought.

### ***Data Collected and Used***

Town of Greenfield data were collected and analyzed. Data on historic property damage and loss, and injuries and deaths, was collected for Franklin County from the NOAA website. Data from this website shows no wildfires have occurred in or impacted Franklin County in the last 20 years. The Commonwealth of Massachusetts State Hazard Mitigation Plan 2010 was also reviewed for information on wildland fires and brushfires hazard data and mitigation measures.

### ***Impact to the Community***

#### ***Exposure and Loss Estimation***

A major out-of-control wildfire can damage property, utilities and forested land; create smoke that can cause breathing problems; and injure or kill people. Other issues associated with this type of hazard include debris management issues including debris removal and identification of disposal sites.

#### ***Property Damage***

According to Robert Strahan, Greenfield EMD, no property damage, injuries or deaths were recorded for wildfires in the past XXXX years and no brush fires of notable size or scope were reported.

### ***Population Impacts***

Populations considered most vulnerable to wildfire impacts are identified based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Table 3-43 summarizes the population over the age of 65 or living in households with an income below \$25,000 per year. See also Environmental Justice section on pages 64-66.

**Table 3-43: Senior and Low Income Populations in Greenfield Exposed to Hazards**

| Population Category  | Number of Persons Exposed | Percentage of Total Population |
|--|---------------------------|--------------------------------|
| Senior (Over 65 years of age)                                | 3,178                     | 17.5%                          |
| Low Income (Persons with annual incomes less than \$25,000)* | 5,320                     | 29.3%                          |
| <b>Total</b>   | <b>8,498</b>              | <b>46.8%</b>                   |

\* Low income population was calculated by multiplying 2000 U.S. Census Households with Incomes of Less than \$25,000 (116) by 2000 U.S. Census Average Household Size (2.45). Source: 2000 U.S. Census.

Because Greenfield has areas that are forested and because it has many historic wooden structures, the entire built environment of the Town could be vulnerable to a wildfire. Table 3-44 identifies the building type and valuation of this inventory as well as the losses that would result from 1%, 5%, and 10% damage to this inventory as a result of a wildfire.

**Table 3-44: Potential Estimated Loss by Land Use**

| Land Use     | Total Assessed Value   | 1% Damage Loss Estimate | 5% Damage Loss Estimate | 10% Damage Loss Estimate |
|--------------|------------------------|-------------------------|-------------------------|--------------------------|
| Residential  | \$1,055,388,591        | \$10,553,886            | \$52,769,430            | \$105,538,859            |
| Commercial   | \$243,076,431          | \$2,430,764             | \$12,153,822            | \$24,307,643             |
| Industrial   | \$33,819,460           | \$338,195               | \$1,690,973             | \$3,381,946              |
| <b>Total</b> | <b>\$1,332,284,482</b> | <b>\$13,322,845</b>     | <b>\$66,614,224</b>     | <b>\$133,228,448</b>     |

Source: Massachusetts Department of Revenue - Division of Local Services, Municipal Databank/Local Aid Section 2010.

### ***Overall Vulnerability Assessment***

While wildfires have caused no damage, injury and loss of life to date in Greenfield, their potential to destroy property and cause injury or death exists. Existing and future mitigation efforts should continue to be developed and employed that will enable Greenfield to be prepared for these events when they occur. Wildfires can also cause utility disruption and air-quality problems. Particular areas of vulnerability include low-income and elderly populations.

### ***Data Deficiencies***

In assessing the risks to Greenfield from wildfire hazards, the following data deficiencies were identified:

- The towns of Franklin County rely on farming for one of its income sources. Little data exists on localized crop damage due to wildfires.
- The Greenfield CEM plan is not available for review by the FRCOG.

## **Dam Failure**

### ***Hazard Summary***

Dams hold back water, and when a dam fails, the potential energy of the stored water behind the dam is instantly released as water rushes in torrent downstream, flooding an area engineers refer to as an “inundation area.” The number of casualties and the amount of property damage will depend upon the timing of the warning provided to downstream residents, the number of people

living or working in the inundation area, and the number of structures in the inundation area. Existing and future mitigation efforts should continue to be developed and employed that will enable the Town to be prepared for these events.

When a dam fails, huge quantities of water quickly flow downstream. Areas adjacent to a river or stream or on low ground are in danger of being inundated by a large volume of water that could destroy structures, utilities, roadways and bridges, and cause injuries or deaths. Many dams in Massachusetts were built in the 19<sup>th</sup> century without the benefit of modern engineering design and construction oversight. Dams can fail because of structural problems due to age and/or lack of proper maintenance. Dam failure can also be the result of structural damage caused by an earthquake or flooding brought on by severe storm events.

***Data Collected and Used***

Data from the National Oceanic and Atmospheric Administration’s National Climactic Data Center website shows no dam failures have occurred in or impacted Franklin County in the last 20 years. According to the members of the Local Multi-Hazard Mitigation Team, no dam failures have occurred in Greenfield in the last 20 years.

***Impact to the Community***

***Exposure and Loss Estimation***

While dam failures are rare, their impacts can be devastating, including loss of property, disruption to infrastructure, and injury and death. Other issues associated with this type of hazard include debris management issues including debris removal and identification of disposal sites.

***Property Damage***

Historic data for dam failure events indicate that between 1993 and 2010, no events were recorded in Franklin County, causing no property damage or population impacts.

***Population Impacts***

Populations considered most vulnerable to dam failure are identified based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Table 3-45 summarizes the population over the age of 65 or living in households with an income below \$25,000 per year. See also Environmental Justice section on pages 64-66.

**Table 3-45: Senior and Low Income Populations in Greenfield Exposed to Hazards**

| <b>Population Category</b>  | <b>Number of Persons Exposed</b> | <b>Percentage of Total Population</b> |
|---|----------------------------------|---------------------------------------|
| <b>Senior (Over 65 years of age)</b>                                | 3,178                            | 17.5%                                 |
| <b>Low Income (Persons with annual incomes less than \$25,000)*</b> | 5,320                            | 29.3%                                 |
| <b>Total</b>  | <b>8,498</b>                     | <b>46.8%</b>                          |

\* Low income population was calculated by multiplying 2000 U.S. Census Households with Incomes of Less than \$25,000 (116) by 2000 U.S. Census Average Household Size (2.45). Source: 2000 U.S. Census.

Structures that lie in the inundation area of each of the dams in Greenfield are vulnerable to a dam failure. Table 3-46 identifies the building type and valuation for all residential, commercial,

and industrial uses in Town, as well as the losses that would result from 1%, 5%, and 10% damage to this inventory as a result of a dam failure.

**Table 3-46: Potential Estimated Loss by Land Use**

| Land Use           | Total Assessed Value   | 1% Damage Loss Estimate | 5% Damage Loss Estimate | 10% Damage Loss Estimate |
|--------------------|------------------------|-------------------------|-------------------------|--------------------------|
| <b>Residential</b> | \$1,055,388,591        | \$10,553,886            | \$52,769,430            | \$105,538,859            |
| <b>Commercial</b>  | \$243,076,431          | \$2,430,764             | \$12,153,822            | \$24,307,643             |
| <b>Industrial</b>  | \$33,819,460           | \$338,195               | \$1,690,973             | \$3,381,946              |
| <b>Total</b>       | <b>\$1,332,284,482</b> | <b>\$13,322,845</b>     | <b>\$66,614,224</b>     | <b>\$133,228,448</b>     |

Source: Massachusetts Department of Revenue - Division of Local Services, Municipal Databank/Local Aid Section 2010.

***Overall Vulnerability Assessment***

Dam failures, while rare, can destroy roads, structures, facilities, utilities, and impact the population of Greenfield. Existing and future mitigation efforts should continue to be developed and employed that will enable Greenfield to be prepared for these events when they occur. Particular areas of vulnerability include low-income and elderly populations, buildings in the floodplain or inundation areas, and infrastructure such as roadways and utilities that can be damaged by such events. According to the members of the Local Multi-Hazard Mitigation Team, no dam failures have occurred in the last 20 years in Greenfield.

As described in the Hazard Identification and Profile section of this plan, there are two significant beavers in Greenfield. The one located on Allen Brook, off Plain road has impacted the private land owner’s fields and could potentially cause flooding downstream. The Town is currently working with the landowner to mitigate the issue. See pages 42-44 for more information on beaver dams.

***Data Deficiencies***

In assessing the risks to Greenfield from dam failure hazards, the following data deficiencies were identified:

- The towns of Franklin County rely on farming for one of its income sources. Little data exists on localized crop damage due to dam failure, if any.
- Data for the location and condition of dams within Greenfield resides with the DCR Office of Dam Safety and with FERC. New software and reporting systems within the Office of Dam Safety has resulted in missing data and questions as to the status of some dams. Requests for additional information have been referred to the Office of Dam Safety’s Legal Department, which charges for any requests for information.

**Earthquakes**

***Hazard Summary***

Earthquakes are rare in Franklin County, however temblors are unpredictable and can cause significant damage to roads, structures, facilities, utilities, and population. Existing and future mitigation efforts should continue to be developed and employed that will enable the Town to be prepared for earthquakes.

While rare in Franklin County, earthquakes have happened in New England. New England experiences an average of 30 to 40 earthquakes each year although most are not noticed by people.<sup>61</sup> Ground shaking from earthquakes can rupture gas mains and disrupt other utility service, damage buildings, bridges and roads, and trigger other hazardous events such as landslides, avalanches, flash floods (dam failure) and fires. Un-reinforced masonry buildings, buildings with foundations that rest on filled land or unconsolidated, unstable soil, and mobile homes not tied to their foundations are at risk during an earthquake.<sup>62</sup>

***Data Collected and Used***

The National Oceanic and Atmospheric Administration recorded no earthquakes for Franklin County in the last 20 years. The Commonwealth of Massachusetts State Hazard Mitigation Plan 2010 was also reviewed for information on earthquake hazard data and mitigation measures.

***Impact on the Community***

*Exposure and Loss Estimation*

A major earthquake could cause severe damage to Greenfield buildings, including older structures that were built before a 1975 law requiring new buildings to withstand earthquakes. Other issues associated with this type of hazard include debris management issues including debris removal and identification of disposal sites.

*Property Damage*

Historic data for earthquake events indicate that between 1991 and 2013, no earthquakes were recorded in Franklin County during this period, causing no damage to property.<sup>63</sup>

*Population Impacts*

Populations considered most vulnerable to earthquake impacts are identified based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Table 3-47 summarizes the population over the age of 65 or living in households with an income below \$25,000 per year. See also Environmental Justice section on pages 64-66.

**Table 3-47: Senior and Low Income Populations in Greenfield Exposed to Hazards**

| <b>Population Category</b>  | <b>Number of Persons Exposed</b> | <b>Percentage of Total Population</b> |
|---|----------------------------------|---------------------------------------|
| <b>Senior (Over 65 years of age)</b>                                | 3,178                            | 17.5%                                 |
| <b>Low Income (Persons with annual incomes less than \$25,000)*</b> | 5,320                            | 29.3%                                 |
| <b>Total</b>  | <b>8,498</b>                     | <b>46.8%</b>                          |

\* Low income population was calculated by multiplying 2000 U.S. Census Households with Incomes of Less than \$25,000 (116) by 2000 U.S. Census Average Household Size (2.45). Source: 2000 U.S. Census.

The entire built environment of Greenfield is vulnerable to earthquakes. Table 3-48 identifies the assessed value of all residential, commercial, and industrial land uses in Greenfield, and the

<sup>61</sup> Northeast States Emergency Consortium web site: [www.nesec.org/hazards/earthquakes.cfm](http://www.nesec.org/hazards/earthquakes.cfm)

<sup>62</sup> Federal Emergency Management Agency web site: [www.fema.gov/hazards/earthquakes/quake.shtm](http://www.fema.gov/hazards/earthquakes/quake.shtm).

<sup>63</sup> NOAA National Climactic Data Center. <http://www4.ncdc.noaa.gov/cgi-win/wcwg.cgi.dll?wwevent~storms>

losses that would result from 1%, 5%, and 10% damage to this inventory as a result of an earthquake.

**Table 3-48: Potential Estimated Loss by Land Use**

| Land Use           | Total Assessed Value   | 1% Damage Loss Estimate | 5% Damage Loss Estimate | 10% Damage Loss Estimate |
|--------------------|------------------------|-------------------------|-------------------------|--------------------------|
| <b>Residential</b> | \$1,055,388,591        | \$10,553,886            | \$52,769,430            | \$105,538,859            |
| <b>Commercial</b>  | \$243,076,431          | \$2,430,764             | \$12,153,822            | \$24,307,643             |
| <b>Industrial</b>  | \$33,819,460           | \$338,195               | \$1,690,973             | \$3,381,946              |
| <b>Total</b>       | <b>\$1,332,284,482</b> | <b>\$13,322,845</b>     | <b>\$66,614,224</b>     | <b>\$133,228,448</b>     |

Source: Massachusetts Department of Revenue - Division of Local Services, Municipal Databank/Local Aid Section 2010.

***Overall Vulnerability Assessment***

Earthquakes, while rare, could cause significant impacts and losses to the roads, structures, facilities, utilities, and population of Greenfield. Existing and future mitigation efforts should continue to be developed and employed that will enable Greenfield to be prepared for these events when they occur. Particular areas of vulnerability include low-income and elderly populations, trailer homes and buildings erected before 1975, and infrastructure such as roadways and utilities that could be damaged by earthquakes. According to the 2010 U.S. Census, nearly 78% of the housing in Greenfield was built prior to 1970. According to members of the Local Multi-Hazard Mitigation Team, no earthquakes have impacted Greenfield in the last 20 years.

***Data Deficiencies***

In assessing the risks to Greenfield from earthquakes, no data deficiencies were identified.

**Landslides**

***Hazard Summary***

Landslides rarely occur in Franklin County but Greenfield has experienced several in recent years. Details can be found on pages 43-46. Landslides can impact the built and natural environments and can displace residents.

***Data Collected and Used***

National Oceanic and Atmospheric Administration’s National Climactic Data Center website shows no landslide events in Franklin County for the last 20 years. The Commonwealth of Massachusetts State Hazard Mitigation Plan 2010 was also reviewed for information on landslide hazard data and mitigation measures.

***Impact to the Community***

***Exposure and Loss Estimation***

While landslides are rare, their impacts can be devastating, including loss of property, disruption to infrastructure, and injury and death. Continued development, particularly on steep slopes or unstable soils, increases the chances that landslides will be a danger. Other issues associated with this type of hazard include debris management issues including debris removal and identification

of disposal sites. The Committee identified debris management and disposal as an ongoing concern.

As noted in the Risk Assessment Section, relatively small landslides have been reported on Factory Hollow Road along the Fall River, on Mead Street and Wisdom Way, Brook Road and Shelburne Road, as well as at the 90-acre Green River Cemetery (Table 3-49).

**Table 3-49: Landslide Events in Greenfield**

| Date          | Event Description     | Location of Event                        | Property Damage |
|---------------|-----------------------|--|-----------------|
| Ongoing       | Small landslide       | Factory Hollow Road on Fall River        | Not available   |
| Ongoing       | Small landslide       | Mead Street and Wisdom Way               | Not available   |
| Ongoing       | Small landslide       | Brook Road and Shelburne Road            | Not available   |
| Ongoing       | Small landslide       | Green River Cemetery                     | Not available   |
| March 7, 2011 | Significant landslide | Green River Cemetery and Meridian Street | Not available   |

***Property Damage and Population Impacts***

Historic data for landslide events indicate that between 1993 and 2013, no significant landslide events were recorded in Franklin County (except for the one in Greenfield, discussed previously). Populations considered most vulnerable to landslide impacts are identified based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Table 3-50 summarizes the population over the age of 65 or living in households with an income below \$25,000 per year. See also Environmental Justice section on pages 64-66.

**Table 3-50: Senior and Low Income Populations in Greenfield Exposed to Hazards**

| Population Category  | Number of Persons Exposed | Percentage of Total Population |
|--|---------------------------|--------------------------------|
| Senior (Over 65 years of age)                                | 3,178                     | 17.5%                          |
| Low Income (Persons with annual incomes less than \$25,000)* | 5,320                     | 29.3%                          |
| <b>Total</b>   | <b>8,498</b>              | <b>46.8%</b>                   |

\* Low income population was calculated by multiplying 2000 U.S. Census Households with Incomes of Less than \$25,000 (116) by 2000 U.S. Census Average Household Size (2.45).

Source: 2000 U.S. Census.

Table 3-51 identifies the assessed value of all residential, commercial, and industrial uses in Town, as well as the losses that would result from 1%, 5%, and 10% damage to this inventory as a result of a massive landslide.

**Table 3-51: Potential Estimated Loss by Land Use**

| Land Use     | Total Assessed Value   | 1% Damage Loss Estimate | 5% Damage Loss Estimate | 10% Damage Loss Estimate |
|--------------|------------------------|-------------------------|-------------------------|--------------------------|
| Residential  | \$1,055,388,591        | \$10,553,886            | \$52,769,430            | \$105,538,859            |
| Commercial   | \$243,076,431          | \$2,430,764             | \$12,153,822            | \$24,307,643             |
| Industrial   | \$33,819,460           | \$338,195               | \$1,690,973             | \$3,381,946              |
| <b>Total</b> | <b>\$1,332,284,482</b> | <b>\$13,322,845</b>     | <b>\$66,614,224</b>     | <b>\$133,228,448</b>     |

Source: Massachusetts Department of Revenue - Division of Local Services, Municipal Databank/Local Aid Section 2010.

### ***Overall Vulnerability Assessment***

Significant landslides, while rare in Franklin County and Greenfield, can destroy roads, structures, facilities, utilities, and impact the population of Greenfield. Existing and future mitigation efforts should continue to be developed and employed that will enable Greenfield to be prepared for these events when they occur. Particular areas of vulnerability include low-income and elderly populations, and buildings, roadways, and utilities near the foot of slopes, especially when slopes are destabilized.

### ***Data Deficiencies***

In assessing the risks to Greenfield from landslides, no data deficiencies were identified.

## **Ice Jams**

### ***Hazard Summary***

Ice jams (or ice dams) occur when water builds up behind a blockage of ice. Ice jams can occur in various ways, but in New England they predominantly form on rivers and streams and mainly threaten infrastructure.

When the upstream part of a river thaws first and the ice is carried downstream into the still-frozen part of the watercourse, ice can form an ice dam and flood low lying areas upstream of the jam. Also, once an ice dam breaks apart, the sudden surge of water that breaks through the dam can flood areas downstream of the jam. The resulting flow of water when an ice jam is broken can cause flooding downstream, threatening infrastructure, structures, and roadways.

### ***Data Collected and Used***

The National Oceanic and Atmospheric Administration's National Climactic Data Center website shows no ice jam events or damage in Greenfield over the last 20 years and the Committee reports none of significance. The Commonwealth of Massachusetts State Hazard Mitigation Plan 2010 was also reviewed for information on ice jam hazard data and mitigation measures.

### ***Impact to the Community***

#### ***Exposure and Loss Estimation***

Losses to ice jams include the rising waters along the river or stream that is being dammed, and the rush of water downstream when the dam either melts or is broken up by human intervention. Buildings, roadways and utilities are threatened by ice blockages. Other issues associated with

this type of hazard include debris management issues including debris removal and identification of disposal sites.

Property Damage

Data on ice jams in Franklin County indicate that no property damage or injuries or deaths occurred as the result of ice jams in the last 20 years. However, the structures and people most at risk from an ice jam are those within the floodplain. The average assessed values of the residential, commercial, and industrial land uses located within the floodplain are displayed in Table 3-52. The total average assessed value for these three land uses within the floodplain is \$4,424,398, with the largest assessed value falling within the residential land use category at \$4,196,873. This is of concern because should a catastrophic flooding event befall Greenfield, the assessed values of these structures would likely be significantly reduced, which in turn would impact the town’s tax revenues.

**Table 3-52: Average Assessed Value of Land Use in Flood Hazard Area**

|                    | Total Acres in Town | Total Assessed Value | Average Assessed Value Per Acre | Acres in Floodplain | Average Assessed Value in Floodplain |
|--------------------|---------------------|----------------------|---------------------------------|---------------------|--------------------------------------|
| <b>Residential</b> | 2,598.51            | \$253,678,000        | \$97,624                        | 42.99               | \$4,196,873                          |
| <b>Commercial</b>  | 11.3                | \$1,992,179          | \$176,299                       | 0.49                | \$86,387                             |
| <b>Industrial</b>  | 2.7                 | \$793,900            | \$294,037                       | 0.48                | \$141,138                            |

Source: Massachusetts Department of Revenue - Division of Local Services, Municipal Databank/Local Aid Section 2010; 2005 MassGIS Land Use data.

Population Impact

Populations considered most vulnerable to ice jam impacts are identified based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Table 3-53 summarizes the population over the age of 65 or living in households with an income below \$25,000 per year. See also Environmental Justice section on pages 64-66.

**Table 3-53: Senior and Low Income Populations in Greenfield Exposed to Hazards**

| Population Category   | Number of Persons Exposed | Percentage of Total Population |
|---|---------------------------|--------------------------------|
| <b>Senior (Over 65 years of age)</b>                                | 3,178                     | 17.5%                          |
| <b>Low Income (Persons with annual incomes less than \$25,000)*</b> | 5,320                     | 29.3%                          |
| <b>Total</b>  | <b>8,498</b>              | <b>46.8%</b>                   |

\* Low income population was calculated by multiplying 2000 U.S. Census Households with Incomes of Less than \$25,000 (116) by 2000 U.S. Census Average Household Size (2.45). Source: 2000 U.S. Census.

The built environment in the floodplain of Greenfield is vulnerable to ice jam events. Land uses located in the floodplain are discussed in the flooding section above. Table 3-54 identifies the average assessed value for all residential, commercial, and industrial uses in Town, as well as the losses that would result from 1%, 5%, and 10% damage to this inventory as a result of an ice jam.

**Table 3-54: Potential Estimated Loss by Land Use Category**

| Land Use    | Total Acres in Town | Total Assessed Value | Average Assessed Value Per Acre | Acres in Flood Hazard Area | Average Assessed Value in Flood Hazard Area |
|-------------|---------------------|----------------------|---------------------------------|----------------------------|---|
| Residential | 386.05              | \$121,791,060        | \$315,480                       | 0.98                       | \$309,170                                   |
| Commercial  | 29.44               | \$7,227,231          | \$245,490                       | 0.12                       | \$29,459                                    |
| Industrial  | 49.29               | \$295,631,498        | \$5,997,799                     | 5.45                       | \$32,688,003                                |

Source: Massachusetts Department of Revenue - Division of Local Services, Municipal Databank/Local Aid Section 2010; 2005 MassGIS Land Use data.

### ***Overall Vulnerability Assessment***

Ice jams occur throughout New England, often causing significant impacts and losses to roads, structures, facilities, utilities, and the population. Existing and future mitigation efforts should continue to be developed and employed that will enable Greenfield to be prepared for these events when they occur. Particular areas of vulnerability include low-income and elderly populations, trailer homes, and infrastructure such as roadways near rivers and streams and utilities and low-lying areas. According to the members of the Local Multi-Hazard Mitigation Team, no ice jams have occurred in the last 20 years in Greenfield.

### ***Data Deficiencies***

In assessing the risks to Greenfield from ice jams, no data deficiencies were identified.

## **Manmade Hazards**

### ***Hazard Summary***

Manmade hazards are being assessed at the local level for the first time in this plan update. A preliminary assessment was made only of those manmade hazards of an accidental nature, such as transportation accidents or fixed facility accidents involving hazardous materials. The potential for these types of hazardous materials accidents could be quite high – particularly transportation related, given the proximity of Route 2 and the railroad tracks to the rivers and to more densely populated areas of Town. No formal vulnerability assessment was done on manmade hazards, however the potential for accidents, the unknown impact of such accidents and the lack of well-analyzed data make this hazard a high priority on the Action Plan.

### ***Data Deficiencies***

- Need to research available models and data requirements to adequately evaluate the potential impact of hazardous accidents on the rivers, on drinking water supply, and on public health.

## **Development Trends Analysis**

---

In assessing development trends for the Town of Greenfield - and the impact those trends might have on hazard mitigation - the Committee was asked to evaluate the probability of development in town and areas most likely to be targeted for development. The Committee was also asked about changes in industry, proposed housing and retail development, and any major highway or public transit improvements that might change accessibility to parts of town. Additionally, data such as number of construction permits issued, change in population, current zoning bylaws and the acres of developable land was considered.

### ***Pending Development***

The Committee forecasted that some development is likely over the next ten years, much of it infill in existing developed areas, including in the downtown. No subdivisions are being proposed at this time. In terms of commercial development, plans have been submitted to the Greenfield Planning Board to build a 135,000-square-foot retail store on a 29.5-acre site northeast of the city's commercial core. There is also the possibility of some development and/or reuse of commercial properties near the rotary. The Bendix site and the Lunt property on Federal Street are also currently under consideration for clean up and redevelopment. None of these properties lie within the floodplain.

Changes in transit include \$12.8 million innovative Franklin Regional Transit Center project, completed in late 2011, and serving as a transportation hub for Franklin County, supporting public and private transit services. The transit center is designed to encourage future passenger rail services along the Connecticut River corridor. The 24,000-square-foot "net zero" building is being designed to drastically minimize energy use through energy efficiency measures and other design features, including the potential for on-site renewable energy generation. The transit center will be located within the Greenfield Bank Row Urban Renewal Zone and is part of the Greenfield Bank Row Private Development Site. Construction of the transit center will be the first project within the Urban Renewal Zone. It is expected to be a catalyst for additional investment and redevelopment in downtown Greenfield, housing offices of the Franklin Regional Transit Authority and the FRCOG.<sup>64</sup>

### ***Other Development Trends***

In addition to the Committee's assessment of development trends, Census data for building permits issued was consulted (Table 3-55). For new privately-owned residential building permits issued in Greenfield, a total of 116 permits were issued between the years 2000 and 2009. The number of annual permits issued has remained relatively stable, except for in 2002, when there number issued was approximately double the number issued in the other years examined.

Although building permits have held fairly steady over the past 10 years, Greenfield's population has actually declined, according to new census information. Total population in 2010 was 17,456, down from 18,168 in 2000 and from 18,866 in 1990. The total 20 year decrease is 1,210, or 6.5%. This is compared to Franklin County overall which saw an increase of 1,280 or 1.8%.

---

<sup>64</sup> [http://www.youmovemassachusetts.org/stimulus\\_13\\_GreenfieldTransitCenter\\_041709.pdf](http://www.youmovemassachusetts.org/stimulus_13_GreenfieldTransitCenter_041709.pdf)

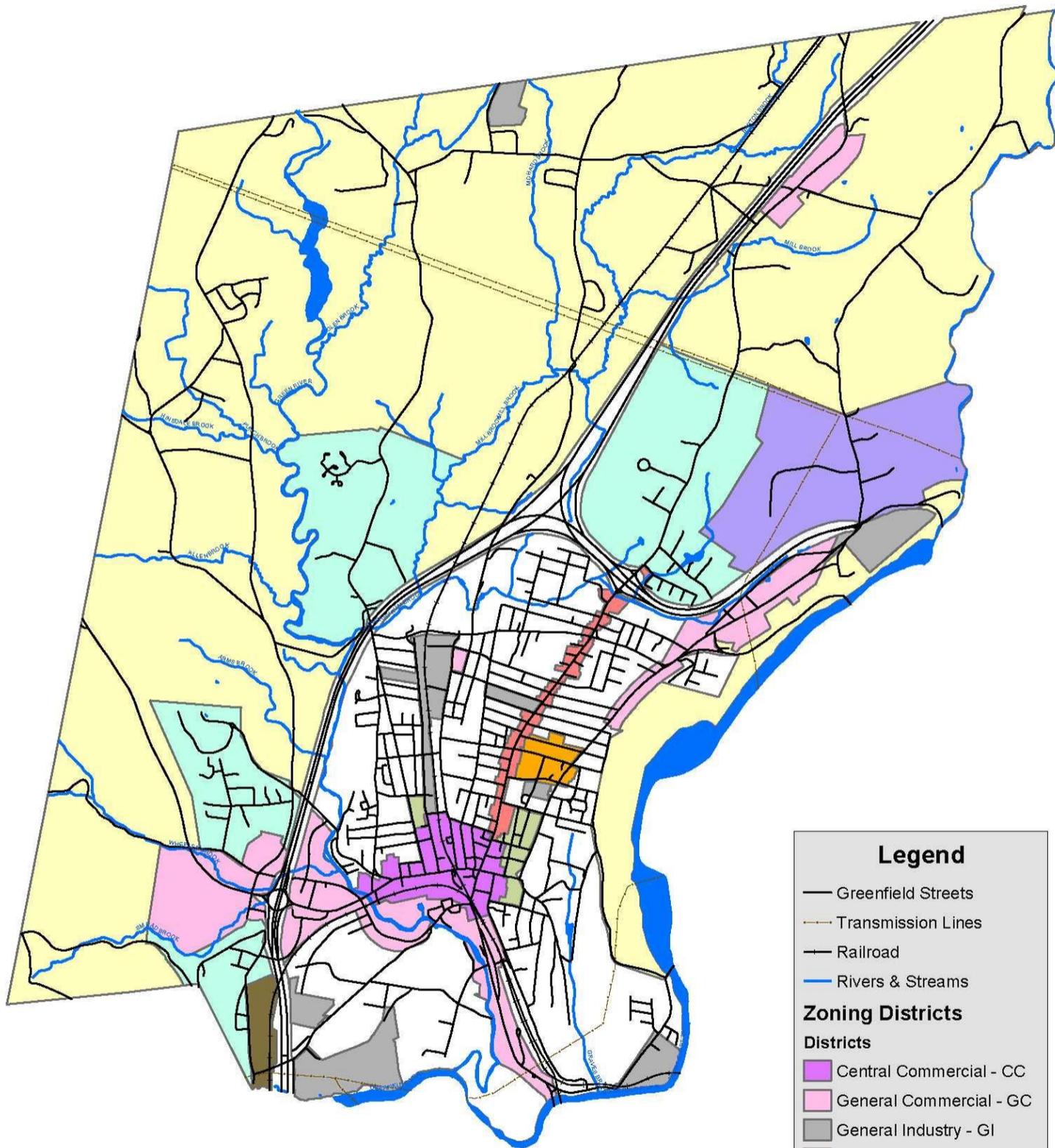
**Table 3-55: Decennial Census Total Population Trends - Franklin County Towns**

| Area Name              | Census Data      |                  |                           | 10 Year Trend        |                  | 20 Year Trend        |                  |
|------------------------|------------------|------------------|---------------------------|----------------------|------------------|----------------------|------------------|
|                        | 1990 Census      | 2000 Census      | 2010 Census Redistricting | 2000-2010 Difference | 2000-2010 Change | 1990-2010 Difference | 1990-2010 Change |
| Ashfield               | 1,715            | 1,800            | 1,737                     | -63                  | -3.5%            | 22                   | 1.3%             |
| Bernardston            | 2,048            | 2,155            | 2,129                     | -26                  | -1.2%            | 81                   | 4.0%             |
| Buckland               | 1,928            | 1,991            | 1,902                     | -89                  | -4.5%            | -26                  | -1.3%            |
| Charlemont             | 1,249            | 1,358            | 1,266                     | -92                  | -6.8%            | 17                   | 1.4%             |
| Colrain                | 1,757            | 1,813            | 1,671                     | -142                 | -7.8%            | -86                  | -4.9%            |
| Conway                 | 1,529            | 1,809            | 1,897                     | 88                   | 4.9%             | 368                  | 24.1%            |
| Deerfield              | 5,018            | 4,750            | 5,125                     | 375                  | 7.9%             | 107                  | 2.1%             |
| Erving                 | 1,372            | 1,467            | 1,800                     | 333                  | 22.7%            | 428                  | 31.2%            |
| Gill                   | 1,583            | 1,363            | 1,500                     | 137                  | 10.1%            | -83                  | -5.2%            |
| Greenfield             | 18,666           | 18,168           | 17,456                    | -712                 | -3.9%            | -1,210               | -6.5%            |
| Hawley                 | 317              | 336              | 337                       | 1                    | 0.3%             | 20                   | 6.3%             |
| Heath                  | 716              | 805              | 706                       | -99                  | -12.3%           | -10                  | -1.4%            |
| Leverett               | 1,785            | 1,663            | 1,851                     | 188                  | 11.3%            | 66                   | 3.7%             |
| Leyden                 | 662              | 772              | 711                       | -61                  | -7.9%            | 49                   | 7.4%             |
| Monroe                 | 115              | 93               | 121                       | 28                   | 30.1%            | 6                    | 5.2%             |
| Montague               | 8,316            | 8,489            | 8,437                     | -52                  | -0.6%            | 121                  | 1.5%             |
| New Salem              | 802              | 929              | 990                       | 61                   | 6.6%             | 188                  | 23.4%            |
| Northfield             | 2,838            | 2,951            | 3,032                     | 81                   | 2.7%             | 194                  | 6.8%             |
| Orange                 | 7,312            | 7,518            | 7,839                     | 321                  | 4.3%             | 527                  | 7.2%             |
| Rowe                   | 378              | 351              | 393                       | 42                   | 12.0%            | 15                   | 4.0%             |
| Shelburne              | 2,012            | 2,058            | 1,893                     | -165                 | -8.0%            | -119                 | -5.9%            |
| Shutesbury             | 1,561            | 1,810            | 1,771                     | -39                  | -2.2%            | 210                  | 13.5%            |
| Sunderland             | 3,399            | 3,777            | 3,684                     | -93                  | -2.5%            | 285                  | 8.4%             |
| Warwick                | 740              | 750              | 780                       | 30                   | 4.0%             | 40                   | 5.4%             |
| Wendell                | 899              | 986              | 848                       | -138                 | -14.0%           | -51                  | -5.7%            |
| Whately                | 1,375            | 1,573            | 1,496                     | -77                  | -4.9%            | 121                  | 8.8%             |
| <b>Franklin County</b> | <b>70,092</b>    | <b>71,535</b>    | <b>71,372</b>             | <b>-163</b>          | <b>-0.2%</b>     | <b>1,280</b>         | <b>1.8%</b>      |
| <b>Massachusetts</b>   | <b>6,016,425</b> | <b>6,349,097</b> | <b>6,547,629</b>          | <b>198,532</b>       | <b>3.1%</b>      | <b>531,204</b>       | <b>8.8%</b>      |

Source: U.S. Department of Commerce - Census Bureau; Decennial Census Program

As discussed in the Vulnerability Assessment Section of this plan, current development in the flood plain includes 825 acres of commercial, public/institutional and industrial uses and 43 acres of residential use. Given current data available, it is unknown exactly how much of the land in and along the floodplain is undeveloped. Further GIS analysis beyond the scope of the current project would be necessary to determine the exact number of developable acres in and along the floodplain. Further assessment of the possible developable lots should take into consideration constraints such as river buffers, highway setbacks, slopes and other constraining factors. The fact remains there is a potential for more development in floodplains in Greenfield and, with that development, the potential flooding impacts on structures and occupants.

# Zoning Map Town of Greenfield



**Legend**

- Greenfield Streets
- Transmission Lines
- Railroad
- Rivers & Streams

**Zoning Districts**

**Districts**

- Central Commercial - CC
- General Commercial - GC
- General Industry - GI
- Health Service - H
- Limited Commercial - LC
- Office - O
- Planned Industry - PI
- Rural Residential - RC
- Semi-Residential - SR
- Suburban Residential - RB
- Urban Residential - RA

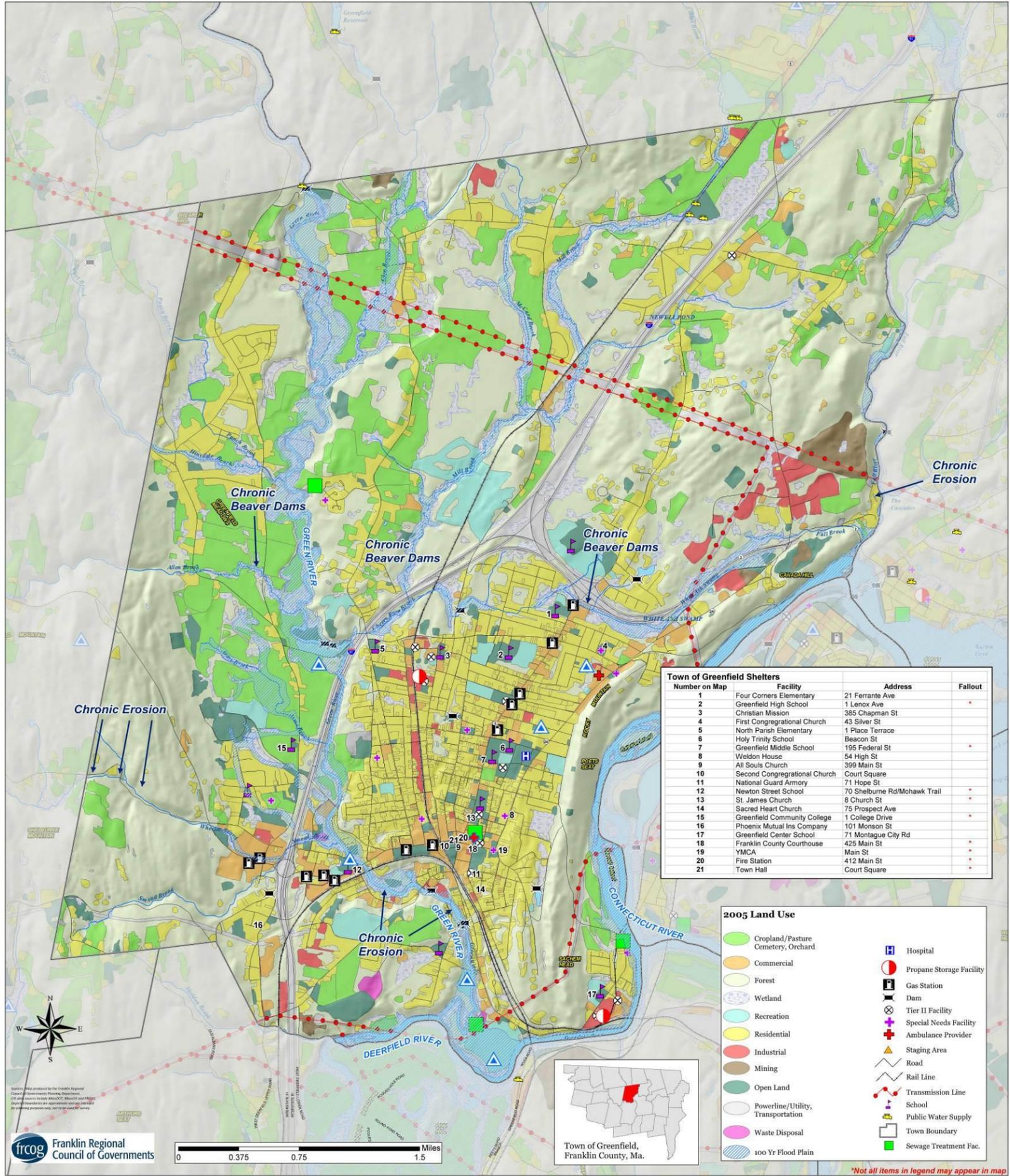
Franklin County Massachusetts  
Adopted October 18, 1989



Map Prepared by: Office of Planning & Community Development  
Data Source: Mass GIS March 2001  
Updated August 7, 2013

# Critical Facilities & Infrastructure, 2012

Town of Greenfield



## 4 – MITIGATION STRATEGIES

This section of the Hazard Mitigation Plan is the long-term blueprint for reducing the losses identified in the risk assessment. Each hazard includes a detailed of current mitigation strategies, a summary table of same mitigation strategies with suggested additions and changes and, in the Appendix, any detailed language from Zoning Bylaws and/or Subdivision Rules and Regulations.

### **Current Mitigation Strategies**

---

#### **Floods**

The Critical Facilities, Infrastructure, 2012 Land Use & Natural Hazards Map for the Town of Greenfield shows the 100-year flood zone identified by FEMA flood maps. The 100-year flood zone is the area that will be covered by water by a flood that has a 1% chance of occurring in any given year. The Map also shows the areas in town that are subject to localized flooding problems, such as the Maple Brook culvert in North and Maple Streets. According to the Greenfield Town Engineer, the Maple Brook culvert is the primary drainage system for 1,000 acres of the town's most urbanized area. The culvert was built in the 1930's. The culvert is in poor condition and studies have shown that it is significantly undersized for the current flows. The Town of Greenfield has a Capital Project on the books to replace or rehabilitate the culvert. Estimated project cost as of the 2005 Plan was \$1,750,000. Town Planner Eric Twarog indicated the cost of the project would need to be re-estimated given how long it has been since it was initially estimated.

Residential and commercial development has occurred within the 100-year floodplain along the Deerfield and Connecticut Rivers, especially in the area of town known as Cheapside. Along the downstream section of the Green River, there is residential and commercial development within or adjacent to the floodplain. Upstream, the land use within the floodplain of the Green River is predominantly forest and crop or pasture land. Land use within the floodplain of the Fall River is predominantly forest and crop or pasture land with sparse residential development adjacent to the floodplain.

The major floods recorded in Greenfield during the 20<sup>th</sup> Century have been the result of rainfall alone or rainfall combined with snowmelt. Historic records on the Connecticut and Deerfield Rivers have also cited backwater flooding from ice jams as a significant problem in the past. One of the goals of this Multi-Hazard Mitigation Plan is to evaluate all of the town's existing policies, practices, and plans related to hazards and identify potential gaps in protection.

#### **Existing Policies, Practices, and Plans**

##### ***Comprehensive Emergency Management (CEM) Plan***

The Comprehensive Emergency Management (CEM) Plan for Greenfield lists the following generic mitigation measures for flood planning and response:

- Identify areas in the community that are flood prone and define methods to minimize the risk. Review National Flood Insurance Maps.
- Disseminate emergency public information and instructions concerning flood preparedness and safety.
- Ensure that Greenfield is enrolled in the National Flood Insurance Program. See pages 131-133 for more information of NFIP.
- Strictly adhere to land use and building codes, (e.g. Wetlands Protection Act), and new construction should not be built in flood prone areas.
- Ensure that flood control works are in good operating condition at all times.
- Preserve natural water storage areas.
- Maintain plans for managing all flood emergency response activities including addressing potentially hazardous dams.

The Comprehensive Emergency Management (CEM) Plan for Greenfield lists the following generic preparedness and response measures for floods:

- Place EOC personnel on standby during stage of flood ‘watch’ and monitor NWS/New England River Forecast Center reports.
- Ensure that public warning systems are working properly and broadcast any information that is needed at this time.
- Review mutual aid agreements.
- Monitor levels of local bodies of water.
- Arrange for all evacuation and sheltering procedures to be ready for activation when needed.
- Carry out, or assist in carrying out needed flood-proofing measures such as sand bag placement, etc.
- Regulate operation of flood control works such as flood gates.
- Notify all Emergency Management related groups that will assist with flood response activities to be ready in case flood ‘warning’.
- Broadcast warning/notification of flood emergency.
- Coordinate traffic control and proceed with evacuation of affected populations as appropriate.
- Open and staff shelters and reception centers.
- Undertake, or continue to carry out, flood proofing measures.
- Dispatch search and rescue teams.
- Dispatch emergency medical teams

### ***Flood Control Structures***

The Town of Greenfield has no flood control structures within its corporate boundaries. Floods on the Connecticut River and portions of its major tributaries that are prone to backwater effects are controlled by nine flood control reservoirs located upstream in Massachusetts, New Hampshire, and Vermont. The hydro-power facilities in the upstream reaches of the Deerfield River in Vermont (Harriman and Somerset Reservoirs) provide some flood attenuation capacity. In addition, there are several dams on the Deerfield in Massachusetts controlled by the TransCanada Corporation and Brookfield Renewable Power that offer minimal flood protection. Flashboards at the Shelburne Falls Dam and TransCanada Dam No. 4 are designed to fail when the river reaches flood stage.

In 2009, the University of Massachusetts Transportation Engineering Department developed an evacuation scenario for Franklin County in the event of the failure of Harriman Dam. In 2010, the Franklin Regional Council of Governments prepared a supplement to the Franklin County: Harriman Dam Failure Case Study II done by UMASS. It makes recommendations for evacuating Greenfield and the other towns in the County should the dam fail.<sup>65</sup>

### ***Land Use Regulations that Mitigate Impacts from Flooding***

The Town of Greenfield has adopted several land use regulations that serve to limit or regulate development in floodplains, to manage stormwater runoff, and to protect groundwater and wetland resources, the latter of which often provide important flood storage capacity. These regulations are summarized below and their effectiveness evaluated in Table 4-1.

### ***Zoning Bylaws - See Appendix A for details***

#### **Floodplain Zoning Ordinance: Section 200-4.13 Floodplain Overlay district**

Permitted Uses (Section 200-4.13.E)

Special Permits (Section 200-4.13.F)

Prohibited (Section 200-4.13.I)

Performance Standards Section 200-6.8

Open Space/Cluster Developments Section 200-7.1

Common Open Space Requirements (Section 200-7.1 H)

Earth Removal, Section 200-7.4

Major Development Review, Section 200-7.12

Site Plan Review and Approval (Section 200-8.4)

#### **Subdivision Rules and Regulations - See Appendix A for details**

Greenfield's Subdivision Rules and Regulations (Chapter 880)

Section 880-9.B Definitive Plan Submission Requirements

Section 880-9.E Wetlands Protection Act.

Section 880-10. Design Requirements

Section 880-11. Open Space

Section 880-12. Protection of Natural Features

Section 880.13. Easements

Section 880-14. Environmental Assessment

#### **Town of Greenfield Code - See Appendix A for details**

Wetlands Protection, Chapter 195

Stormwater System Regulations, Chapter 695

Design Criteria Section 695-12

Water Supply Protection District Section 200-4.14

Limitations upon Uses section (200-4.14.10)

---

<sup>65</sup> *Draft Recommendations, Town Recommendations: Supplement to the Failure of the Harriman Dam Evacuation Planning Report.*

### ***2006 Greenfield Open Space and Recreation Plan***

As its title implies, the intent of Greenfield's Open Space and Recreation Plan is not to address hazard mitigation or flood control in a direct or comprehensive way. However, the plan inventories the natural features and environments in the town, many of which, such as wetlands, aquifer recharge areas, farms, rivers, streams, and brooks, include floodplain areas.

Greenfield's statement of Open Space and Recreation Goals includes protecting important and strategically located open space and protecting the Town's natural resources and the environment. The Plan's Resource Protection Needs Analysis concludes that it is important to think on a "watershed scale" and coordinate with neighboring communities and other entities on projects involving the Connecticut and Deerfield Rivers. More specifically, the Plan states that lands along the Green River, which runs through the heart of Greenfield, is a priority. Protecting lands located near designated water supply areas is also identified as a priority. Greenfield contains some of the most fertile farmland in the county due in large part to its proximity of rivers which deposit the rich soil in their floodplains. The Open Space and Recreation Plan recommended that the Town take a proactive role in protecting these lands through the Agricultural Preservation Restriction Program (APR), the Chapter 61A programs, and adopting zoning ordinances for farmland preservation such as a Farmland Preservation Overlay District.

### ***2009 Greenfield Reconnaissance Report***

The Massachusetts Heritage Landscape Inventory Program's Reconnaissance Report is a valuable resource for Greenfield, helping to identify those landscapes particularly valued by the community, especially those that are significant and unprotected. It also contains information on cultural and historic resources in Town. This inventory could be used by the Committee to help them prioritize those resources that may be threatened by hazards such as flooding.

### ***2002 Greenfield Master Plan***

The Greenfield Master Plan is a statement of the community values of Greenfield and a directive for the physical development of the town that describes how, why, where and when to build, rebuild or preserve the town. As such, it indirectly addresses flooding potential and mitigation in the Land Use Section of the Master Plan. Among the Goals of the Land Use Section which indirectly address flooding are:

- Preserving agriculture;
- Promoting housing choice and natural resource protection through careful site planning in outlying areas; and
- Siting land uses where the carrying capacity of the land is greatest.

Several Implementation Objectives in the Land Use Section also indirectly address flooding by seeking to preserve open space and encourage environmentally sensitive development patterns. These specific Objectives encourage:

- The initiation of an assertive, coordinated, on-going open space resources acquisition and preservation plan; and

- Identifying ways to achieve cluster development as a preferred development pattern for areas with specific attributes such as water resource protection, agricultural soils, landscape character, and wildlife habitat and corridors.

The Goal of the Natural, Cultural, and Historic Resources Section of the Master Plan is the protection and enhancement of Greenfield’s natural resource systems, cultural resources, and historic buildings. Preserving and enhancing natural resource systems, such as wetlands and floodplains, will help to mitigate or prevent flooding. One of the objectives of this section is to protect environmentally sensitive areas and to try and site development away from these areas or mitigate impacts to these areas. Among the Implementation Measures listed in the Natural, Cultural, and Historic Resources Section of the Master Plan is one that would specifically mitigate or prevent flooding, namely – enforcing the Town’s Zoning Ordinance and existing environmental regulations.

The Open Space and Recreation Section of the Greenfield Master Plan includes the Goal of preserving and providing open space “...to enhance Greenfield’s overall environmental quality.” One of the Objectives listed in this section is to “[i]ncrease public awareness pertaining to recreation and conservation opportunities and educate the public in regards to the protection of the environment.”

#### ***2005 Bank Row Urban Renewal Plan***

This plan addresses a specific area of town – Bank Row – and its historic significance and existing substandard or blighted conditions. The plan could be used to help the Committee identify other similar areas in town, to prioritize those cultural and historic possibly threatened by hazards such as flooding and to develop mitigation strategies.

**Table 4-1: Existing Flood Hazard Mitigation Measures**

| Type of Existing Protection                | Description   | Area Covered  | Effectiveness  | 2011 Potential Changes   | Accomplished/ Still Relevant? |
|--|---|---|--|--|-------------------------------|
| <b>Zoning Bylaws</b>                       |   |   |  |  |                               |
| Floodplain Overlay District                | <p>Permitted uses are allowed if they do not require structures, fill or storage of materials.</p> <p>No encroachment allowed within the 100-year floodplain without a Special Permit.</p> <p>Special permit conditions require no decrease in flood storage capacity or increase in flood levels. Use must not substantially affect the water table, water quality or drainage patterns.</p> | Special Flood Hazard Areas (Zones A, A 1-30) to indicate the 100-year floodplain. | Effective for regulating new development within the 100-year floodplain.                                       | Consider limiting all new development within the 100-year floodplain.                                  | Still relevant.               |
| Performance Standards                      | Standard (6.8.3.8) addresses the impacts of uncontrolled surface water runoff and sedimentation of surface waters.  | Entire town.  | Effective for mitigating localized flooding by regulating stormwater runoff.                                   | None.  | N/A                           |
| Open Space and Cluster Development Section | Earth Removal: Regulates the removal of soil, loam, sand & gravel through a permitting process and exempts existing sand and gravel operations, and disturbances due to building construction and landscaping activities.   | Entire town.  | Not Effective for controlling localized flooding. This Ordinance does not include a purpose.                   | Add reducing or eliminating the potential for localized flooding events as a Purpose of the Ordinance. | Still relevant.               |
|  |   |   | This Ordinance does not specifically address the potential for localized flooding that soil removal can cause. | Require mitigation of potential impacts from flooding.   | Still relevant.               |

| Type of Existing Protection                | Description   | Area Covered   | Effectiveness   | 2011 Potential Changes                                | Accomplished/ Still Relevant? |
|--|---|--|---|---|-------------------------------|
|  |   |  | This Ordinance was written to address safety, aesthetics, and potential traffic impacts associated with soil removal. | Add a reference to the Town's stormwater regulations. | Still relevant.               |
| Open Space and Cluster Development Section | <p>Major Development Review:</p> <p>Requires an Impact Statement for certain types of development.</p> <p>The Impact Statement must include an evaluation of the impact of stormwater, runoff, flooding, erosion, sedimentation, grading changes, increased impervious surface, discharges to groundwater, pumping of groundwater, wetlands disruption, and changes to vegetative cover.</p> <p>The Impact Statement must describe proposed mitigation measures for identified impacts.</p> <p>Regulations list the Environmental Standards for Impact Statements that address flooding: specifically, the project shall not cause erosion or flooding of the site.</p> | Entire town.   | Effective for mitigating flooding and flood-related impacts for certain types of large-scale developments.            | None.   | N/A                           |
| Open Space and Cluster Development Section | Site Plan Review: Project proponent must submit information regarding measures to prevent flooding and increased runoff and prevent erosion and sedimentation.  | Required for all uses that require a Special Permit, any business, commercial, industrial or institutional use (except certain home occupations) and | Effective for preventing flooding and uncontrolled stormwater runoff.   | None.   | N/A                           |

| Type of Existing Protection               | Description   | Area Covered   | Effectiveness  | 2011 Potential Changes | Accomplished/ Still Relevant? |
|---|---|--|--|------------------------|-------------------------------|
|   |   | any site containing more than one (1) principal use. |  |                        |                               |
| <b>Subdivision Rules and Regulations:</b> |   |  |  |                        |                               |
| Definitive Plan                           | Proposed layout (including cross sections and profiles) of sewerage, storm drainage and water supply, including invert elevations, slopes, capacity, and velocity and stormwater management plan  | Entire Town  | Effective for mitigating localized flooding of roads and other infrastructure.   | None                   | N/A                           |
|   | An erosion control plan, indicating the erosion control measures to be employed, including description of locations of temporary stockpiles, spoil areas, temporary drainage systems, slope stabilization techniques, sediment basins, etc., and narrative description of how erosion from individual lots onto streets and into drainage systems is proposed to be controlled. | Entire Town  | Effective for mitigating localized flooding of roads and other infrastructure.   | None                   | N/A                           |
| Wetlands Protection Act                   | Guidelines establish that the development must be in compliance with the WPA and the applicant shall obtain approval from the Conservation Commission prior to any construction activity in the affected areas.   | Entire Town  | Effective for mitigating localized flooding of roads and other infrastructure and for preventing filling of flood storage areas. | None                   | N/A                           |
| Design Requirements                       | Requires design to reduce where possible, the volume of cut and fill; the area over which existing vegetation will be disturbed, especially if within 200 feet of a river, pond, or stream, or having a slope of more than 15%;the number of  | Entire Town  | Effective for mitigating localized flooding of roads and other infrastructure and for preventing filling of flood storage areas. | None                   | N/A                           |

| Type of Existing Protection    | Description   | Area Covered | Effectiveness   | 2011 Potential Changes   | Accomplished/ Still Relevant? |
|--------------------------------|---|--------------|---|--|-------------------------------|
|                                | mature trees removed; the extent of waterway altered or relocated; the erosion and siltation; and flood damage.   |              |   |  |                               |
| Open Space                     | Should contain design requirements that can reduce the potential for flooding.  | Entire Town  | Somewhat effective for mitigating localized flooding of roads and other infrastructure and for preventing filling of flood storage areas. | Consider adding prevention of flooding as an explicitly stated purpose for this requirement. | Still relevant.               |
| Protection of Natural Features | Should contain design requirements that can reduce the potential for flooding.  | Entire Town  | Somewhat effective for mitigating localized flooding of roads and other infrastructure and for preventing filling of flood storage areas. | Consider adding prevention of flooding as an explicitly stated purpose for this requirement. | Still relevant.               |
| Easements                      | Should contain design requirements that can reduce the potential for flooding.  | Entire Town  | Somewhat effective for mitigating localized flooding of roads and other infrastructure and for preventing filling of flood storage areas. | Consider adding prevention of flooding as an explicitly stated purpose for this requirement. | Still relevant.               |
| Flood Hazard Areas             | Requires that any portion of a proposed subdivision which is located within the 100-year floodplain shall meet the following requirements:<br><br>All requirements of § 200-4.13 Floodplain District (F) of the Greenfield Zoning | Entire Town  | Somewhat effective for mitigating localized flooding of roads and other infrastructure and for preventing filling of flood storage areas. | Consider prohibited all subdivision development within the 100-year floodplain.              | Still relevant.               |

| Type of Existing Protection          | Description   | Area Covered                        | Effectiveness   | 2011 Potential Changes | Accomplished/ Still Relevant? |
|--------------------------------------|---|-------------------------------------|---|------------------------|-------------------------------|
|                                      | Ordinance.<br><br>The subdivision, including utilities and drainage, shall be designed to be consistent with the needs to minimize flood damage and provide adequate drainage.<br><br>Subdivisions shall include base flood elevation data.   |                                     |   |                        |                               |
| <b>Town of Greenfield Code:</b>      |   |                                     |   |                        |                               |
| Stormwater System Regulation         | Regulations require a permit for all new connections to the stormwater system and any increases in volume from existing development.<br><br>Stormwater Management Plans are required for all nonresidential uses.<br><br>Regulations include stormwater management standards, design criteria and mandate coordination with the Greenfield Conservation Commission. | Entire Town                         | Effective for mitigating or preventing localized flooding of roads and other infrastructure and for controlling impacts from stormwater runoff. | None.                  | N/A                           |
| Water Supply Protection District     | Regulations protect and preserve existing and potential sources of groundwater supply and recharge and watershed areas.   | Areas identified on the Zoning Map. | Effective for mitigating the potential for localized flooding by preserving open space in the watershed and regulating stormwater runoff        | None.                  | N/A                           |
| <b>Town of Greenfield Plans:</b>     |   |                                     |   |                        |                               |
| Greenfield Open Space and Recreation | Inventories natural features and environments in the town, including many   | Entire town.                        | Effective in identifying sensitive resource areas,  | None.                  | N/A                           |

| Type of Existing Protection                           | Description  | Area Covered                       | Effectiveness  | 2011 Potential Changes | Accomplished/ Still Relevant? |
|---|--|------------------------------------|--|------------------------|-------------------------------|
| Plan  | that contain floodplain areas such as wetlands, aquifer recharge areas, farms, rivers, streams and brooks. |                                    | including floodplains and encourages thinking on a “watershed scale”.<br><br>Prioritizes protecting areas along the Green River and recommends that the Town take a proactive role in preserving farmland, much of which lies within the floodplain. |                        |                               |
| Greenfield Master Plan                                | Provides a framework for guiding development in Town.  | Entire town.                       | Effective in establishing priorities for environmentally sensitive development that will mitigate flooding impacts.  | None.                  | N/A                           |
| Participation in the National Flood Insurance Program | As of 2003, there were 48 homeowners with flood insurance policies.  | Areas identified by the FEMA maps. | Effective.   | None.                  | N/A                           |
| State Building Code                                   | The Town of Greenfield has adopted the Massachusetts State Building Code.                                  | Entire Town                        | Effective  | None.                  | N/A                           |

| Type of Existing Protection                                     | Description  | Area Covered                                   | Effectiveness  | 2011 Potential Changes | Accomplished/ Still Relevant? |
|---|--|--|--|------------------------|-------------------------------|
| Deerfield River Watershed Regional Open Space & Recreation Plan | This project will be completed by June 30, 2004. A regional Open Space Committee will be formed to implement a Ten-Year Action Plan. | Entire Town and the Deerfield River Watershed. | Effective in raising awareness of water resources in Town and potential negative impacts of uncontrolled development (loss of open space, farmland, stormwater runoff and other nonpoint source pollution). Will encourage thinking on a watershed scale | None.                  | Still relevant.               |

## Severe Winter Storms

Winter storms can be especially challenging for Emergency Management personnel because, although the storm has usually been forecast, there is no certain way to predict its length, size or severity. The Massachusetts Emergency Management Agency (MEMA) serves as the primary coordinating entity in the state-wide management of all types of winter storms and monitors the National Weather Service alerting systems during periods when winter storms are expected.<sup>66</sup>

### *Management Plans*

The CEM Plan for Greenfield lists the following generic mitigation measures for severe winter storms:

- Develop and disseminate emergency public information concerning winter storms, especially material which instructs individuals and families how to stock their homes, prepare their vehicles, and take care of themselves during a severe winter storm.
- As it is almost guaranteed that winter storms will occur annually in Massachusetts, local government bodies should give special consideration to budgeting fiscal resources with snow management in mind.
- Maintain plans for managing all winter storm emergency response activities.

To the extent that some of the damages from a winter storm can be caused by flooding, all of the flood protection mitigation measures described in Table 4-1 can also be considered as mitigation measures for severe snowstorms/ice storms.

The CEM Plan for Greenfield lists the following generic preparedness and response measures for severe winter storms:

- Ensure that warning/notification, and communications systems are in readiness.
- Ensure that appropriate equipment and supplies, especially snow removal equipment, are in place and in good working order.
- Review mutual aid agreements.
- Designate suitable shelters throughout the community and make their locations known to the public.
- Implement public information procedures during storm 'warning' stage.
- Prepare for possible evacuation and sheltering of some populations impacted by the storm (especially the elderly and special needs).
- Broadcast storm warning/notification information and instructions.
- Conduct evacuation, reception and sheltering activities.
- If appropriate, activate media center. Refer to Resource Manual for media center information.
- Dispatch search and rescue teams.

---

<sup>66</sup> Comprehensive Emergency Management Plan for the Town of Greenfield, August 2002.

- Dispatch emergency medical teams.
- Take measures to guard against further danger from power failure, downed trees and utility lines, ice, traffic problems, etc.
- Close roads, and/or limit access to certain areas if appropriate.
- Provide assistance to homebound populations needing heat, food, and other necessities.
- Provide rescue and sheltering for stranded/lost individuals.

### ***Land Use Regulations that Mitigate Impacts from Severe Winter Storms***

#### *Subdivision Rules and Regulations (See Appendix A for details)*

##### Section 3.1.2 Design Standards

#### ***Other Mitigation Measures***

Severe snowstorms or ice storms can often result in a small or widespread loss of electrical service. The public water supply wells and water treatment plant are both equipped with standby power sources. The distribution system functions by gravity; therefore, no auxiliary power is needed. The sewage pump stations and the wastewater treatment plant are also equipped with standby power sources.

#### *State Building Code*

For new or recently built structures, the primary protection against snow-related damage is construction according to the State Building Code, which addresses designing buildings to withstand snow loads. The Town of Greenfield is a member of the Franklin County Cooperative Building Inspection Program, which provides building inspection services.

**Table 4-2: Existing Severe Winter Storms Hazard Mitigation Measures**

| Type of Existing Protection              | Description   | Area Covered | Effectiveness | 2011 Potential Changes   | Accomplished/ Still Relevant? |
|--|---|--------------|---------------|--|-------------------------------|
| <b>Subdivision Rules and Regulations</b> |   |              |               |  |                               |
| <b>Floodplain Overlay District</b>       | Standards include street grade regulations (six to 10 percent maximum).     | Entire Town. | Effective.    | None.  | N/A                           |
| <b>Shelters</b>                          | Shelters for victims of natural hazards in Greenfield have been identified. | Entire Town. | Effective.    | Ensure that identified shelters have sufficient back-up utility service in the event of primary power failure. | Still relevant.               |
| <b>State Building Code</b>               | The Town of Greenfield has adopted the MA State Building Code               | Entire Town. | Effective.    | None   | N/A                           |

## **Hurricanes (Tornados included in this section)**

The flooding associated with hurricanes and tornados can be a major source of damage to buildings, infrastructure and a potential threat to human lives. Therefore, all of the flood protection mitigation measures described in Table 4-1 can also be considered hurricane mitigation measures. High winds that oftentimes accompany hurricanes and tornados can also damage buildings and infrastructure. See Microbursts on following pages for wind-related mitigation measures.

### ***Management Plans***

The CEM Plan for Greenfield lists the following generic mitigation measures for hurricane and tornado planning and response:

- Develop and disseminate emergency public information and instructions concerning hurricane preparedness and safety.
- Community leaders should ensure that Greenfield is enrolled in the National Flood Insurance Program.
- Develop and enforce local building codes to enhance structural resistance to high winds and flooding. Build new construction in areas that are not vulnerable to direct hurricane effects.
- Maintain plans for managing all hurricane emergency response activities.

The CEM Plan for Greenfield includes the following generic preparedness and response measures for hurricanes and tornados:

- Ensure that warning/notification systems and equipment is ready for use at the ‘hurricane warning’ stage.
- Review mutual aid agreements.
- Designate suitable wind and flood resistant shelters in the community and make their locations known to the public.
- Prepare for coordination of evacuation from potentially impacted areas including alternate transportation systems and locations of special needs facilities.
- Activate warning/notification systems to inform public of protective measures to be taken including evacuation where appropriate.
- Conduct evacuation of affected populations.
- Open and staff shelters and reception centers.
- Dispatch search and rescue teams.
- Dispatch emergency medical teams.
- Activate mutual aid activities.
- Take measures to guard against further danger from downed trees and utility lines, debris, etc.

### ***Evacuation Options***

The Greenfield CEM plan, local officials have identified appropriate shelters for residents in the case of a hurricane or tornado.

Also, the University of Massachusetts Transportation Center completed a Four County Scenario of Berkshire, Franklin, Hampshire and Hamden Counties should a hurricane force a full evacuation of Western Massachusetts. The study looks at critical transportation links; what could be done if such links were totally lost or partially constrained; and what alternative routes and other transportation services would be needed in order to evacuate people effectively to a safe location.

***Zoning Bylaws***

Section 200-7.14 Wireless Communications Facilities.

***Restrictions on Development***

The only restrictions on development that are wind-related are the provisions in the zoning Ordinance related to Wireless Communications Facilities. In addition, new mobile homes, which are susceptible to catastrophic damage during high wind events, are prohibited in town.

***State Building Code***

For new or recently built structures, the primary protection against wind-related damage is construction according to the State Building Code which adequately addresses designing buildings to withstand high winds.

**Table 4-3: Existing Hurricanes and Tornados Hazard Mitigation Measures**

| Type of Existing Protection                                      | Description   | Area Covered | Effectiveness  | 2011 Potential Changes  | Accomplished/ Still Relevant? |
|--|---|--------------|--|---|-------------------------------|
| <b>Zoning Bylaws</b>   |   |              |  |   |                               |
| <b>Zoning regulations for wireless communications facilities</b> | <p>Requires a special permit from the Zoning Board of Appeals and a building permit from the Inspector of Buildings before a facility can be erected.</p> <p>Applicant must provide plans for anchoring and supporting the structure.</p> <p>The Ordinance also establishes a “fall zone” for the structure in relation to property lines and road right-of-ways.</p> | Entire town. | Effective.   | Add safety and prevention of wind-related damage as a stated purpose.                           | Still relevant.               |
| <b>State Building Code</b>                                       | The Town of Greenfield has adopted the Massachusetts State Building Code.   | Entire Town  | Effective  | No Changes  | N/A                           |
| <b>Zoning Regulations Prohibiting new mobile homes</b>           | Town of Greenfield Zoning Ordinance prohibits the siting of new mobile homes.   | Entire Town. | <p>Effective in reducing the potential for loss of life and property damage.</p> <p>Existing mobile homes are “grandfathered” and can be replaced.</p> <p>Replacements must meet standards of current building code.</p> | Ensure that replacement mobile homes be tied down to reduce the damaging impacts of high winds. | Still relevant.               |

## **Microbursts (Includes Thunderstorms and Wind Related Events)**

Most damage from microbursts and wind-related events comes from high winds which can fell trees and electrical wires, generate hurtling debris and, possibly, hail.

### ***Management Plans***

The Greenfield CEM Plan lists three generic mitigation measures for wind-related storm planning and response.

- Develop and disseminate emergency public information and instructions concerning tornado safety, especially guidance regarding in-home protection and evacuation procedures, and locations of public shelters.
- Strict adherence should be paid to building code regulations for all new construction.
- Maintain plans for managing tornado response activities. Refer to the non-institutionalized, special needs and transportation resources listed in the Resource Manual.

The CEM Plan for Greenfield includes the following generic preparedness and response measures for wind-related storms:

- Designate appropriate shelter space in the community that could potentially withstand tornado impact.
- Periodically test and exercise tornado response plans.
- Put Emergency Management on standby at tornado ‘watch’ stage.
- At tornado ‘warning’ stage, broadcast public warning/notification safety instructions and status reports.
- Conduct evacuation, reception, and sheltering services to victims.
- Dispatch search and rescue teams.
- Dispatch emergency medical teams.
- Activate mutual aid agreements.
- Take measures to guard against further injury from such dangers as ruptured gas lines, downed trees and utility lines, debris, etc.
- Acquire needed emergency food, water, fuel, and medical supplies.
- Take measures relating to the identification and disposition of remains of the deceased.

### ***Evacuation Plans***

There are shelters for wind-related storm victims identified in the Greenfield CEM Plan.

### ***Zoning***

See related information under Hurricanes and Tornados, previous section.

***Restrictions on Development***

The only restrictions on development that are wind-related are the provisions in the zoning Ordinance related to Wireless Communications Facilities. In addition, new mobile homes, which are susceptible to catastrophic damage during high wind events, are prohibited in town.

***State Building Code***

For new or recently built structures, the primary protection against wind-related damage is construction according to the State Building Code which adequately addresses designing buildings to withstand high winds.

**Table 4-4: Existing Microbursts Storms (Includes Thunderstorms and Wind Related events) Hazard Mitigation Measures**

| Type of Existing Protection                                      | Description   | Area Covered | Effectiveness   | 2011 Potential Changes  | Accomplished/ Still Relevant? |
|--|---|--------------|---|---|-------------------------------|
| <b>Zoning Bylaws</b>   |   |              |   |   |                               |
| <b>Zoning regulations for wireless communications facilities</b> | <p>Requires a special permit from the Zoning Board of Appeals and a building permit from the Inspector of Buildings before a facility can be erected.</p> <p>Applicant must provide plans for anchoring and supporting the structure.</p> <p>The Ordinance also establishes a “fall zone” for the structure in relation to property lines and road right-of-ways.</p> | Entire town. | Effective.  | Add safety and prevention of wind-related damage as a stated purpose.                           | Still relevant.               |
| <b>State Building Code</b>                                       | The Town of Greenfield has adopted the Massachusetts State Building Code.   | Entire Town  | Effective   | No Changes  | N/A                           |
| <b>Zoning Regulations Prohibiting new mobile homes</b>           | Town of Greenfield Zoning Ordinance prohibits the siting of new mobile homes.   | Entire Town. | Effective in reducing the potential for loss of life and property damage. Existing mobile homes are “grandfathered” and can be replaced. Replacements must meet standards of current building code. | Ensure that replacement mobile homes be tied down to reduce the damaging impacts of high winds. | Still relevant.               |

## Wildfires / Brush Fires

### *Management Plans and Regulatory Measures*

The CEM Plan for Greenfield includes the following generic mitigation measures for wildfire planning and response:

- Promote fire safety measures such as fire-safe landscaping and construction practices to the public and business communities.

The CEM Plan for Greenfield includes the following generic preparedness and response measures for tornados:

- Restrict outside burning etc. based on moisture levels, fuels supply conditions such as drought.
- Identify high vulnerability or problem areas.
- Utilize mutual aid, including the State Fire Mobilization Plan, as needed.

Greenfield also has some specific regulations and programs that pertain to preventing fires.

### *Burn Permits*

The Town of Greenfield Fire Department requires a permit for the outdoor burning of leaves on residential property. The Town issued approximately 600 burn permits between January 15<sup>th</sup> and May 1<sup>st</sup> of 2003 and requires that these permits be obtained in person from the Fire Department. When an individual comes in to obtain a burn permit, Fire Department personnel educate them about safe burning practices. This outreach effort has resulted in lowering the number of outdoor residential brush fires that get out of the homeowner's control.

### *Subdivision Review*

The Fire Department reviews subdivision plans to ensure that their trucks will have adequate access and that the water supply is adequate for fire-fighting purposes.

### *Public Education/Outreach*

The Fire Department implements "Safe Schools", an ongoing educational program in the schools to teach fire safety. As mentioned above, the Fire Department also educates homeowners who apply for burn permits.

### *Restrictions on Development*

There are currently no restrictions on development that are based on the need to mitigate the hazards of wildfires/brushfires.

**Table 4-5: Existing Wildfires / Brush Fires Hazard Mitigation Measures**

| Type of Existing Protection          | Description  | Area Covered | Effectiveness | 2011 Potential Changes | Accomplished/ Still Relevant? |
|--------------------------------------|--|--------------|---------------|------------------------|-------------------------------|
| <b>Zoning Bylaws</b>                 |  |              |               |                        |                               |
| <b>Burn Permits</b>                  | Residents are required to appear in person to obtain burn permits. Fire Department personnel provide information on safe burn practices. | Entire Town. | Effective.    | None.                  | N/A                           |
| <b>Subdivision Review</b>            | The Fire Department is involved in the review of subdivision plans.  | Entire Town. | Effective.    | None.                  | N/A                           |
| <b>Public Education and Outreach</b> | The Fire Department has an ongoing educational program in the schools.   | Entire Town. | Effective.    | None.                  | N/A                           |
| <b>Forestry Management</b>           | A Forestry Management Program for town owned lands.  | Entire Town. | Effective.    | None.                  | N/A                           |

## Dam Failures

The only mitigation measures in place are the state regulations that control the construction and inspection of dams and the Emergency Action Plans for the FERC-regulated projects on the Deerfield River.

### *Management Plans and Regulatory Measures*

The Greenfield CEM Plan contains the following generic mitigation measures for dam failure:

- Develop and conduct public education programs concerning dam hazards.
- Maintain up-to-date plans to deal with threat and actual occurrence of dam overspill or failure.
- Emergency Management and other local government agencies should familiarize themselves with technical data and other information pertinent to the dams which impact Greenfield. This should include determining the probable extent and seriousness of the effect to downstream areas.
- Dams should be inspected periodically and monitored regularly.
- Repairs should be attended to promptly.
- As much as is possible burdens on faulty dams should be lessened through stream re-channeling.
- Identify dam owners.
- Determine minimum notification time for downstream areas.

The Greenfield CEM Plan contains the following generic preparedness and response measures for dam failure:

- Pre-place adequate warning/notification systems in areas potentially vulnerable to dam failure effects.
- Develop procedures for monitoring dam site conditions at first sign of any irregularity that could precipitate dam failure.
- Identify special needs populations, evacuations routes, and shelters for dam failure response.
- Have sandbags, sand, and other items to reinforce dam structure or flood proof flood prone areas.
- Disseminate warning/notification of imminent or occurring dam failure.
- Coordinate evacuation and sheltering of affected populations.
- Dispatch search and rescue teams.
- Coordinate evacuation and sheltering of affected populations.
- Activate mutual aid if needed.
- Acquire additional needed supplies not already in place, such as earth moving machinery.
- Establish incident command post as close to affected area as safely possible.
- Provide security for evacuated public and private property.

### ***Evacuation Options***

Evacuation information is contained in the Town of Greenfield CEM Plan.

### ***Permits Required for New Dam Construction***

Massachusetts State Law (M.G.L. Chapter 253 Section 45) regulates the construction of new dams. A permit must be obtained from the Department of Conservation and Recreation (DCR) before construction can begin. One of the permit requirements is that all local approvals or permits must be obtained.

### ***Dam Inspections***

The DCR requires that dams rated as Low Hazards be inspected every ten (10) years and dams that are rated as Significant Hazards be inspected every five (5) years. Of the nine (9) dams in Greenfield, the Town is the Owner and Caretaker of record for six (6) of these dams. According to DCR records, four (4) of the dams the Town is responsible for are classified as Significant Hazards and the remaining two (2) dams are Low Hazard. The remaining three (3) dams in town are under private ownership. All three (3) are classified as Significant Hazard dams. The dam safety information provided by DCR indicates that four (4) of the dams in town have not been inspected according to the required schedule.

Responsibility for dam inspections resides with the owner of the dam, which will likely create a significant financial hardship, both for towns and individuals who own dams, and result in fewer dams being inspected according to the required schedule.

### ***Zoning***

While no specific mention is made regarding the construction of new dams in either the Floodplain District (Section 200-4.13) or the Wetlands Protection section (Section 195-1), the language regarding encroachment and the erection of structures in both ordinances would indicate that a Special Permit would be required from the Zoning Board of Appeals and an Order of Conditions would be required from the Conservation Commission.

### ***Restrictions on Development***

There are no Town restrictions on dam locations. The DCR issues permits for new dams and does have the authority to deny a permit if it is determined that the design and/or location of the dam is not acceptable.

**Table 4-6: Existing Dam Failure Hazard Mitigation Measures**

| Type of Existing Protection                      | Description   | Area Covered  | Effectiveness   | 2011 Potential Changes  | Accomplished/ Still Relevant? |
|--|---|---|---|---|-------------------------------|
| <b>Zoning Bylaws</b>                             |   |   |   |   |                               |
| <b>Permits required for new dam construction</b> | State law requires a permit for the construction of any dam.  | Entire Town.  | Effective. Ensures dams are adequately designed.  | None.   | N/A                           |
| <b>Dam Inspections</b>                           | DCR has an inspection schedule that is based on the hazard rating of the dam (low, significant, high hazard). | Entire Town.  | Very Low. The state passed a law in 2002 to shift responsibility for inspections from the state to the dam owner. The regulations have not been issued so DCR continues to inspect only the High Hazard dams. It is highly likely that the remaining dams are not being inspected according to the required schedule. | Repeal the state law requiring dam owners pay for inspections. Adequate staff and resources should be given to DCR to ensure the inspection schedules are maintained. | Still relevant.               |
|  |   |   |   | Map dams and Inundation Areas.  | Still relevant.               |
|  |   |   |   | Evaluate the Need for Dam Inspections by the Town.  | Still relevant.               |
|  |   |   |   | Incorporate Dam Safety into Development Review process.   | Still relevant.               |
| <b>Zoning</b>                                    | Special Permit and/or Order of Conditions required for dams in Floodplain district or wetlands.               | Floodplain areas and those under the jurisdiction of the Conservation Commission. | Effective.  | None.   | N/A                           |

See also Table 4-1: Existing Flood Hazard Mitigation Measures.

## Earthquakes

Although there are five mapped seismological faults in Massachusetts, there is no discernable pattern of previous earthquakes along these faults nor is there a reliable way to predict future earthquakes along these faults or in any other areas of the state. Consequently, earthquakes are arguably the most difficult natural hazard to plan for.

### *Management Plans*

The Greenfield CEM Plan lists five generic earthquake mitigation measures, including:

- Community leaders in cooperation with Emergency Management Personnel should obtain local geological information and identify and assess structures and land areas that are especially vulnerable to earthquake impact and define methods to minimize the risk.
- Strict adherence should be paid to land use and earthquake resistant building codes for all new construction.
- Periodic evaluation, repair, and/or improvement should be made to older public structures.
- Emergency earthquake public information and instructions should be developed and disseminated.
- Earthquake drills should be held in schools, businesses, special care facilities, and other public gathering places.

The Greenfield CEM Plan lists the following generic preparedness and response measures for earthquakes:

- Earthquake response plans should be maintained and ready for immediate use.
- All equipment, supplies and facilities that would be needed for management of an earthquake occurrence should be maintained for readiness.
- Emergency Management personnel should receive periodic training in earthquake response.
- If the designated Emergency Operations Center (EOC) is in a building that would probably not withstand earthquake impact, another building should be chosen for an earthquake EOC.
- Mass Care shelters for earthquake victims should be pre-designated in structures that would be most likely to withstand earthquake impact.
- It is assumed that all special needs facilities could be affected to some extent by earthquake effects therefore preparedness measures should be in place to address the needs of all facilities listed in the Resource Manual.
- Most likely the entire population of the community will be affected by a seismic event. Estimate the maximum peak population affected, considering peak tourism, special event populations, and work hours.
- EOC will be activated and response will immediately be engaged to address any and all earthquake effects.

- Emergency warning/notification information and instructions will be broadcast to the public.
- Search and rescue teams will be dispatched.
- Emergency medical teams will be dispatched.
- Firefighters will address fires/explosions, and HAZMAT incidents.
- Law enforcement personnel will coordinate evacuation and traffic control.
- Reception centers and shelters will be opened and staffed.
- Animal control measures will be taken.
- Law enforcement personnel will protect critical facilities and conduct surveillance against criminal activities.
- Immediate life-threatening hazards will be addressed such as broken gas lines or downed utility wires.
- Emergency food, water, and fuel will be acquired.
- Activate mutual aid.
- Measures will be taken relating to identification and disposition of remains of deceased by the Chief Medical Examiner.

### ***Evacuation Options***

The Greenfield CEM lists shelters for victims of earthquakes.

### ***State Building Code***

The first edition of the Massachusetts State Building Code was issued on January 1, 1975 and included specific earthquake resistant design standards. These seismic requirements for new construction have been revised and updated over the years and are part of the current, 8th Edition of the Massachusetts State Building Code (780 CMR 120.AA). Given that many structures in the state and in Greenfield were built before 1975 (nearly 78% were built prior to 1970); it may be assumed that these structures were built without earthquake resistant design features. It is also important to note that the earthquake resistant design standards are the minimum standards for the structure to pass the State Building Code. This does not ensure that the structure will be perfectly safe during an earthquake. Built areas underlain by artificial fill, sandy or clay soils are particularly vulnerable to damage during an earthquake.

### ***Restrictions on Development***

There are no seismic-related restrictions on development.

**Table 4-7: Existing Earthquake Hazard Mitigation Measures**

| Type of Existing Protection | Description   | Area Covered | Effectiveness | 2011 Potential Changes | Accomplished/ Still Relevant? |
|-----------------------------|---|--------------|---------------|------------------------|-------------------------------|
| <b>Zoning Bylaws</b>        |   |              |               |                        |                               |
| <b>State Building Code</b>  | The Town of Greenfield has adopted the Massachusetts State Building Code. | Entire Town  | Effective     | No Changes             | N/A                           |

## **Landslides**

Regulating land use and development to avoid construction on steep slopes and ensuring that construction does not reduce slope stability is one way to mitigate the hazard potential of landslides. The mitigation measures for landslides were found to be the same as for Floods. Please see Table 4-1: Existing Flood Hazard Mitigation Measures for summary of the above Land Use Regulations and Appendix A detailed Land Use Regulations.

## **Ice Jams**

The most common hazard associated with ice jams is flooding upstream of the ice jam. Therefore strategies to mitigate flooding are also appropriate for mitigating the impacts of ice jams. Please see Current Mitigation Strategies for Flooding section and refer to Table 4-1: Existing Flood Hazard Mitigation Measures as well as Appendix A for complete language for same measures.

## **Manmade Hazards**

Timely, informative and accurate notification of a hazardous material emergency is critical for an effective emergency response and for the safety and protection of Greenfield's citizens. With the frequency of transportation of hazardous materials via Route 2 and railroad, the possibility exists of a catastrophic accident or spill. Strategies to plan for the evacuation of residents and for the cleanup of any chemical spill are key to hazard mitigation.

### ***Management Plans and Regulatory Measures***

The following are generic preparedness and response measures for manmade hazards listed in the Town CEM Plan, specifically hazardous materials emergencies:

- The immediate notification of the community emergency coordinator and the State is required when a release of an extremely hazardous substance or hazardous chemical in an amount above the Reportable Quantity (RQ) occurs. Specific information is required by the notification such as chemical name, method of release, health effects, medical attention and protective actions.
- The Hazardous Materials Release Report Form must be used in the event of the release of a hazardous substance
- Both local and State response personnel, including the DEP must be notified immediately of a release. The local point of contact is the local fire department through the 911 dispatch Center.

### ***Evacuation Options***

Evacuation of an incident site could be required upon the recommendation of the on-scene commander. The routes of evacuation and staging areas for the evacuees will be determined by the Incident Commander. Once the incident site has been evacuated, law enforcement officials will support expanded evacuation if required. The necessity for additional evacuation will be determined by the Incident Commander.

## Future Mitigation Strategies

### Hazard Mitigation Goal Statements and Action Plan

As part of the multi-hazards mitigation planning process undertaken by the Greenfield Multi-Hazards Mitigation Planning Committee, existing gaps in protection and possible deficiencies were identified and discussed. The committee then developed general goal statements and action items that, when implemented, will help to reduce risks and future damages from multiple hazards. The goal statements, action items, Town department(s) responsible for implementation, and the proposed timeframe for implementation for each category of hazard are described below. There are also several general action items that were developed.

### 2014 Action Plan

#### Prioritization of Hazards

The Committee examined the results of the All Hazards Vulnerability Assessment completed by the Committee (see Section 3) and used the results to prioritize the identified hazards.

The All Hazards Vulnerability Assessment is an interactive table that the Committee completed with the FRCOG staff to evaluate the natural hazards that can impact the town based on probability of occurrence, severity of impacts, area of occurrence and preparedness. The completed table gives the town an overall understanding of the natural hazards, provides guidance on which hazards the Town may want to focus mitigation efforts on, reaffirms that Greenfield's planning and preparedness is on track, and shows residents that town departments and agencies are organized in case of a natural disaster. Those hazards receiving the highest Weighted Hazard Index number were assigned the highest priority as shown in Tables 4-8 and 4-9. *Note: The All Hazards Risk Assessment was conducted prior to Tropical Storm Irene. It is not known whether the Assessment would have been significantly changed if it had been conducted after this storm event.*

**Table 4-8: Weighted Hazard Index Priority Level**

| Weighted Hazard Index | Priority Level |
|-----------------------|----------------|
| > 5                   | High           |
| 4.0 – 5.0             | Medium         |
| < 4.0                 | Low            |

**Table 4-9: Hazard Priority Level Rating**

| Hazard   | Weighted Hazard Index | Priority Level |
|--|-----------------------|----------------|
| Microbursts (Includes Thunderstorms and Wind Related Events) | <b>6.8</b>            | <b>High</b>    |
| Hurricanes   | <b>6.1</b>            | <b>High</b>    |
| Severe Winter Storms   | <b>5.2</b>            | <b>High</b>    |
| Floods   | <b>4.7</b>            | <b>Medium</b>  |
| Tornados   | <b>4.4</b>            | <b>Medium</b>  |

| Hazard                    | Weighted Hazard Index | Priority Level |
|---------------------------|-----------------------|----------------|
| Earthquakes               | <b>4.1</b>            | <b>Medium</b>  |
| Wildfires and Brush Fires | <b>4.0</b>            | <b>Medium</b>  |
| Landslides                | <b>3.8</b>            | <b>Low</b>     |
| Ice Jams                  | <b>3.2</b>            | <b>Low</b>     |
| Dam Failures              | <b>3.2</b>            | <b>Low</b>     |

### ***Identification of Most Important Hazards***

To identify the hazards most important to the Town of Greenfield and to develop a range of mitigation actions for the most important hazards, the Committee discussed the hazard prioritization information (Table 4-8), assessed which hazards most often impact Western Massachusetts and considered the results of the Risk Assessment (Section 3). The Committee also discussed damages from recent hazard events, including Tropical Storm Irene, and determined that the hazards most important to Greenfield are Microbursts, Hurricanes and Floods.

In addition, the Committee realized that some Action Items could mitigate several hazards and thus created a category labeled “Multiple Hazards”.

**Table 4-10: Hazards Most Important to Greenfield**

| Hazard   | Hazard Priority Level | Hazard Most Important to Greenfield |
|--|-----------------------|-------------------------------------|
| Microbursts (Includes Thunderstorms and Wind Related Events) | <b>High</b>           | ✓                                   |
| Hurricanes   | <b>High</b>           | ✓                                   |
| Severe Winter Storms   | <b>High</b>           |                                     |
| Floods   | <b>Medium</b>         | ✓                                   |
| Tornados   | <b>Medium</b>         |                                     |
| Earthquakes  | <b>Medium</b>         |                                     |
| Wildfires and Brush Fires                                    | <b>Medium</b>         |                                     |
| Landslides   | <b>Low</b>            |                                     |
| Ice Jams   | <b>Low</b>            |                                     |
| Dam Failures   | <b>Low</b>            |                                     |
| Manmade Hazards  | <b>Not Applicable</b> |                                     |
| Multiple Hazards   | <b>Not Applicable</b> |                                     |

With respect to Manmade Hazards, the Committee evaluated the potential for fixed facility and transportation hazardous materials accidents as quite high—particularly transportation related accidents, given the proximity of railroad tracks and Interstate 91, Routes 5/10 and Route 2 to the Green River and to more densely populated areas of Town. However, no formal vulnerability assessment was done for manmade hazards due to the lack of available data to use in an appropriate assessment model. Because of the potential for these types of manmade hazards to occur; the unknown impact of such accidents on the town’s population, infrastructure, and the natural and built environments; and the lack of available and well-analyzed data, the Committee suggested a number of Action Items relating to this hazard that are included on the Preparedness and Response Action Plan (Table 4-13), although it was not assigned a Hazard Priority Level Rating.

### Goal Statements and Action Items

Action items from the 2005 plan were evaluated by the Committee and, if still relevant, were carried forward to the 2014 plan, with some modifications where necessary. Those action items that have been completed since the last plan are listed below in the following table. Most of the 2005 action items were identified as preparedness or response actions and were, therefore, separated from the mitigation action items in the 2014 plan and added to any new preparedness or response actions identified by the Committee for the plan update (see Table 4-13).

**Table 4-11: 2005 Action Items Completed:**

| Action Item   | Responsible Department / Board | Estimated Completion Date | Status                     |
|---|--------------------------------|---------------------------|----------------------------|
| Review and update the Subdivision Regulations. Special consideration should be given to requiring that new utilities be placed underground. | Planning Department            | June 2005                 | Completed in November 2008 |

Note: Many other action items from 2005 have been begun and/or were updated and carried over to the 2014 plan. See Tables 4-12 and 4-13.

### Prioritization of Action Items

The Committee worked to prioritize the mitigation Action Items for the hazards identified as the most important to Greenfield. For most, if not all, of the Action Items, project costs are not specifically known so only a generalized estimate could be used during the prioritization process. Due to the lack of detailed cost information for the mitigation Action Items, a more detailed prioritization process such as STAPLEE could not be used. However, Action Items may be reprioritized by the town once a cost is developed and a Benefit Cost Analysis is conducted on specific projects.

The Committee used a qualitative ranking system of High, Medium or Low to prioritize the mitigation Action Items for the hazards most important to Greenfield.

|        |               |
|--------|---------------|
| High   | 71-100 points |
| Medium | 31-70 points  |
| Low    | 0-30 points   |

The ranking system consists of the following criteria, each assigned a points value. The maximum number of points = 100:

1. What are the anticipated benefits (including avoided costs such as loss of life and the costs incurred to repair damaged infrastructure, buildings and natural resources) from the implementation of the action item to the town’s population (10 points), infrastructure (10 points), and to the built (10 points) and natural environment (10 points)?
2. Can the town provide the necessary maintenance (future costs that must be included in the town’s budget) when the mitigation measure is completed? Yes (10 points); No (0 points).
3. Does the town have the technical and administrative capability (staff costs and in-kind costs of volunteer boards and committee members) to carry out the mitigation measures? Yes (10 points); No (0 points).
4. Based on the evaluation of the above criteria, do the costs (if known or can be reasonably estimated) seem reasonable when considering the size of the problem and likely benefits from mitigation? Yes (20 points); No (0 points).
5. Is there political support and public support to implement the mitigation measures? Yes (20 points); No (0 points).

For larger construction projects, the town has limited funds to hire consultants and engineers to assist them with implementation. For these projects, the Town will seek assistance through the Franklin Regional Council of Governments (FRCOG) or other funding sources such as those listed in Table 5-1 on page 149 of this document. Limited technical assistance is available from the FRCOG. However, the availability of FRCOG staff can be constrained by the availability of grant funding.

The final 2014 Greenfield Multi-Hazards Mitigation Prioritized Action Plan is shown in Table 4-12. Potential funding sources for mitigation action items are listed in Table 4-12. Other potential funding sources are listed in Table 5-1 on page 149 of this document. The town should request assistance from MEMA and/or FRCOG to explore which of these funding sources might supplement or replace town funding for the mitigation action items in Table 4-12. When Town

funds are listed as a source to fund hazard mitigation projects or activities, either in part (match) or in full, typically these funds would be obtained from the town's "general fund".

The timeframe for implementation of the mitigation action items are listed as Year 0-1, which is the first year following plan adoption, and subsequent years after plan adoption through the 5 year life of the plan (Year 2, Year 3, Year 4 and Year 5). The Committee recognized that many mitigation action items have a timeframe that is ongoing due to either funding constraints that delay complete implementation and/or the action item should be implemented each of the five years of the plan, if possible. Therefore, a category of *Year 0-1, to be reviewed annually and implemented in subsequent years (Years 2-5), as appropriate* was added.

The 2005 Greenfield Local Natural Hazards Mitigation Plan did not prioritize Action Items, so it is not possible to evaluate any change in priorities since the last plan. The 2014 action plan is prioritized so in future updates to the plan it will be possible to document any changes in priorities. The 2005 planning process did include a vulnerability assessment that rated hazards according to the risk to the Town from each hazard (the 2005 plan did not evaluate landslides or ice jams). The methodology of the 2005 assessment differs greatly from the methodology used in the 2014 All Hazards Vulnerability Assessment, making it difficult to compare the two.

**Table 4-12: 2014 Greenfield Local Multi-Hazard Mitigation Prioritized Action Plan**

| Hazard Identified As Most Important To The Town of Greenfield   | Hazard  | Action Item  | Responsible Department / Board | Benefits What Areas Primarily? Built (B), Natural (N), Population (P), Infrastructure (I) | Potential Funding Source | Estimated Completion Date  | Priority for Implementation/Status  |
|---|---|--|--------------------------------|---|--------------------------|--|---|
| <b>The priority for implementation of each Action Item is ranked as High, Medium or Low</b>   |   |  |                                |   |                          |  |   |
| ✓   | <b>MICROBURSTS (INCLUDES THUNDERSTORMS AND WIND-RELATED EVENTS) – These action items could also apply to high winds associated with thunderstorms, hurricanes, tropical storms and tornados</b> |  |                                |   |                          |  |   |
| <i>Goal: To minimize the loss of life, damage to property, and the disruption of governmental services and general business activities due to high winds.</i>                     |   |  |                                |   |                          |  |   |
|   |   | Research, update and amend Section 200-7.14 of the Greenfield Zoning Ordinance that regulates wireless communication facilities to include provisions related to preventing wind-related damage in fall zone areas to reduce the risk to life and property from high winds associated with microbursts and other high wind events. | Planning Department            | B, P  | Town staff               | Year 1   | <b>High/</b><br>Updated and carried over from 2005 plan.  |
|   |   | Enforce the State Building Code and provide training to the Building Inspector, as needed, to ensure new buildings are designed and constructed to reduce the risk of damage from high winds.  | Building Inspector             | B, P  | Town staff               | Year 0-1, to be reviewed annually and implemented in subsequent years (Years 2-5), as appropriate. | <b>High/</b><br>Updated and carried over from 2005 plan.  |
|   |   | Encourage the construction of new homes with basements or crawl spaces or “safe rooms” to provide shelter during a microburst, hurricane or other storm event with high winds.   | Building Inspector             | B, P  | Town staff               | Year 0-1, to be reviewed annually and implemented in subsequent years (Years 2-5), as appropriate. | <b>Medium/</b><br>Updated and carried over from 2005 plan.  |
|   |   | To reduce the risk to property and infrastructure during high wind events, implement a program to inventory Town trees so pruning or removal of trees/limbs can be done to reduce risks/hazards.   | Department of Public Works     | I, B, P   | Town, FRCOG              | Year 0-1, to be reviewed annually and implemented in subsequent years (Years 2-5), as appropriate. | <b>High/</b><br>Updated and carried over from 2005 plan. Inventory of street trees completed in 2013. |
|   |   | Work with utility companies to establish and implement an annual tree pruning program to reduce risk to infrastructure from high wind events.  | Department of Public Works     | P, I  | Town, Utility Company    | Year 0-1, to be reviewed annually and implemented in subsequent years (Years 2-5), as appropriate. | <b>High/</b><br>New Action Item.  |
| ✓   | <b>HURRICANES and TROPICAL STORMS</b>   |  |                                |   |                          |  |   |
| <i>Goal: To minimize the loss of life, damage to property, and the disruption of governmental services and general business activities due to hurricanes and tropical storms.</i> |   |  |                                |   |                          |  |   |

| Hazard Identified As Most Important To The Town of Greenfield | Hazard        | Action Item   | Responsible Department / Board      | Benefits What Areas Primarily? Built (B), Natural (N), Population (P), Infrastructure (I) | Potential Funding Source | Estimated Completion Date         | Priority for Implementation/Status   |
|---|---------------|---|-------------------------------------|---|--------------------------|-----------------------------------|--|
|   |               | See wind-related action items under microbursts (above)   | N/A                                 | N/A   | N/A                      | N/A                               | N/A  |
|   |               | See action items listed under Floods that address the flooding that can result from a hurricane or tropical storm.  | N/A                                 | N/A   | N/A                      | N/A                               | N/A  |
| ✓   | <b>FLOODS</b> |   |                                     |   |                          |                                   |  |
|   |               | <i>To minimize the loss of life, damage to property, and the disruption of governmental services and general business activities due to flooding.</i>   |                                     |   |                          |                                   |  |
|   |               | To reduce the risk of flooding and damage to infrastructure from uncontrolled stormwater runoff, make improvements to stormwater drainage systems and access road to Leyden Glen Reservoir, which is essential for access to town's water supply reservoir.   | Department of Public Works          | B, N, P, I  | HMGP Grants, Town        | Year 3 – if funding is available. | <b>High</b><br>New Action Item.  |
|   |               | Fortify and flood-proof the wastewater treatment plant to an elevation of 144 feet (currently at 140 feet)  | Department of Public Works          | B, N, P, I  | FEMA, MEMA, Town         | Year 2 – if funding is available. | <b>High/</b><br>New Action Item.<br>New flood doors installed in 2013 to 144.3 ft. |
|   |               | To reduce the risk of flooding and damage to infrastructure from uncontrolled stormwater runoff, replace and rehabilitate the existing Maple Brook Culvert in North and Maple Streets.  | Department of Public Works          | I   | Town Bond, USDA          | Year 4 – if funding is available. | <b>High/</b><br>Updated and carried over from 2005 plan.                           |
|   |               | Review and amend the Floodplain District Overlay Zoning Ordinance using the FRCOG Model Floodplain District Bylaw to reduce the risk of flooding and damage to infrastructure and natural resources. Special consideration should be given to further restricting or limiting new development within the 100-year floodplain. | Planning Department                 | B, N  | Town staff               | Year 1                            | <b>High/</b><br>Updated and carried over from 2005 plan.                           |
|   |               | To reduce the risk of flooding and damage to infrastructure and natural resources from uncontrolled stormwater runoff, add flood prevention and mitigation to the Purpose Section of the Land Use regulations reviewed in Section 4 and noted in Table 4-1 of this report.  | Planning Department                 | B, P  | Town staff               | Year 1                            | <b>High/</b><br>Updated and carried over from 2005 plan.                           |
|   |               | Update and amend the town's Subdivision Rules and Regulations to include provisions, like adding flood prevention and mitigation to the Purpose Section, requiring the use of low impact development (LID) techniques, and regulations to   | Planning Department, Planning Board | B, N, P, I  | Town staff, Volunteers   | Year 2                            | <b>High/</b><br>New Action Item.   |

| Hazard Identified As Most Important To The Town of Greenfield | Hazard | Action Item   | Responsible Department / Board   | Benefits What Areas Primarily? Built (B), Natural (N), Population (P), Infrastructure (I) | Potential Funding Source                            | Estimated Completion Date  | Priority for Implementation/Status                       |
|---|--------|---|--|---|---|--|--|
|   |        | minimize development in dam breach inundation areas that reduce the risk of flooding and damage to infrastructure and natural resources from uncontrolled stormwater runoff.                                      |  |   |   |  |  |
|   |        | Support local and regional, watershed-wide open space protection efforts, particularly in floodplain areas.   | Planning Department, Town Council  | N   | Conservation Partnership Program, (EEA), Town staff | Year 0-1, to be reviewed annually and implemented in subsequent years (Years 2-5), as appropriate. | <b>High/</b><br>Updated and carried over from 2005 plan. |
|   |        | Conduct a fluvial geomorphological assessment of erosion and erosion hazards along the banks of the Green River.  | Department of Public Works, Planning Department, Emergency Management Director | B, N, P, I  | Town, MEMA/FEMA, FRCOG                              | Year 3   | <b>Medium/</b><br>New Action Item.                       |
|   |        | Using Assessors' data and other available information, expand and update the Vulnerability Assessment for properties located within the 100-year floodplain, including information on crop damages, if available. | Planning Department, Assessors.  | B, P, I   | Town staff  | Year 2   | <b>High/</b><br>Updated and carried over from 2005 plan. |
| <b>SEVERE WINTER STORMS</b>                                   |        |   |  |   |   |  |  |
|   |        | <i>Goal: To minimize the loss of life, damage to property, and the disruption of governmental services and general business activities due to severe winter storms.</i>   |  |   |   |  |  |
|   |        | Work with utility companies to establish and implement an annual tree pruning program to reduce risk to infrastructure from severe winter storms.   | Department of Public Works   | P, I  | Town, Utility Company                               | Year 0-1, to be reviewed annually and implemented in subsequent years (Years 2-5), as appropriate. | <b>High/</b><br>New Action Item.                         |
| <b>TORNADOS</b>   |        |   |  |   |   |  |  |
|   |        | <i>Goal: To minimize the loss of life, damage to property, infrastructure and natural resources, and the disruption of governmental services and general business activities due to tornados.</i>                 |  |   |   |  |  |
|   |        | See wind-related Action Items in microburst section, above  | N/A  | N/A   | N/A   | N/A  | N/A  |
| <b>WILDFIRES /BRUSH FIRES</b>                                 |        |   |  |   |   |  |  |
|   |        | <i>Goal: To minimize the loss of life, damage to property, infrastructure and natural resources, and the disruption of governmental services and general business activities due to wildfires/brushfires.</i>     |  |   |   |  |  |

| Hazard Identified As Most Important To The Town of Greenfield | Hazard | Action Item   | Responsible Department / Board   | Benefits What Areas Primarily? Built (B), Natural (N), Population (P), Infrastructure (I) | Potential Funding Source           | Estimated Completion Date  | Priority for Implementation/Status                         |
|---|--------|---|--|---|------------------------------------|--|--|
|   |        | Implement forest stewardship practices that produce more stable, successional forested landscapes and which reduce the risk of fire hazards (such as the removal of slash).   | Conservation Commission, Planning Department, Fire Department                                      | N, P  | Town staff, US Forest Service, DCR | Year 0-1, to be reviewed annually and implemented in subsequent years (Years 2-5), as appropriate. | <b>Medium/</b><br>Updated and carried over from 2005 plan. |
|   |        | Educate homeowners about the risk of wildfires and brushfires and how to reduce the risk by adopting general fire safety techniques.  | Fire Department  | N, P  | Town staff, DCR                    | Year 0-1, to be reviewed annually and implemented in subsequent years (Years 2-5), as appropriate. | <b>Medium/</b><br>Updated and carried over from 2005 plan. |
| <b>EARTHQUAKES</b>  |        |   |  |   |                                    |  |  |
|   |        | <i>Goal: To minimize the loss of life, damage to property, infrastructure and natural resources, and the disruption of governmental services and general business activities due to earthquakes.</i>  |  |   |                                    |  |  |
|   |        | Review the town's critical facilities and infrastructure to determine if they are particularly vulnerable to earthquake damage and determine appropriate retrofitting measures to reduce the risk of damage from earthquakes.   | Emergency Management Director, Building Inspector, Department of Public Works, Planning Department | B   | Town staff                         | Year 4   | <b>Medium/</b><br>Updated and carried over from 2005 plan. |
|   |        | Ensure Compliance with the Massachusetts State Building Code. Provide training to the Building Inspector, as needed, to ensure that all new construction complies with the appropriate seismic requirements of the State Building Code. Participate in trainings offered by FEMA's National Earthquake Technical Assistance Program (NETAP). NETAP is designed to help state, local, and tribal governments obtain the knowledge, tools, and support that they need to plan and implement effective earthquake mitigation strategies. | Building Inspector   | B   | Town staff                         | Year 0-1, to be reviewed annually and implemented in subsequent years (Years 2-5), as appropriate. | <b>High/</b><br>Updated and carried over from 2005 plan.   |
| <b>LANDSLIDES</b>   |        |   |  |   |                                    |  |  |
|   |        | <i>Goal: To minimize the loss of life, damage to property, infrastructure and natural resources, and the disruption of governmental services and general business activities due to landslides.</i>   |  |   |                                    |  |  |
|   |        | Complete an inventory of locations in town where critical infrastructure, including roads, buildings and utilities, are vulnerable to landslides. Use GIS to identify and map these potential landslide hazard areas.   | Department of Public Works, Planning Department  | B, I  | Town staff                         | Year 3   | <b>Medium/</b><br>New Action Item.                         |
|   |        | Investigate appropriate retrofitting measures to prevent roadway damage, traffic disruptions, and damage to other critical infrastructure from landslides. vulnerability.   | Department of Public Works   | B, I  | Town staff                         | Year 3   | <b>Medium/</b><br>New Action Item                          |

| Hazard Identified As Most Important To The Town of Greenfield | Hazard | Action Item   | Responsible Department / Board   | Benefits What Areas Primarily? Built (B), Natural (N), Population (P), Infrastructure (I) | Potential Funding Source | Estimated Completion Date  | Priority for Implementation/Status  |
|---|--------|---|--|---|--------------------------|--|---|
|   |        | Complete an inventory of locations along the Green River and other streams where bank erosion and landslides threaten critical infrastructure, including roads, buildings and utilities. Use GIS to identify and map these potential erosion/landslide hazard areas.  | Conservation Commission, Planning Department, Department of Public Works       | N   | Town staff               | Year 2   | <b>Medium/</b><br>New Action Item   |
| <b>ICE JAMS</b>   |        |   |  |   |                          |  |   |
|   |        | <i>Goal: To minimize the loss of life, damage to property, infrastructure and natural resources, and the disruption of governmental services and general business activities due to ice jams and associated flooding.</i>   |  |   |                          |  |   |
|   |        | See Floods section for related Action Items   | N/A  | N/A   | N/A                      | N/A  | N/A   |
| <b>DAM FAILURES</b>   |        |   |  |   |                          |  |   |
|   |        | <i>Goal: To minimize the loss of life, damage to property, and the disruption of governmental services and general business activities due to dam failures.</i>   |  |   |                          |  |   |
|   |        | Conduct inspections of the Mill and Meridian Street dams, which were identified by the Committee as possibly being in poor condition.   | Department of Public Works, Planning Department, Town Engineer                 | P, I  | Town staff               | Year 0-1, to be reviewed annually and implemented in subsequent years (Years 2-5), as appropriate. | <b>High/</b><br>New Action Item.<br><br>This activity has already started. The Meridian Street Dam is on a yearly inspection schedule and the Mill Street Dam is on a 5-year inspection schedule. |
|   |        | In order to reduce the risk and potential loss of life from dam failure, prepare a GIS Dam and Inundation Areas map of the location of all dams in the town and immediately upstream of the town's borders and the areas that are likely to be flooded in the event of a dam failure. This map should include the Inundation Areas for the US GEN High Hazard dams on the Deerfield River. Review the available inspection reports to determine if any dams should be inspected or re-inspected. Distribute map to all public safety officials in the Town. | Emergency Management Director, Department of Public Works, Planning Department | P, I  | HMGP, Town staff         | Year 5   | <b>Medium/</b><br><br>Updated and carried over from 2005 plan.  |
|   |        | Amend relevant town ordinances to incorporate a Dam Safety Overlay District to integrate dam safety into Development Review. The overlay district would include require the Planning Department, Planning Board, and Zoning Board of Appeals consult the Dam and Inundation Areas map (see previous action  | Department of Public Works, Planning Department, Planning Board,               | B, N, P, I  | Town staff               | Year 5   | <b>Medium/</b><br><br>Updated and carried over from 2005 plan.  |

| Hazard Identified As Most Important To The Town of Greenfield  | Hazard | Action Item  | Responsible Department / Board                                 | Benefits What Areas Primarily? Built (B), Natural (N), Population (P), Infrastructure (I) | Potential Funding Source        | Estimated Completion Date  | Priority for Implementation/Status  |
|--|--------|--|--|---|---------------------------------|--|---|
|  |        | item) during their review of major development proposals, especially subdivisions. If there is a dam upstream of a proposed development, the dam would be inspected prior to the start of construction to ensure that the dam is safe.   | Zoning Board of Appeals  |   |                                 |  |   |
| <b>MULTIPLE HAZARDS</b>  |        |  |  |   |                                 |  |   |
| <i>Goal: to minimize the loss of life, damage to property, and the disruption of governmental services and general business activities due to natural hazards.</i> |        |  |  |   |                                 |  |   |
|  |        | Purchase generators for the DPW and purchase and install emergency back-up generators for all emergency facilities.  | Planning Department, Department of Public Works                | P, I  | Town Capital Budget, MEMA, FEMA | Year 2   | <b>High/</b><br>New Action Item. Some generators have been purchased..  |
|  |        | Develop and implement an annual program to improve household disaster preparedness. Use available pamphlets and other information to educate the public on how to prepare for hazards and disaster, including how to prepare homes and other structures to withstand flooding and high winds, encouraging residents to prepare by stocking up the necessary items and planning for how family members respond during a disaster, including proper evacuation procedures. | Police Department, Fire Department, Department of Public Works | P   | Town                            | Year 0-1, to be reviewed annually and implemented in subsequent years (Years 2-5), as appropriate. | <b>High/</b><br>The Town has done this and will continue to provide this information via Cable TV and the Town website. |

**Table 4-13: 2014 Greenfield Local Multi-Hazard Mitigation Preparedness and Response Action Plan**

| Hazard                  | Goal   | Action Item   | Responsible Department / Board  | Benefits What Areas Primarily? Built (B), Natural (N), Population (P), Infrastructure (I) | Potential Funding Source                                | Estimated Completion Date | Status                                     |
|-------------------------|--|---|---|---|---|---------------------------|--|
| <b>MULTIPLE HAZARDS</b> |  |   |   |   |   |                           |  |
|                         | <i>To provide adequate shelter, water, food and basic first aid to displaced residents in the event of a natural disaster.</i> |   |   |   |   |                           |  |
|                         |  | Identify existing shelters that are equipped with an auxiliary power supply and/or are earthquake resistant. Disseminate this information to appropriate town departments.  | Emergency Management Director, Building Inspector, Department of Public Works | P   | FRCOG, Western MA Homeland Security Council, Town staff | 2015                      | Carried over from 2005. Activity underway. |
|                         |  | Identify potential locations for new shelters, in particular, buildings that are equipped with an auxiliary power supply and/or are earthquake resistant. Disseminate this information to appropriate town departments. | Emergency Management Director, Building Inspector, Department of Public Works | P   | FRCOG, Town staff                                       | 2015                      | Carried over from 2005. Activity underway. |

| Hazard   | Goal | Action Item  | Responsible Department / Board   | Benefits What Areas Primarily? Built (B), Natural (N), Population (P), Infrastructure (I) | Potential Funding Source | Estimated Completion Date | Status                                     |
|--|------|--|--|---|--------------------------|---------------------------|--|
|  |      | Inventory supplies at existing shelters. Establish arrangements with local or neighboring vendors for supplying shelters with potable water, food and first aid supplies in the event of a natural disaster.             | Emergency Management Director, Fire Department, Police Department                    | P   | FRCOG, Town staff        | 2015                      | Carried over from 2005. Activity underway. |
| <i>To ensure adequate communication and coordination among all emergency personnel in the event of a natural disaster.</i>                                   |      |  |  |   |                          |                           |  |
|  |      | The Multi-Hazard Mitigation Planning Committee will collaborate with appropriate state and local partners to integrate relevant Action Items from this plan into the Greenfield Comprehensive Emergency Management Plan. | Emergency Management Director, Greenfield Multi-Hazard Mitigation Planning Committee | B, N, P, I  | FRCOG, Town staff        | 2015                      | Carried over from 2005. Activity underway. |
|  |      | Purchase equipment to assist with tree removal and debris associated with a hazard or disaster.  | Department of Public Works   | B, I  | WMECO, Town, MEMA, FEMA  | Dependent upon Funding    | New Action Item                            |
|  |      | Identify sites for city-wide or regional debris disposal and processing.   | Planning Department, Department of Public Works, Health Department                   | B, I  | FRCOG, Town staff        | 2016                      | New Action Item                            |
|  |      | Review strategies for animal control and sheltering during and after a disaster or hazard.   | Police Department, Department of Public Works, Health Department                     | P, I  | FRCOG, Town, MEMA, FEMA  | 2016                      | New Action Item                            |
| <i>To provide adequate notification and information regarding evacuation procedures, etc., to residents in the event of a natural disaster.</i>              |      |  |  |   |                          |                           |  |
|  |      | Investigate the feasibility of a Reverse 911 system for the Town of Greenfield. Develop a preliminary project proposal and cost estimate.  | Police Department, Fire Department, Department of Public Works                       | P   | Town                     | 2014                      | Completed in 2010.                         |
| <b>MANMADE HAZARDS</b>   |      |  |  |   |                          |                           |  |
| <i>To minimize the loss of life, damage to property, and the disruption of governmental services and general business activities due to manmade hazards.</i> |      |  |  |   |                          |                           |  |
|  |      | Research appropriate vulnerability assessment models for fixed facility and transportation hazardous materials accidents, collect relevant data, and populate model to further prioritize manmade hazard action items.   | Emergency Management Director, Planning Department, FRCOG                            | B, N, P, I  | FEMA, MEMA               | 2015                      | New Action Item.                           |
|  |      | Develop an evacuation plan and notification system in the event of a chemical spill in a fixed structure or in a transportation setting  | Emergency Management Director, Planning Department                                   | P   | FEMA, MEMA               | 2015                      | New Action Item.                           |

| Hazard  | Goal | Action Item   | Responsible Department / Board  | Benefits What Areas Primarily? Built (B), Natural (N), Population (P), Infrastructure (I) | Potential Funding Source | Estimated Completion Date                        | Status                                  |
|---|------|---|---|---|--------------------------|--|---|
|   |      | such as Route 2 or the railroad.  |   |   |                          |  |   |
|   |      | Seek technical assistance to ensure annual update of Town of Greenfield CEM Plan.   | Emergency Management Director   | B, N, P, I  | FEMA, MEMA               | This action will continue over the next 5 years. | New Action Item.                        |
| <b>FLOODS</b>   |      |   |   |   |                          |  |   |
| <i>To minimize the loss of life, damage to property, and the disruption of governmental services and general business activities due to flooding.</i>   |      |   |   |   |                          |  |   |
|   |      | Review evacuation procedures for the flood prone areas in town (identified on the map) and mapped dam failure Inundation Areas, and update, if necessary.   | Emergency Management Director, Police Department, Fire Department     | P   | Town staff               | 2014   | Carried over from 2005. Still relevant. |
|   |      | Coordinate with state and regional agencies to identify a location(s) for the temporary storage of contaminated and/or hazardous flood debris.  | Department of Public Works, Planning Department, Franklin County LEPC | N   | Town staff, FRCOG        | 2014   | Carried over from 2005. Still relevant. |
| <b>WILDFIRES /BRUSH FIRES</b>   |      |   |   |   |                          |  |   |
| <i>To minimize the loss of life, damage to property, infrastructure and natural resources, and the disruption of governmental services and general business activities due to wildfires/brushfires.</i> |      |   |   |   |                          |  |   |
|   |      | West Side Water Distribution Tank and 20-inch Main. This project would construct a 3.5 million gallon water storage tank on the west side of town off of Gorge Road and a 20-inch water transmission main to Main Street to address poor pressures and flows (especially critical for firefighting) as well as provide a backup for the Rocky Mountain Storage tank. This project has been identified as an infrastructure need since the 1970's. | Department of Public Works  | I   | Town Bond, Grant(s)      | Dependent Upon Funding                           | Carried over from 2005. Still relevant. |
| <b>DAM FAILURES</b>   |      |   |   |   |                          |  |   |
| <i>To minimize the loss of life, damage to property, and the disruption of governmental services and general business activities due to dam failures.</i>   |      |   |   |   |                          |  |   |
|   |      | Identify locations for emergency shelters and evacuation routes for people who live in an inundation area.  | Police Department, Fire Department, Planning Department               | P   | Town staff               | 2014   | Carried over from 2005. Still relevant. |



## **National Flood Insurance Program Compliance**

---

The U.S. Congress established the National Flood Insurance Program (NFIP) in 1968, with the passage of the National Flood Insurance Act of 1968. “For decades, the national response to flood disasters was generally limited to constructing flood-control works such as dams, levees, seawalls, and the like, and providing disaster relief to flood victims. This approach did not reduce losses, nor did it discourage unwise development. In some instances, it may have actually encouraged additional development. To compound the problem, the public generally could not buy flood coverage from insurance companies, and building techniques to reduce flood damage were often overlooked.

“In the face of mounting flood losses and escalating costs of disaster relief to the general taxpayers, the U.S. Congress created the NFIP. The intent was to reduce future flood damage through community floodplain management ordinances, and provide protection for property owners against potential losses through an insurance mechanism that requires a premium to be paid for the protection.”<sup>67</sup>

The State of Massachusetts, through its local communities,<sup>68</sup> complies with the NFIP in part by enforcing the Wetlands Protection Act (WPA), which helps restrict development in flood-prone areas, enforcing the State Building Code, which regulates building specifications and additional related zoning bylaws, such as a floodplain overlay district. At the local level, Greenfield’s compliance with the NFIP is enforced through the building inspector and building code, the Conservation Commission and wetland and floodplain regulations, and the zoning bylaws and subdivision regulations related to flooding. While the local building code cannot be more restrictive than the state building code, the local Conservation Commission can restrict development above and beyond the requirements in the WPA. The ability of the Conservation Commission to further regulate development in flood prone areas could be a crucial tool in flood mitigation. In addition, the ability of the Select Board to adopt further bylaws such as a floodplain overlay district could also mitigate flooding.

The Town of Greenfield participates in the National Flood Insurance Program. As of November 2013, there were 42 policies in effect in Greenfield for a total of \$10,484,500 worth of insurance. FEMA has identified one repetitive flood loss structure in the Town of Greenfield. The Town is not a member of the Community Rating System, which entitles policyholders to a discount on flood insurance premiums. The CRS ranking is based on the steps the town has taken to control flood losses. See following pages for more information on NFIP.

### ***NFIP Community Rating System (CRS)***<sup>69</sup>

The town is not a member of the NFIP Community Rating System, which entitles policyholders to a discount on flood insurance premiums. The Community Rating System is a part of NFIP and provides incentives and tools to further these goals. The goals of the CRS are to recognize,

---

<sup>67</sup> <http://www.fema.gov/library/viewRecord.do?id=1404>

<sup>68</sup> Massachusetts is a Home Rule state, the local communities have significant power and authority to implement state regulations and many towns adopt their own wetland and floodplain regulations that are more stringent than state requirements.

<sup>69</sup> <http://training.fema.gov/EMIWeb/CRS/>

encourage, and reward, by the use of flood insurance premium adjustments, community and state activities beyond the minimum required by the NFIP that:

- Reduce flood damage to insurable property,
- Strengthen and support the insurance aspects of the NFIP, and
- Encourage a comprehensive approach to floodplain management.

The Community Rating System reduces flood insurance premiums to reflect what a community does above and beyond the National Flood Insurance Program's (NFIP) minimum standards for floodplain regulation. The objective of the CRS is to reward communities for what they are doing, as well as to provide an incentive for new flood protection activities. It provides lower insurance premiums under the National Flood Insurance Program. The premium reduction is in the form of a CRS Class, similar to the classifications used for fire insurance. For example, a Class 1 provides a 45% premium reduction while a Class 10 provides no reduction. The CRS Class is based on the floodplain management activities a community implements. In many cases, these are activities already implemented by the community, the state, or a regional agency. The more activities implemented, the better the CRS class.

Benefits of participating in the Community Rating System:

- Money stays in the community instead of being spent on insurance premiums.
- Every time residents pay their insurance premiums, they are reminded that the community is working to protect them from flood losses, even during dry years.
- The activities credited by the CRS provide direct benefits to the community, including:
  - Enhanced public safety,
  - Reduction in damage to property and public infrastructure,
  - Avoidance of economic disruption and losses,
  - Reduction of human suffering, and
  - Protection of the environment.
- Local flood programs will be better organized and more formal.
- The community can evaluate the effectiveness of its flood program against a nationally recognized benchmark.
- Technical assistance in designing and implementing some activities is available at no charge.
- The community will have an added incentive to maintain its flood programs over the years.
- The public information activities will build a knowledgeable constituency interested in supporting and improving flood protection measures.

Costs to the local government to participate in the Community Rating System:

- The community must designate a CRS Coordinator who prepares the application papers and works with FEMA and the Insurance Services Office (ISO) during the verification visit.
- Each year the community must recertify that it is continuing to implement its activities. It must provide copies of relevant materials (e.g., permit records).
- The community must maintain elevation certificates, permit records, and old Flood Insurance Rate Maps forever.

- The community must maintain other records of its activities for five years, or until the next ISO verification visit, whichever comes sooner.

***Community Rating System Process***

One of the actions that Greenfield can take to improve their CRS rating (and subsequently lower their premiums) is to develop a CRS plan. The CRS 10-step planning process provides additional points for activities that communities can take during their planning process that go above the minimum described below, thus possibly lowering insurance rates. At a minimum, an *approved* multi-hazard mitigation plan that addresses floods could qualify for CRS credit. Although communities are not required to participate in CRS in order to receive approval of a Local Multi-Hazard Mitigation Plan, FEMA encourages jurisdictions to integrate the CRS planning steps into their multi-hazard mitigation plans.

Credit is provided for preparing, adopting, implementing, evaluating, and updating a comprehensive floodplain management plan or repetitive loss area analyses. The Community Rating System does not specify what must be in a plan, but it only credits plans that have been prepared and kept updated according to CRS standard planning process. Credit is also provided for implementing a habitat conservation plan.

*Community Rating System Credit Points*<sup>70</sup>

A total of up to 359 points are provided for three elements. Up to 294 points are provided for adopting and implementing a floodplain management plan (FMP) that was developed using the following standard planning process. There must be some credit for each of the 10 planning steps (Table 4-11).

**Table 4-11: CRSC Standard Planning Process Steps**

| <b>Step</b>                         | <b>Maximum Points</b> |
|-------------------------------------|-----------------------|
| 1. Organize to prepare the plan     | 10                    |
| 2. Involve the public               | 85                    |
| 3. Coordinate with other agencies   | 25                    |
| 4. Assess the hazard                | 20                    |
| 5. Assess the problem               | 35                    |
| 6. Set goals                        | 2                     |
| 7. Review possible activities       | 30                    |
| 8. Draft an action plan             | 70                    |
| 9. Adopt the plan                   | 2                     |
| 10. Implement, evaluate, and revise | 15                    |

Up to 50 additional points are provided for conducting repetitive loss area analyses (RLAA) and up to additional 15 points are provided for adopting and implementing a Habitat Conservation Plan (HCP).

---

<sup>70</sup> FEMA Local Multi-Hazard Mitigation Planning Guidance, July 1, 2008.

More information is available at <http://www.fema.gov/business/nfip/crs.shtm>. A copy of the “Local Official’s Guide to Saving Lives, Preventing Property Damage, and Reducing the Cost of Flood Insurance” is including in the Appendix of this plan or can be downloaded at <http://www.fema.gov/library>.

## **5 – PLAN ADOPTION AND MAINTENANCE**

### **Plan Adoption**

---

The Franklin Regional Council of Governments (FRCOG) provided support to the Greenfield Local Multi-Hazard Mitigation Planning Committee as they underwent the planning process. Town officials such as the Planning Department Director and Emergency Management Director were invaluable resources to the FRCOG and provided background and policy information and municipal documents, which were crucial to facilitating completion of the plan.

When the preliminary draft of the Local Multi-Hazard Mitigation Plan was completed, copies were disseminated to the Greenfield Local Multi-Hazard Mitigation Planning Committee for comment and approval. The Committee was comprised of representatives of Town boards and departments who bear the responsibility for implementing the action items and recommendations of the completed plan.

Copies of the Final Draft Local Multi-Hazard Mitigation Plan for the Town of Greenfield were distributed to the Town boards and to Northfield Mountain Facility for their review and comment. A copy of the plan was also available at the Planning Department for public review. Once reviewed and approved by MEMA, the plan was sent to the Federal Emergency Management Agency (FEMA) for their approval. On \_\_\_\_\_, the Town Council voted to adopt the plan.

The implementation of the Greenfield Local Multi-Hazard Mitigation Plan will begin following its approval by MEMA and FEMA and formal adoption by the Greenfield Select Board. Specific Town departments and boards will be responsible for ensuring the development of policies, bylaw revisions, and programs as described in Table 4-11: 2014 Greenfield Local Multi-Hazard Mitigation Prioritized Action Plan. The Greenfield Multi-Hazard Mitigation Planning Committee will oversee the implementation of the plan.

### **Plan Maintenance Process**

---

The implementation of the Greenfield Local Multi-Hazard Mitigation Plan will begin following its approval by MEMA and FEMA and its formal adoption by the Greenfield Town Council. Specific town departments and boards will be responsible for ensuring the development of policies, bylaw revisions, and programs as described in Sections 4 and Table 4-11 of this plan. The Greenfield Multi-Hazard Planning Committee will oversee the implementation of the plan.

### **Monitoring, Evaluating and Updating the Plan**

The measure of success of the Greenfield Local Multi-Hazard Mitigation Plan will be the number of identified mitigation strategies implemented. In order for the town to become more disaster resilient and better equipped to respond to natural disasters, there must be a coordinated effort between elected officials, appointed bodies, town employees, regional and state agencies involved in disaster mitigation, and the general public.

## **Implementation Schedule**

### ***Annual Meetings***

The Greenfield Multi-Hazard Planning Committee will meet on an annual basis or as needed (i.e., following a natural disaster) to monitor the progress of implementation, evaluate the success or failure of implemented recommendations, and brainstorm for strategies to remove obstacles to implementation. Following these discussions, it is anticipated that the committee may decide to reassign the roles and responsibilities for implementing mitigation strategies to different Town departments and/or revise the goals and objectives contained in the plan. At a minimum, the committee will review and update the plan every five years, beginning in the fall of 2015. Annual meetings of the committee will be organized and facilitated by the Emergency Management Director.

### ***Bi-Annual Progress Report***

The Emergency Management Director will prepare and distribute a biannual progress report in years two and four of the plan. The progress report will be distributed to all of the local implementation group members and other interested local stakeholders. The progress report 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, as needed, to the local hazard mitigation plan. The Emergency Management Director and the Greenfield Multi-Hazard Planning Committee will have primary responsibility for tracking progress and updating the plan.

### ***Five-Year Update Preparation***

During the fourth year after initial plan adoption, the Emergency Management Director will convene the Committee to begin preparations for an update of the plan, which will be required by the end of year five in order to maintain approved plan status with FEMA. The team will use the information from the annual meetings and the biannual progress reports to identify the needs and priorities for the plan update.

### ***Updated Local Hazard Mitigation Plan – Preparation and Adoption***

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. Because of the time required to secure a planning grant, prepare an updated plan, and complete the approval and adoption of an updated plan, the Committee should begin the process by the end of Year 3. This will help the town avoid a lapse in its approved plan status and grant eligibility when the current plan expires.

The Committee may decide to undertake the update themselves, request assistance from the Franklin Regional Council of Governments, or hire another consultant. However the Committee decides to proceed, the group will need to review the current FEMA hazard mitigation plan guidelines for any changes. The updated Greenfield Multi-Hazard Mitigation Plan will be forwarded to MEMA and to FEMA for approval.

As is the case with many Franklin County towns, Greenfield's government relies on few public servants filling many roles, upon citizen volunteers and upon limited budgets. As such, implementation of the recommendations of this plan could be a challenge to the Committee. As

the Committee meets regularly to assess progress, it should strive to identify shortfalls in staffing and funding and other issues which may hinder Plan implementation. The Committee should seek technical assistance from the Franklin Regional Council of Governments to help alleviate some of the staffing shortfalls. The Committee could also seek assistance and funding from such sources as are listed in Table 5-1.

**Table 5-1: Potential Funding Sources for Hazard Mitigation Plan Implementation**

| Program  | Type of Assistance   | Availability                            | Managing Agency                     | Funding Source   |
|--|--|---|-------------------------------------|--|
| National Flood Insurance Program               | Pre-disaster insurance   | Any time (pre & post disaster)          | DCR Flood Hazard Management Program | Property Owner, FEMA   |
| Community Assistance Program                   | State funds to provide assistance to communities in complying with NFIP requirements         | Annually                                | DCR                                 | FEMA/NFIP  |
| Community Rating System (Part of the NFIP)     | Flood insurance discounts  | Any time (pre & post disaster)          | DCR Flood Hazard Management Program | Property Owner   |
| Flood Mitigation Assistance Program            | Cost share grants for pre-disaster planning & projects                                       | Annual pre-disaster grant program       | MEMA                                | 75% FEMA/<br>25% non-federal   |
| Hazard Mitigation Grant Program                | Post-disaster cost-share Grants  | Post disaster program                   | MEMA                                | 75% FEMA/<br>25% non-federal   |
| Pre-Disaster Mitigation Program                | National, competitive grant program for projects & planning                                  | Annual, pre-disaster mitigation program | MEMA                                | 75% FEMA/<br>25% non-federal   |
| Severe Repetitive Loss                         | For SRL structures insured under the NFIP.   | Annual                                  | MEMA                                | Authorized up to \$40 million for each fiscal year 2005 through 2009 |
| Small Business Administration Mitigation Loans | Pre- and post- disaster loans to qualified applicants  | Ongoing                                 | MEMA                                | Small Business Administration  |
| Public Assistance                              | Post-disaster aid to state and local governments   | Post Disaster                           | MEMA                                | FEMA/ plus a non-federal share                                       |
| Dam Safety Program                             | Provides funding to state to promote dam safety through emergency action plans and exercises | Annual                                  | DCR                                 | FEMA   |

| Program   | Type of Assistance   | Availability | Managing Agency                                 | Funding Source   |
|---|--|--------------|---|--|
| Homeland Security Grants                                  | Multiple grant sources provide funding for homeland security activities, including THIRA development, planning, and training at the state and local levels | Annual       | MEMA  | DOJ, DHS, FEMA   |
| National Fire Plan  | Provides pre-disaster funds for wildfire mitigation and planning for all-hazards.  | Annual       | DCR   | U.S. Land Management Agencies                                    |
| Clean Water Act Section 319 Grants                        | Provides grants for wide variety of activities related to non-point source pollution runoff mitigation   | Annual       | MassDEP   | EPA  |
| Economic Development Administration Grants and Investment | Provides grants for community construction projects, including mitigation activities   | Annual       | Massachusetts Office of Business Development    | U.S. Department of Commerce, Economic Development Administration |
| Emergency Watershed Protection                            | Provides funding and technical assistance for emergency measures, e.g., floodplain easements in impaired watersheds  | Annual       | DCR   | USDA NRCS  |
| Forest Land Enhancement Program                           | Provides educational, technical, and financial assistance to help landowners implement sustainable forest management objectives.                           | Annual       | DCR   | U.S. Forest Service  |
| Housing and Urban Development                             | Provides various grant programs related to safe-housing initiatives  | Annual       | Department of Housing and Community Development | U.S. Dept. of Housing and Urban Development                      |
| Reclamation and Development Grants Program                | Provides funding for water-related projects, studies, etc.   | Annual       | MassDEP and others                              | EPA  |
| National Wildlife Wetland Refuge System                   | Provides funding for acquisition of lands into federal wildlife refuge system  | Annual       | U.S. Fish and Wildlife Service                  | U.S. Fish and Wildlife Service                                   |
| North American Wetland Conservation Fund                  | Provides funding for wetland conservation projects   | Annual       | U.S. Fish and Wildlife Service                  | U.S. Fish and Wildlife Service                                   |
| Rural Development Grants                                  | Provides grants and loans for infrastructure and public safety development and enhancement in rural areas  | Annual       | Department of Housing and Community Development | USDA, Rural Development  |

| Program  | Type of Assistance  | Availability                             | Managing Agency   | Funding Source  |
|--|---|--|---|---|
| Rural Fire Assistance Grants   | Funds fire mitigation activities in rural communities   | Annual                                   | DCR   | National Interagency Fire Center                                  |
| Chapter 90 Program   | Funds maintaining, repairing, improving and constructing town and county ways and bridges which qualify under the State Aid Highway Guidelines  | Annual                                   | Mass DOT  | State Transportation Bond   |
| 2013 MassWorks Infrastructure Program  | Funds targeted investments in infrastructure such as roadways, streetscapes, water, and sewer   | Annual                                   | Executive Office of Housing and Economic Development (EOHED), | State Appropriation-Section 11 of Chapter 238 of the Acts of 2012 |
| Accelerated Bridge Program   | Funds bridge rehabilitation, replacement, preservation, maintenance, painting and cleaning projects   | Rolling basis (bridges are pre-selected) | MassDOT and DCR   | State Appropriation - Chapter 233 of the Acts of 2008             |
| Dam, Levee and Coastal Infrastructure Repair and Removal Program   | Funds grants and loans for the repair and removal of dams, levees, seawalls, and other forms of inland and coastal flood control.   | Annual                                   | Executive Office of Energy and Environmental Affairs (EEA)    | State Revolving Loan  |
| Conservation Partnership   | Funds assist not-for-profit corporations in acquiring land and interests in lands suitable for conservation or recreation.  | Annual                                   | Executive Office of Energy and Environmental Affairs (EEA)    | Executive Office of Energy and Environmental Affairs (EEA)        |
| PARC - Parkland Acquisitions and Renovations for Communities   | Provides grant assistance to cities and towns to acquire parkland, develop new parks, or renovate existing outdoor public recreation facilities (formerly the Urban Self-Help Program). | Annual                                   | Executive Office of Energy and Environmental Affairs (EEA)    | State Appropriations  |
| <b>Other Sources:</b><br><a href="http://www.grants.gov">www.grants.gov</a> a source for federal government grants<br><a href="http://www.grants.com">www.grants.com</a> a source for private funding opportunities<br><a href="http://www.epa.gov/ogd/grants/funding_opportunities">www.epa.gov/ogd/grants/funding_opportunities</a> U.S. Environmental Protection Agency<br><a href="http://www.corporateservices.noaa.gov/grantsonline">www.corporateservices.noaa.gov/grantsonline</a> National Oceanic and Atmospheric Administration<br><a href="http://www.mass.gov/eea/agencies/massdep/water/grants/watersheds-water-quality.html">www.mass.gov/eea/agencies/massdep/water/grants/watersheds-water-quality.html</a> for 604b and s.319 grants |   |  |   |   |

### **Incorporating the Plan into Existing Planning Mechanisms**

Upon approval of the Greenfield Multi-Hazard Mitigation Plan by FEMA, the Committee will provide all interested parties and implementing departments with a copy of the plan, with emphasis on Table 4-11: 2014 Greenfield Local Multi-Hazard Mitigation Prioritized Action Plan. The Committee should also consider initiating a discussion with each department on how the plan can be integrated into that department's ongoing work. At a minimum, the plan should be distributed to and reviewed with the following entities:

- a. Fire Department
- b. Emergency Management Director
- c. Police Department
- d. Public Works / Highway Department
- e. Planning Board
- f. Zoning Board of Appeals
- g. Conservation Commission
- h. Franklin County Regional Emergency Planning Committee
- i. Building Inspector
- j. Town Council
- k. Board of Health

Incorporating the Greenfield Local Multi-Hazard Mitigation Plan into existing and future planning mechanisms could help ensure its success and implementation. Some possible planning mechanisms could include:

- Incorporation of relevant Hazards Mitigation information into the Open Space and Recreation Plan. There are opportunities to discuss findings of the hazard mitigation plan and incorporate them into Environmental Inventory and Analysis section of the OSRP and to include appropriate action items from the hazard mitigation plan in the OSRP Action Plan.
- When the Final Draft Local Multi-Hazard Mitigation Plan for the Town of Greenfield is distributed to the Town boards for their review, a letter asking each board to endorse any action item that lists that board as a responsible party would help to encourage completion of action items.
- The Planning Board could include discussions of the Hazards Mitigation Plan Action Items in one meeting annually and assess progress.

### **Continued Public Involvement**

The Town of Greenfield is dedicated to continued public involvement in the hazard mitigation planning and review process. During all phases of plan maintenance, the public will have the opportunity to provide feedback. The 2014 Plan will be maintained and available for review on the Town website through 2020. Individuals will have an opportunity to submit comments for the Plan update at any time. Any public meetings of the Committee will be publicized. This will provide the public an opportunity to express their concerns, opinions, or ideas about any updates/changes that are proposed to the Plan. The Plan will also be consulted by the Town of Greenfield Planning and Development Department as they work on updating the Town of Greenfield's Master Plan, which began in late 2012 and is still underway.

## 6 – APPENDICES

### Appendix A: Zoning Bylaws and Subdivision Regulations

#### Zoning Bylaws (Excerpts)

##### Floodplain Zoning Ordinance: Section 200-4.1:

Floodplain Overlay district. Greenfield's Zoning Ordinance, last amended October 20, 2010 establishes a Floodplain Overlay District (Section 200-4.13) for "the purposes of protecting the public health, safety, and general welfare, to protect human life and property from the hazards of periodic flooding, to reduce the public costs resulting from flood damage, to preserve the natural flood control characteristics and the flood storage capacity of the floodplain, and to preserve and maintain the groundwater table and ground water recharge areas within the floodplain." Specifically, the Ordinance requires that:

Permitted Uses (Section 200-4.13.E) in the Floodplain Overlay District include the following uses with low flood damage potential and causing no obstructions to flood flows shall be allowed in the 100-year floodplain provided they are permitted in the underlying district and they do not require structures, fill, or storage of materials or equipment:

1. Agricultural uses such as farming, grazing, truck farming, horticulture, etc;
2. Forestry and nursery uses;
3. Outdoor recreational uses, including fishing, boating, play areas, etc;
4. Conservation of water, plants, wildlife;
5. Wildlife management areas, foot, bicycle, and horse paths;
6. Temporary nonresidential structures used in connection with fishing, growing, harvesting, storage, or sale of crops raised on the premises;
7. Buildings lawfully existing prior to the adoption of these provisions;
8. Installation of utility, sewer or septic systems, water supplies and production, and water lines provided the Department of Public Works is satisfied that there is adequate protection against breaking, leaking, short-circuiting, grounding, igniting, or floating during flooding;
9. The portion of any lot within the Floodplain District may be used to meet the lot area or yard requirements for the district in which the remainder of the lot is located.

The following are uses in the Floodplain Overlay District requiring Special Permits (Section 200-4.13.F). No encroachment shall be permitted within the 100-year floodplain as shown on the FIRM Maps unless a special permit is granted by the Zoning Board of Appeals. Encroachment shall include:

1. Structures or buildings erected, constructed, or otherwise created or moved;
2. Reconstruction or repair due to flood damage and improvement or expansion of any building or structure lawfully existing prior to the adoption of these provisions;
3. Storage, dumping, filling, excavation, disposal or transfer of earth or other material;

4. Installation of driveways or roads to serve areas outside the floodplain district where other access is not feasible.

The following are uses in the Floodplain Overlay District that are Prohibited (Section 200-4.13.I). No encroachment shall be permitted in the floodway as shown on the FBFM Maps, and the following uses are prohibited in the 100-year floodplain:

Solid waste landfills, junkyards, dumps;

1. The manufacture, storage, or disposal of hazardous, toxic, or radioactive wastes;
2. The temporary or permanent storage or disposal of materials used in snow and ice control including sand, salt or other deicing chemicals;
3. The outdoor storage or placement of storage tanks, above or below ground, for petroleum products or other hazardous material;
4. The storage, dumping, filling, dredging, excavation, disposal, transfer, or removal of earth or other material except as permitted by special permit under this provision.

#### Performance Standards Section 6.8

The purpose of the Zoning Ordinance Performance Standards, amended in July of 2009, is “to ensure that any use allowed by right or special permit in any district is conducted in a manner which does not adversely affect the surrounding natural or human environment by creating a dangerous, injurious or objectionable condition.” One of the standards (6.8.8 A) directly addresses the impacts of uncontrolled surface water runoff and sedimentation as follows:

- Whenever the existing contours of the land are altered; grading, site design, and construction shall be designed to prevent soil erosion, sedimentation, uncontrolled surface water runoff or alteration of runoff to or from abutting properties. The primary reasons for having erosion and sedimentation control measures in place are to:
  - Prevent topsoil from migrating off a construction site,
  - Protect the Town’s streets and storm water systems,
  - Protect adjacent property from siltation, and
  - Protect fish and other wildlife from siltation of ponds, lakes, streams and rivers.
- Procedure:
  - These standards shall pertain to all building sites under new construction or redevelopment. The applicant shall submit an erosion and sedimentation control plan to the Inspector of Buildings for approval. If Site Plan Review and Approval is required under the Greenfield Zoning Ordinance, an erosion and sedimentation control plan shall be submitted to the reviewing authority along with all other submittal requirements.
  - The Inspector of Buildings or any of his designees shall conduct a site visit to ensure that all temporary erosion and sedimentation control measures required under this policy are properly installed prior to and maintained throughout construction. Failure to comply with these standards may result in a stop work order or the revocation of permits.
  - Erosion of soil and sedimentation shall be minimized by using the following erosion control standards, which are in addition to any erosion control measures required by the Greenfield Conservation Commission as part of the issuance of a

wetland related permit (Negative Determination of Applicability with Conditions or an Order of Conditions).

- Temporary erosion control measures shall be installed for the following:
  - All construction areas that slope toward the road or an abutting property shall require a properly installed siltation fence and/or baled hay barrier to prevent siltation of the roadway or neighboring property.
  - All wetland areas shall be protected by a properly installed siltation barrier. Work that occurs in or within 100 feet of a wetland resource area or within 200 feet of a perennial river or stream requires filing with the Greenfield Conservation Commission. In areas outside the jurisdiction of the Conservation Commission but where the ground slopes toward a wetland area, a properly installed siltation fence and/or baled hay barrier shall be required.
  - Stockpiles of loam shall be protected by a siltation fence and/or baled hay barrier. Stockpiles that remain on site for longer than 30 days shall also be seeded to prevent erosion. These measures shall remain until all material has been placed or disposed off site.
  - The smallest practical area of land shall be disturbed at any one time.
  - The duration of exposure of disturbed areas due to stripping of vegetation, soil removal, and regarding shall be kept to a minimum.
  - Baled hay barriers and siltation fencing are to be maintained and cleaned until all slopes have a healthy stand of grass or other approved vegetation.
  - Baled hay and mulch shall be mowings of acceptable herbaceous growth, free from noxious weeds or woody stems. No salt hay shall be used.
  - All disturbed areas shall be loamed and seeded with grass or other approved vegetation.
  - After all disturbed areas have been stabilized, the temporary erosion control measures are to be removed. Disturbed areas resulting from removal of the temporary erosion control measures shall be repaired and seeded.
  - A temporary mud tracking bed (construction entrance) shall be put in place at each site entrance where necessary. This tracking bed shall consist of a four (4) inch minimum layer of 1 ¾ inch crushed stone and shall be a minimum of twenty (20) feet in length and fifteen (15) feet in width. This bed shall be maintained during construction to prevent tracking or flowing of sediment onto the public right-of-way and shall be removed prior to the placement of a gravel base and pavement.
  - It shall be the responsibility of the contractor to control blowing dust and soil. Dust control shall be used during grading operations if the grading is to occur within five hundred (500) feet of an occupied residence or place of business and may consist of grading fine soils on calm days only or dampening the ground with water.
  - Permanent erosion control and vegetative measures shall be in accordance with the Erosion and Sediment Control and Vegetative Practices in Site Development Guides published by the U.S. Department of Agriculture, Natural Resources Conservation Service.

- The construction of roads or structures on slopes of fifteen (15) percent or greater shall require a special permit from the Planning Board. Such permit shall only be granted if the Board finds that adequate provisions have been made to protect against soil erosion and sedimentation, soil instability and uncontrolled surface water runoff.

Open Space/Cluster Developments Section 200-7.1

The Zoning Ordinance Open Space/Cluster Developments Part A, amended in May of 2007 lists as its purpose in part the following:

- Promotes a more efficient use of land in harmony with its natural features
- Encourages a less sprawling form of development that consumes less open land
- Encourages the permanent preservation of open space, agricultural lands and other natural resources

This type of residential development can preserve larger areas of undeveloped land which in turn could reduce the impacts of stormwater runoff. The Common Open Space Requirements (Section 200-7.1 H) require that preserved open space shall be at least twenty-five (25) percent of the total land area of the tract not including wetlands, floodplains and slopes in excess of twenty-five (25) percent. In addition, “[a]t least one-half (1/2) of the open space shall be shaped for land uses such as recreation and agriculture.”

Earth Removal, Section 200-7.4

Any removal of earth products shall be undertaken only in accordance with the Soil Removal regulations (Chapter 154 of the Town of Greenfield Code) require that a license be issued by the Greenfield Selectmen prior to the removal of soil, loam, sand or gravel from land not in public use except in conjunction with construction of a building, landscaping activities, or the continued operation of an existing sand and gravel pit. The Soil Removal regulations do not mention flood prevention or mitigation.

Major Development Review, Section 200-7.12

According to this section, amended in May 2006, the purpose of this ordinance is to identify and attempt to mitigate potential negative impacts to the City of Greenfield, such as to Town services, traffic patterns, the environment, abutting properties, or the public health and safety, caused directly or indirectly by major development.

Site Plan Review and Approval (Section 200-8.4)

The Site Plan Review and Approval section of the Greenfield Zoning Ordinance specifically mentions flooding and requires mitigating potential impacts from flooding. The purpose of the Site Plan Review and Approval section of the Greenfield Zoning Ordinance is to ensure that new development reasonably protects the visual, environmental and aesthetic qualities of the neighborhood and the Town. Site plan review and approval is required for all uses that require a Special Permit, any business, commercial, industrial or institutional use (except certain home occupations) and any site containing more than one (1) principal use. The applicant must submit information regarding the measures to:

- Prevent pollution of surface and groundwater, increased runoff, changes in groundwater levels, and flooding.
- Control measures to prevent erosion and sedimentation during and after construction and the sequence of grading and construction activities, location of temporary control measures, and final stabilization of the site.

Approval guidelines that the Planning Board uses include:

- Provision for integrating the project into the existing terrain and surrounding landscape by minimizing use of wetlands, steep slopes, and hilltops; protecting visual amenities and scenic views; preserving unique natural or historical features; minimizing tree, vegetation and soil removal; and minimizing grade changes;
- Provisions for surface runoff and drainage which protects the site and adjacent properties from erosion, maximizes groundwater recharge, and prevents the collection of surface runoff on paved surfaces which may obstruct pedestrian or vehicular flow;
- Measures to prevent pollution of surface or groundwater, and to prevent increased flooding;

Section 200-7.14 of the Greenfield Zoning Ordinance regulates wireless communications facilities. The Ordinance does not mention safety as one of the purposes of the Ordinance. However, the Ordinance does require a special permit from the Zoning Board of Appeals and a building permit from the Inspector of Buildings before a facility can be erected and the applicant must provide plans for anchoring and supporting the structure. The Ordinance also establishes a “fall zone” for the structure in relation to property lines and road right-of-ways. The Ordinance does not prohibit the construction of wireless communications facilities within flood-prone areas.

### **Subdivision Rules and Regulations (Excerpts)**

Greenfield’s Subdivision Rules and Regulations (Chapter 880) were adopted on May 29, 1984 – and subsequently amended on November 21, 2008 – for the purpose of “protecting the safety, convenience and welfare of the inhabitants of Greenfield by regulating the laying out and construction of ways in subdivisions providing access to the several lots therein, but which have not become public ways, and ensuring sanitary conditions in the subdivisions and, in proper cases, parks and open areas.” The Planning Board and Board of Appeals shall exercise their powers to secure the safety of residents in the case of fire, flood, panic and other emergencies and to ensure adequate drainage for the subdivision.

The Subdivision Rules and Regulations contain several provisions that mitigate the potential for flooding, including:

- Section 880-9.B Definitive Plan Submission Requirements requires the proponent to:
  - Proposed layout (including cross sections and profiles) of sewerage, storm drainage and water supply, including invert elevations, slopes, capacity, and velocity.
  - Indication of all areas believed to be subject to control under the Wetlands Protection Act, MGL c. 131, § 40, under procedures outlined at 310 CMR 10.00.

- Stormwater management plan in compliance with the provisions of Chapter 695 of the Greenfield Code
- An erosion control plan, indicating the erosion control measures to be employed, including description of locations of temporary stockpiles, spoil areas, temporary drainage systems, slope stabilization techniques, sediment basins, etc., and narrative description of how erosion from individual lots onto streets and into drainage systems is proposed to be controlled. Review comments on the plan by the Conservation Commission and by the Soil Conservation Service or by others acceptable to the Board as expert in soil erosion. Any site disturbing more than one (1) acre must have a detailed Storm Water Pollution Prevention Plan (SWPPP) and an Erosion Control Plan submitted to and approved by the EPA or its designee in accordance with EPA's NPDES Phase II regulations.
- Section 880-9.E Wetlands Protection Act.
  - (1) In accordance with MGL c. 131, § 40, no person shall remove, fill, dredge or alter any bank, beach, dune, flat, marsh, meadow or swamp bordering on any existing creek, river, stream, pond, lake or any land under said waters or subject to flooding without filing a written notice of intention to perform said work with the local Conservation Commission and the Department of Environmental Protection.
  - (2) In order to determine if the proposed subdivision, or parts thereof, are subject to the provisions of the Wetlands Protection Act, the Planning Board will, where it deems necessary, submit a copy of the definitive plan to the Conservation Commission. The Conservation Commission shall, to the extent practicable, file a report with the Planning Board not later than forty-five (45) days after receipt of the plan stating that the proposed plans are not subject to the provisions of the Wetlands Protection Act, or the Wetlands Protection Act applies to certain designated areas. In the event the plan shall be governed by said Act, the Planning Board shall include in its decision for approval a condition that the applicant shall obtain approval from the Conservation Commission prior to any construction activity in the affected areas.
- Section 880-10. Design Requirements states, in part, that all subdivisions shall be designed to reduce, to the extent reasonably possible:
  - Volume of cut and fill;
  - Area over which existing vegetation will be disturbed, especially if within 200 feet of a river, pond, or stream, or having a slope of more than 15%;
  - Number of mature trees removed;
  - Extent of waterway altered or relocated;
  - Erosion and siltation; and
  - Flood damage.
- Section 880-11. Open Space, Section 880-12. Protection of Natural Features, and Section 880.13. Easements contain design requirements that can reduce the potential for flooding. However, the prevention of flooding is not explicitly stated as a purpose for these requirements.

- Section 880-14. Environmental Assessment. A comparative environmental assessment may be required for any subdivision creating frontage of ten (10) or more dwelling units within one thousand (1,000) feet of a perennial river or stream as defined by the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00). The scope of such assessment, including development alternatives to be compared and consequences to be studied, shall be as agreed to by the Planning Board and may be required to include up to two (2) major alternatives to the plan proposed including a cluster version, with as much of the following information as determined by the Planning Board to be necessary for plan evaluation; and shall be prepared by an interdisciplinary team to include a land surveyor, civil engineer, and an architect or landscape architect, unless otherwise agreed to by the Planning Board.
  - Narrative discussion of differences among alternatives regarding, in part, the following:
    - Impact upon surface water quality and level;
    - Impact upon ground water quality and level;
    - Material effects upon important wildlife habitats, outstanding botanical features, and scenic or historic environs;
    - Capability of soils, vegetative cover, and proposed erosion control efforts to support proposed development without danger of erosion, silting, or other instability;
    - Relationship to the requirements of MGL c. 131, §§ 40 and 40A (the Wetlands Protection Act).
    - Estimated phosphate and nitrate loading on ground water and surface water from septic tanks, lawn fertilizer, and other activities within the development.
  - Discussion of impact on a waterway of a subdivision with topographical features of more than thirty (30) feet above said waterway.
- Section 880-16. Flood Hazard Areas. Any portion of a proposed subdivision which is located within the 100-year floodplain as shown on the Town of Greenfield Flood Insurance Rate Maps (FIRM) together with the Flood Boundary and Floodway Maps contained in the Flood Insurance Study shall meet the following requirements:
  - All requirements of § 200-4.13 Floodplain District (F) of the Greenfield Zoning Ordinance.
  - The subdivision, including utilities and drainage, shall be designed to be consistent with the needs to minimize flood damage and provide adequate drainage.
  - Subdivisions shall include base flood elevation data.

Section 3.1.2 Design Standards of the Town of Greenfield Subdivision Rules and Regulations set grade limits on streets, which, although not specified as weather hazard mitigation, can serve to minimize the potential for motor vehicle accidents during severe winter storms (i.e., reduce road icing).

- Vertical grades should not exceed six (6) percent for primary roads and ten (10) percent for secondary roads; and

- Horizontal alignment must provide minimum safe stopping sight distances for motor vehicle traffic. This is specified as 300 feet for primary roads and 200 feet for secondary roads.

The Town also requires a permit from the Department of Public Works for a curb cut on town-owned roads and a permit for a curb cut on state-owned roads must be obtained from Mass Highway. These permits help to ensure proper driveway and roadway drainage and help minimize icing during winter storms. Large residential developments and commercial developments are required to manage stormwater (discussed above in the flooding section) which also helps to reduce icing from melting snow.

## **Town of Greenfield Code (Excerpts)**

### Wetlands Protection, Chapter 195

Chapter 195 of the Town of Greenfield Code, adopted by the Town Council of the Town of Greenfield in 2001, addresses the protection of wetland resources within the town and includes provisions to address issues particular to Greenfield. The Ordinance includes a brief explanation of the intended purpose and intent of each of the provisions. The prevention of flooding events or the mitigation of impacts from flooding are addressed directly and indirectly in this Ordinance, as indicated below. The italicized sections are the town's intended purpose for each provision.

- A minimum of a 25-foot naturally vegetated "No Disturb Zone" shall be maintained or provided between resource areas and all altered areas. A wider "No Disturb Zone" may be required within the 100-foot buffer zone. *This provision serves to ensure protection from negative impacts during construction activities and the long-term viability of a resource area.* It also serves to preserve, intact, a portion of the floodplain associated with some resource areas.
- A list of prohibited new uses within the 100-year floodplain. *These restrictions serve to protect areas within the floodplain from potential sources of contamination from pollutants. Vehicles and their accessories (road salt, sand, oil, gas) stored in the floodplain will pollute surface water during flooding events. Vehicles and their accessories can also become dangerous debris during a flooding event.*
- 100% compensatory storage shall be provided for all flood storage volume that will be lost as the result of a proposed project within the 100-year floodplain. *This provision clarifies that the Commission considers all incremental reductions in flood storage capacity to be significant over time, and therefore requires replacement at a 1:1 ratio.*
- The Commission shall not consider the replication of wetlands adequate mitigation for the destruction of resource areas. Alteration of wetlands requiring replication shall be permitted only where the landowner will be deprived of substantially all

economic use of the property, there are no reasonable alternatives, and the wetland area to be lost is minimized to the greatest extent possible. *The purpose of this provision is to provide clarification that the destruction of natural wetlands shall only be considered as a last resort. In general, the Commission shall not permit replication of wetlands because replication does not in fact substitute for many wetlands values. Proposed wetlands replications are at the discretion of the Commission based upon solid scientific reasoning and shall not be permitted simply based upon a proposed 1:1 replication ratio or the “highest and best use” of a property based upon development potential.*

#### Stormwater System Regulations, Chapter 695

Chapter 695 of the Town of Greenfield Code, dated June 2003, contains regulations governing the use of the town’s stormwater system. The regulations specifically address flood prevention. The stated purpose of the regulations is to “...ensure high water quality standards and address any potential water quantity problems associated with development and to:

- Preserve hydrologic conditions that closely resemble pre-development conditions;
- Prevent *flooding* by managing the peak discharge and volume of runoff; and
- Reduce the amount of suspended solids and other pollutants in order to maintain water quality.”

The Stormwater System Regulations establish a permitting process that governs any new discharge or increase in the volume of discharge of stormwater to a public way or stormwater sewer. There are two (2) classes of stormwater permit applications: Residential (single and two-family dwelling units) and Nonresidential (multi-family dwellings, subdivisions, commercial, industrial and institutional uses). For Nonresidential stormwater connection permits, an applicant must submit a Stormwater Management Plan to the Department of Public Works. The Stormwater Management Plan must be coordinated with requirements of the Wetlands Protection Act and the Greenfield Conservation Commission. The Stormwater System Regulations establish Stormwater Management Standards (section 695-11) that mitigate the potential for flooding, including:

- The stormwater management system shall be designed so that the post-development peak discharge rates do not exceed the pre-development discharge rates for a 10-year 24-hour storm.
- Loss of annual recharge to groundwater should be minimized through the use of infiltration measures to the maximum extent practicable. The annual recharge from the post-development site should approximate the annual recharge from the pre-development or existing site conditions based on soil types.

The regulations also include Design Criteria that address flood prevention and mitigation. Section 695-12 states:

- Stormwater management systems are encouraged to be designed to incorporate the use of natural topography and land cover. The use of such features as natural swales

- and depressions as they exist prior to development to the degree that they can accommodate the additional flow of water are recommended.
- All stormwater management systems shall be designed to provide an emergency overflow system, and incorporate measures to provide a non-erosive velocity of flow along its length and at any outfall.

Inspection and maintenance agreements are also required for stormwater management systems located on private land.



## Appendix B: Massachusetts Cultural Resource Information System

| Inv. No. | Property Name                                      | Street       | Year |
|----------|--|--------------|------|
| GRE.A    | Main Street Historic District                      |              |      |
| GRE.B    | East Main - High Street Historic District          |              |      |
| GRE.C    | Central Main Street Area                           |              |      |
| GRE.D    | Crescent Street - Highland Avenue Area             |              |      |
| GRE.E    | Factory Hollow Road Area                           |              |      |
| GRE.F    | Fort Square  |              |      |
| GRE.G    | Grinnell - Congress - Prospect Streets Area        |              |      |
| GRE.H    | Hope Street Area                                   |              |      |
| GRE.I    | Lampblack Road Area                                |              |      |
| GRE.J    | Leonard Street Area                                |              |      |
| GRE.K    | Meridian Street - Petty Plain Road Area            |              |      |
| GRE.L    | Mill Street Area                                   |              |      |
| GRE.M    | Pierce - Garfield Streets Area                     |              |      |
| GRE.N    | Nash's Mill  |              |      |
| GRE.O    | North Meadows                                      |              |      |
| GRE.P    | Riddell - Hastings - Haywood Streets Area          |              |      |
| GRE.Q    | Washington Streetscape                             |              |      |
| GRE.R    | Sanderson Street Area                              |              |      |
| GRE.S    | Franklin County Fairgrounds                        |              |      |
| GRE.T    | Green River Cemetery                               |              |      |
| GRE.U    | Highland Park - Temple Woods - Rocky Mountain Park |              |      |
| GRE.W    | Riverside Archaeological District                  |              |      |
| GRE.X    | Greenfield Tap and Die Plant #1                    |              |      |
| GRE.Y    | Lower Federal Street Area                          |              |      |
| GRE.186  | Keefe, Jeremiah House                              | 17 Abbott St | 1902 |
| GRE.187  | Davenport, William A. House                        | 21 Abbott St | 1900 |
| GRE.188  | Rosen, David House                                 | 22 Abbott St | 1905 |
| GRE.189  |  | 37 Abbott St | 1900 |
| GRE.218  | Adams, Andrew House                                | 127 Adams Rd | 1815 |
| GRE.136  | Conway Street Elementary School                    | Allen St     | 1909 |
| GRE.927  | B & M Railroad Connecticut River Main Line Bridge  | Allen St     | 1934 |
| GRE.407  | The C. Bau Photography Studio                      | 4 Ames St    | 1990 |
| GRE.145  | Threadwell Tap and Die Company                     | Arch St      | 1882 |
| GRE.919  | Arch Street Overpass                               | Arch St      | 1848 |
| GRE.29   | Prospect Hill School for Girls                     | 4 Armory St  | 1856 |
| GRE.920  | Bank Row Underpass                                 | Bank Row     | 1846 |
| GRE.87   | First National Bank and Trust of Greenfield        | 9 Bank Row   | 1929 |

| <b>Inv. No.</b> | <b>Property Name</b>                        | <b>Street</b>       | <b>Year</b> |
|-----------------|---|---------------------|-------------|
| GRE.88          | First Franklin County Courthouse            | 15 Bank Row         | 1813        |
| GRE.89          | Pond, Frank A. Block                        | 19-21 Bank Row      | 1874        |
| GRE.90          | Siano Block                                 | 25-27 Bank Row      | 1921        |
| GRE.91          | Coleman, William - Hollister, J. H. House   | 36 Bank Row         | 1797        |
| GRE.92          | Chevalier Block                             | 38-46 Bank Row      | 1916        |
| GRE.270         | Ambercrombie Building                       | 56 Bank Row         | 1892        |
| GRE.271         | King's Appliance Store                      | 60 Bank Row         |             |
| GRE.245         | Phillips, McHard House                      | 205 Barton Rd       | 1782        |
| GRE.246         | Barton, Isaac House                         | 283 Barton Rd       | 1837        |
| GRE.247         | Allen, J. S. House                          | 335 Barton Rd       | 1797        |
| GRE.379         | Sawyer - Tyler House and Farm               | 1 Bascom Rd         | 1870        |
| GRE.201         | Beacon Street School                        | Beacon St           | 1929        |
| GRE.932         | Beacon Field                                | Beacon St           | 1912        |
| GRE.204         | Wells, F. E. Tool Manufacturing Company     | 39 Beacon St        | 1910        |
| GRE.250         | Sprague, Avery - Newton, Hervey C. House    | Bernardston Rd      | 1845        |
| GRE.251         | Stoneleigh - Prospect Hill School for Girls | Bernardston Rd      | 1930        |
| GRE.255         | Fay, Damon L. Farm                          | Bernardston Rd      | 1852        |
| GRE.249         | Sprague, Asa House                          | 560 Bernardston Rd  | 1840        |
| GRE.252         | Davis, George House                         | 611 Bernardston Rd  | 1937        |
| GRE.253         | Stevens, R. E. House                        | 629 Bernardston Rd  | 1940        |
| GRE.254         | Winer, Benjamin Home                        | 633 Bernardston Rd  | 1930        |
| GRE.256         | Bullard, Silas House                        | 804 Bernardston Rd  | 1865        |
| GRE.257         | Bullard, Mark House                         | 878 Bernardston Rd  | 1881        |
| GRE.258         | Spaulding, Varney House                     | 890 Bernardston Rd  | 1835        |
| GRE.259         | Pickett, Samuel House                       | 908 Bernardston Rd  | 1820        |
| GRE.262         | Strickland, Russell F. House                | 1012 Bernardston Rd | 1830        |
| GRE.807         | Log Plain Cemetery                          | 1037 Bernardston Rd | 1802        |
| GRE.190         |   | 3 Bowker St         | 1900        |
| GRE.191         |   | 22 Bowker St        | 1830        |
| GRE.214         | Canada Hill Elementary School               | 40 Canada Hill Rd   | 1920        |
| GRE.272         | Victoria Theater                            | 13-25 Chapman St    | 1913        |
| GRE.275         | Outlet Store                                | 14-18 Chapman St    | 1890        |
| GRE.274         | Rist Building                               | 26 Chapman St       | 1920        |
| GRE.273         | Deland Building                             | 27-31 Chapman St    | 1911        |
| GRE.108         | Mohawk Engraving Company Building           | 52 Chapman St       | 1900        |
| GRE.109         | Chapman, Henry House                        | 58 Chapman St       | 1850        |
| GRE.151         | Wiley and Russell Box Company               | 330 Chapman St      | 1912        |
| GRE.152         | Guiding Star Grange                         | 401 Chapman St      | 1932        |
| GRE.45          | Comstock, Samuel W. House                   | Chestnut Hill       | 1890        |

| <b>Inv. No.</b> | <b>Property Name</b>                            | <b>Street</b>     | <b>Year</b> |
|-----------------|---|-------------------|-------------|
| GRE.77          | Saint James Protestant Episcopal Church         | 8 Church St       | 1847        |
| GRE.422         | Saint James Protestant Episcopal Church Rectory | 8 Church St       |             |
| GRE.336         | Stevens House                                   | 18 Church St      | 1900        |
| GRE.334         | Prentice House                                  | 19 Church St      | 1870        |
| GRE.333         | Eldrich House                                   | 20 Church St      | 1860        |
| GRE.78          | Potter, Waymes N. House                         | 24 Church St      | 1885        |
| GRE.79          | First Methodist Episcopal Church                | 25 Church St      | 1885        |
| GRE.329         | Wise House                                      | 40 Church St      | 1864        |
| GRE.80          | Greenfield Historic Society Building            | 43 Church St      | 1851        |
| GRE.328         |   | 44 Church St      | 1920        |
| GRE.327         |   | 46-48 Church St   | 1920        |
| GRE.81          | Fay, Charles F. - Griswold, Whiting House       | 51 Church St      | 1854        |
| GRE.392         | Long, Alanson House and Farm                    | 175 Cleveland St  | 1838        |
| GRE.922         | Colrain Road Bridge over Allen Brook            | Colrain Rd        | 1905        |
| GRE.810         | Lower Meadows Cemetery                          | 213 Colrain Rd    | 1793        |
| GRE.219         | Arms, Moses Farmhouse                           | 248 Colrain Rd    | 1777        |
| GRE.221         | Belgrade, David House                           | 350 Colrain Rd    | 1939        |
| GRE.222         | Nims, Thomas Barn                               | 370 Colrain Rd    | 1810        |
| GRE.223         | Nims, Thomas Homestead                          | 465 Colrain Rd    | 1826        |
| GRE.224         | Nims, Prudence House                            | 479 Colrain Rd    | 1847        |
| GRE.225         | Brook, Allen Farmhouse                          | 620 Colrain Rd    | 1766        |
| GRE.226         | Coleman, Capt. Thadeus House                    | 637 Colrain Rd    | 1813        |
| GRE.227         | Wells, Capt. Ebenezer House                     | 638 Colrain Rd    | 1747        |
| GRE.811         | Upper Meadows Cemetery                          | 711 Colrain Rd    | 1821        |
| GRE.228         | Smead, Asaph House                              | 729 Colrain Rd    | 1810        |
| GRE.229         | Wells Tavern                                    | 758 Colrain Rd    | 1780        |
| GRE.230         | Parmenter, Dea. Elias A. - Spear, George House  | 789 Colrain Rd    | 1851        |
| GRE.232         | Old Tavern Farm                                 | 817 Colrain Rd    | 1740        |
| GRE.30          | Washburn, William B. House                      | 35 Congress St    | 1859        |
| GRE.31          | Wiley, Solon L. House                           | 60 Congress St    | 1877        |
| GRE.141         | North Parish School                             | Conway St         | 1920        |
| GRE.137         | Emerson, Professor L. O. House                  | 70 Conway St      | 1840        |
| GRE.138         | Severance, Charles D. House                     | 93 Conway St      | 1910        |
| GRE.139         | Newton, James House                             | 117-119 Conway St | 1850        |
| GRE.140         | Smart, Albert J. House                          | 136 Conway St     | 1870        |
| GRE.917         | Country Club Road Overpass                      | Country Club Rd   | 1848        |
| GRE.83          | Second Franklin County Courthouse               | Court Sq          | 1848        |
| GRE.310         | Second Congregational Church                    | Court Sq          | 1868        |
| GRE.903         | Civil War Monument                              | Court Sq          | 1870        |

| <b>Inv. No.</b> | <b>Property Name</b>                               | <b>Street</b>        | <b>Year</b> |
|-----------------|--|----------------------|-------------|
| GRE.46          | Snow, Walter N. House                              | 50 Crescent St       | 1895        |
| GRE.178         | Grammar School                                     | Davis St             | 1902        |
| GRE.175         |  | 63-65 Davis St       | 1845        |
| GRE.16          | Harugari Hall                                      | Deerfield St         | 1886        |
| GRE.908         | Cheapside Railroad Bridge                          | Deerfield St         | 1912        |
| GRE.17          | Potter, Mary Pratt - Ward Elizabeth House          | 50 Deerfield St      | 1850        |
| GRE.18          |  | 98 Deerfield St      | 1850        |
| GRE.99          |  | 11 Deven St          | 1850        |
| GRE.135         | Franklin County Jail and House of Correction       | Elm St               | 1886        |
| GRE.134         | Mitchell, J. E. House                              | 34 Elm St            | 1875        |
| GRE.244         | Green River Pumping Station                        | Eunice Williams Dr   | 1896        |
| GRE.901         | Pumping Station Bridge                             | Eunice Williams Dr   | 1972        |
| GRE.916         | Williams, Eunice Monument                          | Eunice Williams Dr   | 1884        |
| GRE.215         | Little Brick House                                 | 7 Factory Hollow Rd  | 1830        |
| GRE.905         | Factory Hollow Mill Bell Tower                     | 12 Factory Hollow Rd | 1830        |
| GRE.217         | Hastings, Obed House                               | 17 Factory Hollow Rd | 1700        |
| GRE.216         | Wood, Seth House and Store                         | 24 Factory Hollow Rd | 1835        |
| GRE.373         |  | 30 Factory Hollow Rd | 1900        |
| GRE.374         |  | 39 Factory Hollow Rd | 1933        |
| GRE.375         |  | 53 Factory Hollow Rd | 1900        |
| GRE.910         | First Meeting House Marker and Watering Trough     | Federal St           | 1894        |
| GRE.911         | Revolutionary War Memorial                         | Federal St           | 1916        |
| GRE.154         | Pioneer National Bank and Trust Company            | 1 Federal St         | 1970        |
| GRE.938         | Untitled Sculpture                                 | 1 Federal St         | 1975        |
| GRE.153         | Corsiglia Block                                    | 8 Federal St         | 1898        |
| GRE.428         | Rosge Garden Building - Donovan Block              | 18 Federal St        | 1926        |
| GRE.155         | Levy Block   | 26-28 Federal St     | 1915        |
| GRE.409         | Famous Bill's Restaurant                           | 30-44 Federal St     | 1900        |
| GRE.156         | Odd Fellows Block                                  | 31 Federal St        | 1922        |
| GRE.157         | Schick, Jacob Block                                | 41 Federal St        | 1912        |
| GRE.410         | Greenfield Electric Light and Power Company Office | 45 Federal St        | 1930        |
| GRE.159         | Graves Bakery                                      | 54 Federal St        | 1910        |
| GRE.158         | Greenfield Power and Light Company Service Station | 55R Federal St       | 1918        |
| GRE.160         | Mansion House Hotel Garage                         | 62 Federal St        | 1915        |
| GRE.411         | Greenfield Co-Operative Bank                       | 63 Federal St        | 1950        |
| GRE.161         | Knights of Columbus Block                          | 70 Federal St        | 1926        |
| GRE.162         | Brown's Toy Company Store                          | 78-80 Federal St     | 1922        |
| GRE.163         | Weldon Hotel Garage                                | 90 Federal St        | 1909        |
| GRE.164         | Wilcox, George Auto Dealership                     | 100 Federal St       | 1930        |

| <b>Inv. No.</b> | <b>Property Name</b>                    | <b>Street</b>      | <b>Year</b> |
|-----------------|---|--------------------|-------------|
| GRE.165         | Wiley - O'Brien, Dr. John C. House      | 111 Federal St     | 1845        |
| GRE.168         | Leonard, Theodore House                 | 116 Federal St     | 1850        |
| GRE.183         | Greenfield First Baptist Church         | 116 Federal St     | 1912        |
| GRE.166         | Federal Street Elementary School        | 125 Federal St     | 1911        |
| GRE.167         | Third Greenfield High School            | 125 Federal St     | 1904        |
| GRE.412         | Hull, A. N. House                       | 128 Federal St     | 1880        |
| GRE.413         | Lamb, J. H. House                       | 132 Federal St     | 1880        |
| GRE.419         | Krohne's Automotive Service Garage      | 151 Federal St     | 1912        |
| GRE.420         |   | 155-157 Federal St | 1900        |
| GRE.421         |   | 159-161 Federal St | 1900        |
| GRE.414         | Bardwell, Oscar House                   | 162 Federal St     | 1885        |
| GRE.417         | Scobey, C. House                        | 166 Federal St     | 1880        |
| GRE.418         | Stratton, O. House                      | 168-170 Federal St | 1890        |
| GRE.415         | Ingell and Shepard Funeral Home         | 180 Federal St     | 1923        |
| GRE.801         | Federal Street Cemetery                 | 187 Federal St     | 1803        |
| GRE.802         | Pierce, John J. Burial Lot              | 187 Federal St     |             |
| GRE.425         |   | 189 Federal St     |             |
| GRE.180         | Fourth Greenfield Senior High School    | 195 Federal St     | 1924        |
| GRE.198         | Pierce, John D. House                   | 196 Federal St     | 1887        |
| GRE.199         | Woodleigh Villa                         | 220 Federal St     | 1888        |
| GRE.416         |   | 224 Federal St     | 1900        |
| GRE.200         | First National Stores                   | 226-230 Federal St | 1927        |
| GRE.367         | Severance, Asa House                    | 234 Federal St     | 1896        |
| GRE.368         | Parker, George W. House                 | 240 Federal St     | 1903        |
| GRE.369         | Allen, Dr. Porter C. House              | 244 Federal St     | 1906        |
| GRE.370         | Corbin, Charles G. House                | 246 Federal St     | 1910        |
| GRE.212         | Lunt Silversmith Factory                | 298 Federal St     | 1890        |
| GRE.371         | Braff's Royal Cleaners                  | 430 Federal St     | 1950        |
| GRE.106         | Greenfield Storage                      | 1 Fiske Ave        | 1915        |
| GRE.267         | Avenue Lighting                         | 10 Fiske Ave       | 1920        |
| GRE.68          | Greenfield Library Association Building | 7 Franklin St      | 1878        |
| GRE.351         | Washburn House                          | 15 Franklin St     | 1882        |
| GRE.350         | Fiske, O. H. House                      | 23 Franklin St     | 1890        |
| GRE.349         | Reed Apartments                         | 24 Franklin St     | 1915        |
| GRE.69          | Russell, Isabella House                 | 29 Franklin St     | 1890        |
| GRE.348         | Howland House                           | 34 Franklin St     | 1860        |
| GRE.347         |   | 37 Franklin St     | 1960        |
| GRE.346         | Ward House                              | 42 Franklin St     | 1880        |
| GRE.345         | Smead House                             | 43 Franklin St     | 1880        |

| <b>Inv. No.</b> | <b>Property Name</b>                               | <b>Street</b>      | <b>Year</b> |
|-----------------|--|--------------------|-------------|
| GRE.344         | Crafts, Fannie E. House                            | 68 Franklin St     | 1880        |
| GRE.343         | Newcomb House                                      | 69 Franklin St     | 1865        |
| GRE.331         |  | 81 Franklin St     | 1880        |
| GRE.332         | Burrage House                                      | 87 Franklin St     | 1924        |
| GRE.243         | Greenfield Town Farm                               | 34 Glenbrook Dr    | 1847        |
| GRE.396         | Greenfield Town Farm Barn                          | 34 Glenbrook Dr    | 1909        |
| GRE.924         | Gerrett Bridge                                     | Green River Rd     | 1907        |
| GRE.233         | Smead, Capt. Thomas House                          | 11 Green River Rd  | 1794        |
| GRE.234         | Ewers, Henry A. Blacksmith Shop                    | 18 Green River Rd  | 1840        |
| GRE.235         | Smead, Jonathan House                              | 200 Green River Rd | 1739        |
| GRE.236         | Smead, Lemuel House                                | 276 Green River Rd | 1766        |
| GRE.32          | Conant, Samuel D. House                            | 3 Grinnell St      | 1880        |
| GRE.33          | Wells, F. O. House                                 | 9 Grinnell St      | 1880        |
| GRE.34          | Reed, Frank H. House                               | 16 Grinnell St     | 1880        |
| GRE.35          | Hardison, F. S. House                              | 26 Grinnell St     | 1882        |
| GRE.36          | Day, Charles J. House                              | 29 Grinnell St     | 1880        |
| GRE.37          | Allen, Sylvester House                             | 41 Grinnell St     | 1836        |
| GRE.38          |  | 55 Grinnell St     | 1880        |
| GRE.210         | Akey, Clifford House                               | 11 Haywood St      | 1900        |
| GRE.211         | Greenfield Machine Company                         | 38 Haywood St      | 1900        |
| GRE.812         | Country Farms Cemetery                             | Health Camp Rd     | 1794        |
| GRE.276         | Hoyt House   | 11-15 High St      | 1883        |
| GRE.277         | Walker Funeral Home                                | 14 High St         | 1893        |
| GRE.278         | Lamb House   | 17 High St         | 1851        |
| GRE.70          | Beals, Dr. Joseph House                            | 21 High St         | 1845        |
| GRE.71          | Simons, H. K. House                                | 22 High St         | 1875        |
| GRE.320         | Arms, George House                                 | 23-25 High St      | 1850        |
| GRE.72          | Kellog, Dwight B. - Conant, Chester C. House       | 28 High St         | 1854        |
| GRE.321         | Forbes House                                       | 29 High St         | 1850        |
| GRE.322         | Packard House                                      | 32 High St         | 1855        |
| GRE.323         | Moors - Comstock House                             | 35 High St         | 1850        |
| GRE.324         |  | 36-38 High St      | 1855        |
| GRE.73          | Taylor, Rinaldo Rinaldine - Russell, Nathaniel Hse | 40 High St         | 1855        |
| GRE.74          | Field, Charles R. House                            | 43 High St         | 1870        |
| GRE.326         | Fletcher House                                     | 51 High St         | 1870        |
| GRE.75          | Weldon Hotel, The                                  | 54 High St         | 1905        |
| GRE.76          | Bolter, Cyprian - Jones, Orra Martin Cottage       | 77 High St         | 1852        |
| GRE.205         | Hastings, Lemuel - Riddell, John Wesley House      | 186 High St        | 1790        |
| GRE.206         |  | 193 High St        | 1915        |

| <b>Inv. No.</b> | <b>Property Name</b>                             | <b>Street</b>    | <b>Year</b> |
|-----------------|--|------------------|-------------|
| GRE.209         | Taylor, Lewis House                              | 210 High St      | 1930        |
| GRE.41          | Lupinwood  | Highland Ave     | 1890        |
| GRE.42          | Cutler, Nahum Sawin House                        | 35 Highland Ave  | 1886        |
| GRE.43          | Field, David C. G. - Esleek, Augustine W. House  | 58 Highland Ave  | 1895        |
| GRE.44          | Rogers, George E. House                          | 93 Highland Ave  | 1903        |
| GRE.22          | Cutler, Lyons and Field Shoe Factory             | Hope St          | 1891        |
| GRE.27          |  | Hope St          | 1890        |
| GRE.403         | Mohawk Cadillac Company Repair Garage            | 36 Hope St       | 1920        |
| GRE.404         | Father Mathew Temperance Society Hall            | 44 Hope St       | 1920        |
| GRE.21          | Greenfield Armory                                | 71 Hope St       | 1910        |
| GRE.23          | Saint Paul's Lutheran Church                     | 88 Hope St       | 1883        |
| GRE.24          | Noyes, B. B. Foundry                             | 106 Hope St      | 1893        |
| GRE.25          |  | 123 Hope St      | 1870        |
| GRE.26          | Toiletine Building                               | 143 Hope St      | 1910        |
| GRE.264         | Childs, Timothy - Bascom, Moses House            | 509 Lampblack Rd | 1774        |
| GRE.380         | Griswold Farmhouse                               | 588 Lampblack Rd | 1873        |
| GRE.376         | Griswold Farmstead                               | 599 Lampblack Rd | 1920        |
| GRE.377         | Philips - Bascom House                           | 672 Lampblack Rd | 1830        |
| GRE.378         | Chapin, C. House                                 | 692 Lampblack Rd | 1820        |
| GRE.100         | Main Street Primary School                       | 7 Legion Ave     | 1877        |
| GRE.169         | Mosa, G. W. House                                | 8-10 Leonard St  | 1880        |
| GRE.170         | Whitney, E. House                                | 11 Leonard St    | 1885        |
| GRE.171         |  | 12 Leonard St    | 1895        |
| GRE.386         |  | 15 Leonard St    | 1900        |
| GRE.381         |  | 16 Leonard St    | 1895        |
| GRE.172         | Smith, C. House                                  | 17 Leonard St    | 1900        |
| GRE.382         |  | 18 Leonard St    | 1895        |
| GRE.385         |  | 21 Leonard St    | 1900        |
| GRE.173         | Partenheimer, Philip House                       | 22 Leonard St    | 1883        |
| GRE.384         |  | 23 Leonard St    | 1900        |
| GRE.383         |  | 27 Leonard St    | 1880        |
| GRE.394         | Green River Booster Pumping Station - North Bldg | Leyden Rd        | 1922        |
| GRE.395         | Green River Booster Pumping Station - South Bldg | Leyden Rd        | 1923        |
| GRE.237         | Wilder, Samuel House                             | 21 Leyden Rd     | 1835        |
| GRE.238         | Parsonage, The                                   | 31 Leyden Rd     | 1845        |
| GRE.265         | Nash, Daniel House                               | 36 Leyden Rd     | 1820        |
| GRE.239         | Newcomb, Allyn S. House                          | 46 Leyden Rd     | 1885        |
| GRE.240         | Martindale, Uriah and Theodore House             | 127 Leyden Rd    | 1835        |
| GRE.241         | Smead, Charles Dea. House                        | 219 Leyden Rd    | 1840        |

| <b>Inv. No.</b> | <b>Property Name</b>                           | <b>Street</b>   | <b>Year</b> |
|-----------------|--|-----------------|-------------|
| GRE.242         | Smead, Jonathan Jr. House                      | 274 Leyden Rd   | 1765        |
| GRE.808         | Hebrew Cemetery                                | Log Plain Rd    | 1924        |
| GRE.925         | Log Plain Road Bridge over Mill - Barton Brook | Log Plain Rd    | 1939        |
| GRE.260         | Adams, George House                            | 136 Lover's Ln  | 1870        |
| GRE.915         | Spanish War Memorial                           | Main St         | 1928        |
| GRE.918         | Main Street Arch                               | Main St         | 1848        |
| GRE.939         | Peace Symbol - Greenfield Civil War Memorial   | Main St         | 1965        |
| GRE.940         | Serpentine Wall - Greenfield War Memorial      | Main St         | 1965        |
| GRE.127         | Goodell Manufacturing Company                  | 1 Main St       | 1897        |
| GRE.124         | Coombs, Joseph House                           | 6 Main St       | 1854        |
| GRE.123         | Noyes, Baxter B. House                         | 8 Main St       | 1895        |
| GRE.126         | Simons House                                   | 30 Main St      | 1865        |
| GRE.399         | Benson Block                                   | 94 Main St      | 1915        |
| GRE.398         | Sears Building                                 | 102 Main St     | 1929        |
| GRE.397         | Abrahamson Furniture and Appliance Building    | 122 Main St     | 1918        |
| GRE.94          |  | 130 Main St     | 1913        |
| GRE.95          | Holy Trinity Roman Catholic Church             | 133 Main St     | 1871        |
| GRE.426         | Holy Trinity Roman Catholic Church Rectory     | 133 Main St     | 1901        |
| GRE.96          |  | 138 Main St     | 1916        |
| GRE.400         | McLellan Women's Clothing Store                | 142 Main St     | 1940        |
| GRE.402         | Penny, J. C. Department Store                  | 144 Main St     | 1940        |
| GRE.97          | Potter, W. N. Grain Store                      | 155 Main St     | 1910        |
| GRE.401         | Cohn, Simon L. Block                           | 156 Main St     | 1928        |
| GRE.408         | Miles, Isaac House                             | 173 Main St     | 1855        |
| GRE.101         | Blake Block                                    | 201 Main St     | 1909        |
| GRE.102         | Kennedy - Maniatty Block                       | 204-206 Main St | 1904        |
| GRE.103         | Ragovin Block                                  | 205-209 Main St | 1924        |
| GRE.104         | Pond - Coughlin Block                          | 217-219 Main St | 1902        |
| GRE.311         | National Shoe Service                          | 221-223 Main St | 1915        |
| GRE.105         | Pillar Building                                | 226-228 Main St | 1845        |
| GRE.110         | Botsford Block                                 | 231 Main St     | 1873        |
| GRE.111         | Union - Taylor Block                           | 232-240 Main St | 1854        |
| GRE.112         | Sullivan Building                              | 233 Main St     | 1873        |
| GRE.268         | Borofsky Block                                 | 239 Main St     | 1947        |
| GRE.113         | American House                                 | 242-258 Main St | 1876        |
| GRE.269         | Greenfield Police Station                      | 253 Main St     | 1936        |
| GRE.115         | Wiley - Cohn Block                             | 269 Main St     | 1845        |
| GRE.116         | Heritage NIS Bank                              | 270 Main St     | 1976        |
| GRE.118         | Pond's Block                                   | 276-294 Main St | 1874        |

| <b>Inv. No.</b> | <b>Property Name</b>                              | <b>Street</b>   | <b>Year</b> |
|-----------------|---|-----------------|-------------|
| GRE.117         | Sheldon Block                                     | 277 Main St     | 1912        |
| GRE.119         | Arms, George A. Block                             | 285-291 Main St | 1876        |
| GRE.120         | Hollister Block                                   | 298-302 Main St | 1874        |
| GRE.121         | Bird - Hovey Block                                | 310 Main St     | 1812        |
| GRE.122         | Franklin County Trust Company Building            | 324 Main St     | 1972        |
| GRE.84          | Franklin Savings Bank                             | 332 Main St     | 1911        |
| GRE.85          | Allen Corner Block                                | 351 Main St     | 1827        |
| GRE.86          | Garden Theater Block                              | 353-367 Main St | 1928        |
| GRE.48          | Greenfield Masonic Block                          | 375 Main St     | 1896        |
| GRE.49          | Lyons - Nims Building                             | 377-379 Main St | 1871        |
| GRE.50          | Unitarian Church Hall                             | 397 Main St     | 1837        |
| GRE.51          | All Souls Unitarian Church                        | 399 Main St     | 1894        |
| GRE.52          | Greenfield Savings and Loan Bank                  | 400 Main St     | 1963        |
| GRE.53          | Leavitt - Hovey House                             | 402 Main St     | 1797        |
| GRE.54          | Second Greenfield Fire Station                    | 412 Main St     | 1936        |
| GRE.55          | Franklin County Court House                       | 425 Main St     | 1931        |
| GRE.56          | U. S. Post Office - Greenfield Main Branch        | 442 Main St     | 1916        |
| GRE.57          | Greenfield YMCA                                   | 451 Main St     | 1949        |
| GRE.58          | Coldbrook Springs Baptist Church                  | 463 Main St     | 1842        |
| GRE.59          | Snow, Newell House - Greenfield Club              | 466 Main St     | 1881        |
| GRE.60          | Elliott, William House                            | 473 Main St     | 1836        |
| GRE.61          | Wright, Aaron H. - Sanderson, John H. House       | 474 Main St     | 1881        |
| GRE.62          | Ripley, Franklin - Root, Rebecca L. House         | 479 Main St     | 1834        |
| GRE.63          | Gould, Elijah Addison - Clapp, Henry Wells House  | 486 Main St     | 1827        |
| GRE.64          | Bird, George - Fessenden, Franklin Goodrich House | 488 Main St     | 1845        |
| GRE.65          | Morgan, Alexander - Allen, Franklin R. House      | 491 Main St     | 1816        |
| GRE.66          | Smith, Martin House                               | 497 Main St     | 1824        |
| GRE.67          | Grinnell, George - Tufts, Nathan House            | 500 Main St     | 1846        |
| GRE.179         | Day, Nina L. House                                | 23 Maple St     | 1900        |
| GRE.15          | Snow, Newell Factory                              | Mead St         | 1879        |
| GRE.5           | Greenfield Tap and Die Plant #1 - Boiler Building | Meridian St     | 1860        |
| GRE.7           | Green River Elementary School                     | Meridian St     | 1949        |
| GRE.352         | Greenfield Tap and Die Plant #1 - Pump House      | Meridian St     | 1860        |
| GRE.353         | Greenfield Tap and Die Plant #1 - Machine Shop    | Meridian St     | 1890        |
| GRE.354         | Greenfield Tap and Die Plant #1 - Hardening Shop  | Meridian St     | 1887        |
| GRE.355         | Greenfield Tap and Die Plant #1 - Machine Shop    | Meridian St     | 1889        |
| GRE.356         | Greenfield Tap and Die Plant #1 - Hardening Shop  | Meridian St     | 1888        |
| GRE.357         | Greenfield Tap and Die Plant #1 - Storehouse      | Meridian St     | 1896        |
| GRE.358         | Greenfield Tap and Die Plant #1 - Meter House     | Meridian St     | 1896        |

| <b>Inv. No.</b> | <b>Property Name</b>                               | <b>Street</b>        | <b>Year</b> |
|-----------------|--|----------------------|-------------|
| GRE.359         | Greenfield Tap and Die Plant #1 - Machine Shop     | Meridian St          | 1891        |
| GRE.360         | Greenfield Tap and Die Plant #1 - Restaurant       | Meridian St          | 1945        |
| GRE.361         | Greenfield Tap and Die Plant #1 - Machine Shop     | Meridian St          | 1887        |
| GRE.362         | Greenfield Tap and Die Plant #1 - Squaring Shop    | Meridian St          | 1912        |
| GRE.363         | Greenfield Tap and Die Plant #1 - Auto Shop        | Meridian St          | 1912        |
| GRE.364         | Greenfield Tap and Die Plant #1 - Machine Shop     | Meridian St          | 1920        |
| GRE.365         | Greenfield Tap and Die Plant #1 - Oil Filter Bldg. | Meridian St          | 1970        |
| GRE.907         | Meridian Marker                                    | Meridian St          | 1870        |
| GRE.921         | Wiley and Russell Bridge                           | Meridian St          | 1917        |
| GRE.934         | Greenfield Tap and Die Plant #1 - Smokestack       | Meridian St          | 1930        |
| GRE.935         | Greenfield Tap and Die Plant #1 - Canal            | Meridian St          |             |
| GRE.936         | Greenfield Tap and Die Plant #1 - Wood Crib Dam    | Meridian St          |             |
| GRE.937         | Greenfield Tap and Die Plant #1 - Flood Walls      | Meridian St          | 1938        |
| GRE.6           |  | 98 Meridian St       | 1860        |
| GRE.107         | Miles Hotel  | 10 Miles St          | 1900        |
| GRE.406         | B&M Railroad - Fitchburgh Line Divisional Offices  | 59 Miles St          | 1914        |
| GRE.923         | Mill Street Bridge over Green River                | Mill St              | 1910        |
| GRE.11          | Greenfield Monumental Works Shop                   | 9 Mill St            | 1911        |
| GRE.372         | Jones, Levi House                                  | 15 Mill St           | 1845        |
| GRE.12          |  | 38 Mill St           | 1900        |
| GRE.388         | Green River Mill Company Worker Housing            | 51 Mill St           | 1838        |
| GRE.914         | Three State Long View Tower                        | Mohawk Trail         | 1952        |
| GRE.10          | Abercrombie Elementary School                      | Montague City Rd     | 1920        |
| GRE.926         | Pierce, Gen. Frederick E. Bridge                   | Montague City Rd     | 1947        |
| GRE.8           | Cheapside District Schoolhouse                     | 21 Montague City Rd  | 1800        |
| GRE.9           |  | 151 Montague City Rd | 1890        |
| GRE.40          | Eager, Noah - Temple, Philo Farm                   | 230 Mountain Rd      | 1815        |
| GRE.1           | Westside Chapel                                    | 59 Munson St         | 1909        |
| GRE.2           | Newton, Alpheus House                              | 176 Munson St        | 1826        |
| GRE.913         | Turner, Capt. William Monument                     | Nash's Mill Rd       | 1905        |
| GRE.931         | Nash's Mills Bridge over Green River               | Nash's Mill Rd       | 1933        |
| GRE.335         |  | 1-3 Newell Ct        | 1909        |
| GRE.82          | Potter, Aaron D. and Sons Garage                   | 13 Newell Ct         | 1896        |
| GRE.261         | McHard Red Salt Box House                          | Newell Pond Pl       | 1750        |
| GRE.902         | Langstroth Memorial                                | Newton Pl            | 1948        |
| GRE.128         | Rugg Manufacturing Company                         | 105 Newton St        | 1855        |
| GRE.203         | Sisters of Saint Joseph Convent                    | North St             | 1929        |
| GRE.405         | Olive Street Garage                                | 11 Olive St          | 1922        |
| GRE.93          | Pierce, E. Lumber Company Planing Mill             | 30 Olive St          | 1860        |

| <b>Inv. No.</b> | <b>Property Name</b>                              | <b>Street</b>   | <b>Year</b> |
|-----------------|---|-----------------|-------------|
| GRE.427         | Mohawk Cadillac Company Repair Shop               | 33 Olive St     | 1922        |
| GRE.47          | Gun House Hill                                    | 30 Orchard St   | 1895        |
| GRE.429         | Phelps, Col. Ansel House                          | 13 Osgood St    |             |
| GRE.342         | McClellan House                                   | 3 Park St       | 1850        |
| GRE.330         |   | 5 Park St       | 1970        |
| GRE.341         | Thayer House                                      | 7-9 Park St     | 1870        |
| GRE.340         | Field House                                       | 10 Park St      | 1883        |
| GRE.339         | Sheldon House                                     | 11 Park St      | 1865        |
| GRE.338         | Scotts House                                      | 14 Park St      | 1900        |
| GRE.337         |   | 15 Park St      | 1920        |
| GRE.366         | Nichols, Louise J. House                          | 7 Peirce St     | 1895        |
| GRE.195         | Pierce Street Primary School                      | Pierce St       | 1894        |
| GRE.194         | Second Baptist Church                             | 27 Pierce St    | 1898        |
| GRE.196         | Chauncey Wing and Sons Mailing Machine Factory    | 78 Pierce St    | 1892        |
| GRE.197         | Diamond Electric Soap Company                     | 85 Pierce St    | 1900        |
| GRE.220         | Bass, Nathaniel House                             | 318 Plain Rd    | 1820        |
| GRE.174         | Inkwell House                                     | 61 Pleasant St  | 1850        |
| GRE.184         |   | 12-14 Pond St   | 1900        |
| GRE.185         | Houston, Hayden House                             | 27 Pond St      | 1900        |
| GRE.13          | Field, Charles A. Baby Carriage Manufacturing Co. | Power Sq        | 1860        |
| GRE.14          | Greenfield Electric Light and Power Company       | Power Sq        | 1900        |
| GRE.28          | Thompson, John Webber House                       | 34 Prospect St  | 1840        |
| GRE.207         |   | 21 Riddell St   | 1894        |
| GRE.208         |   | 23 Riddell St   | 1890        |
| GRE.912         | Green River Railroad Bridge                       | River Rd        | 1918        |
| GRE.900         | Poet Seat Tower                                   | Rocky Mountain  | 1912        |
| GRE.928         | Route 2 Eastbound Ramp over I-91 Northbound       | Rt 2            | 1964        |
| GRE.929         | Route 2 Eastbound Ramp over I-91 Southbound       | Rt 2            | 1964        |
| GRE.930         | Route 2 Westbound Ramp over I-91 Northbound       | Rt 2            | 1964        |
| GRE.933         | Cheapside Bridge                                  | Rt 5            | 1931        |
| GRE.39          |   | Russell St      | 1850        |
| GRE.424         |   | 8 Sanderson St  |             |
| GRE.181         | Otterson, James P. S. - Spencer, Archer J. House  | 10 Sanderson St | 1890        |
| GRE.423         |   | 14 Sanderson St |             |
| GRE.182         | Greenfield Tap and Die Factory #2                 | 34 Sanderson St | 1889        |
| GRE.177         | Richardson, John B. House                         | 25-27 School St | 1840        |
| GRE.114         | New England Telephone and Telegraph Company Bldg  | 53 School St    | 1912        |
| GRE.176         | Brown, Frank H. House                             | 162 School St   | 1898        |
| GRE.248         | Greenfield District #7 Schoolhouse                | Severance St    | 1873        |

| <b>Inv. No.</b> | <b>Property Name</b>                              | <b>Street</b>        | <b>Year</b> |
|-----------------|---|----------------------|-------------|
| GRE.909         | Commemorative Watering Trough                     | Shattuck Park        | 1903        |
| GRE.132         | Newton Street School                              | Shelburne Rd         | 1915        |
| GRE.129         | Potter, J. Warren House                           | 107 Shelburne Rd     | 1800        |
| GRE.390         | Edgemere Inn, The                                 | 140 Shelburne Rd     | 1920        |
| GRE.389         | Turnbull's Green Mountain Ice Cream Company       | 184 Shelburne Rd     | 1926        |
| GRE.133         | Falcon Knight Motors Showroom and Service Station | 189 Shelburne Rd     | 1927        |
| GRE.809         | High Street Cemetery                              | 11 Silver St         | 1768        |
| GRE.387         | Newton, Samuel House                              | 287 Silver St        | 1812        |
| GRE.142         | North Meeting House District School               | 384 Silver St        | 1839        |
| GRE.143         | Graves, John J. House                             | 399 Silver St        | 1824        |
| GRE.130         | Arms, Ebenezer Farm                               | 54 Thayer Rd         | 1800        |
| GRE.213         |   | Turners Falls Rd     | 1880        |
| GRE.263         | Snow, Barnabus House                              | Upper Bernardston Rd | 1795        |
| GRE.20          | Green River Primary School                        | Washington St        | 1857        |
| GRE.19          |   | 57 Washington St     | 1840        |
| GRE.98          | Millers Falls Tool Company                        | Wells St             | 1892        |
| GRE.144         | Hunt, Wilfred E. Feeds Store                      | 121 1/2 Wells St     | 1922        |
| GRE.146         | Pray, Frank G. House                              | 143 Wells St         | 1880        |
| GRE.147         | Pray, Robert E. House                             | 149 Wells St         | 1900        |
| GRE.148         | Pray, Frank G. House                              | 153 Wells St         | 1900        |
| GRE.393         | Knight, Theodore R. House                         | 189 Wells St         | 1870        |
| GRE.149         |   | 238 Wells St         | 1905        |
| GRE.150         | Bickford Machine Company                          | 309 Wells St         | 1908        |
| GRE.125         | Woffenden, Judson House                           | 61 West Fort Sq      | 1915        |
| GRE.4           | Green River Cemetery Mortuary Chapel              | Wisdom Way           | 1921        |
| GRE.803         | Our Lady of Sorrows Cemetery                      | Wisdom Way           | 1923        |
| GRE.906         | Russell Family Memorial Tombstone                 | Wisdom Way           | 1926        |
| GRE.806         | Green River Cemetery                              | 56 Wisdom Way        | 1851        |
| GRE.904         | Franklin County Fairground Gates                  | 85 Wisdom Way        | 1917        |
| GRE.3           | Franklin County Fairgrounds Roundhouse Barn       | 89 Wisdom Way        | 1899        |
| GRE.805         | Catholic Cemetery, Old                            | 171 Wisdom Way       | 1804        |
| GRE.804         | Calvary Catholic Cemetery                         | 202 Wisdom Way       | 1877        |
| GRE.131         | Woodard, H. G. House                              | Woodard St           | 1835        |
| GRE.192         |   | 7 Woodleigh St       | 1900        |
| GRE.193         |   | 11 Woodleigh St      | 1900        |

## Appendix C: In the News

### Tropical Storm Irene

<http://greenfieldrecorder.ma.newsmemory.com/eebrowser/frame/check.6...>

#### Covered bridge left stranded

From August 30, 2011

#### Irene severs water supply pipe, disables treatment plant

By CHRIS CURTIS

##### Recorder Staff

GREENFIELD — Green River flooding Sunday knocked out part of the town's water supply, left one of the state's few covered bridges hanging precariously over the swollen river and disabled the town's wastewater treatment plant, perhaps for weeks.

Superintendent of Public Works Sandra Shields stressed that the quality of the town's drinking water has not been affected.

Water is being supplied exclusively by the town's wells and is fully filtered, treated and drinkable, Shields said Monday.

Usually, the town draws water from the Green River near Eunice Williams Drive, from the Leyden Glen Reservoir in Leyden and from the town well field off Log Plain Road.

The town uses the Green River supply only during the peak usage months from May to November, and the river supplies only about 20 percent of the town's water during that period.

A concrete retaining wall by the Leyden Glen dam on the Green River above the Eunice Williams covered bridge was knocked over and swept aside by flood waters.

The water released from behind the wall washed away about 100 feet of the Leyden Road side of Eunice Williams Drive, exposing and breaking the pipe that drew water from the river and leaving the covered bridge sitting useless in the rushing water.

Shields said the wells can easily supply the amount of water currently being used, especially with groundwater high as it is now, and she does not foresee usage restrictions this year.

It was unclear Monday how damaged the bridge was, although it appeared to be intact.

At the sewage treatment plant at the south end of Deerfield Street near the confluence of the Green and Deerfield rivers, water, muck and debris filled the two basement floors of the plant and destroyed the motors powering the pumps in the outlying pump station.

Three workers remained at the plant Sunday to try to keep the facility operational as the water rose, but had to be rescued by boat around 3 p.m., Shields said.

The three are fine and were back at work Monday beginning to clean up the plant, she said.

Monday afternoon, treatment plant buildings still sat in a pond of brown water.

Shields said it may take as long as eight weeks for the plant to become fully operational again, and full restoration will take months.

In the meantime, the 2.5 million to 3 million gallons daily of sewage produced by the town will spill out of a manhole on the grounds and flow into the Green River untreated.

From the Green River, pollutants will flow quickly into the Deerfield River and then the Connecticut.

Shields warned that people should not use the lower end of the Green or Deerfield rivers or the Connecticut River for swimming, fishing or other recreation.

"It is a health hazard, I cannot sugarcoat it," Shields said, but she **See GREENFIELD Page C2**

The Greenfield Covered Bridge sits askew on its abutment after flood waters breached the retaining wall next to the dam, carving a new channel for the river through what was road and severing one source of the town's water supply, which is the pipe in the foreground.



Recorder/Paul Franz

---

#### ■ Greenfield: Public utility repairs estimated at \$6M

##### From Page C1

repeated that the town drinking water is not affected as the town wells are safely upstream.

Shields estimated the cost of repairs to the sewage plant at about \$1 million, and repairs to the Green River water supply system at \$5 million.

##### Leyden Glen

The Leyden reservoir was not damaged, but the Green River dam may take a year to 18 months to repair, she said.

The remains of the dam and covered bridge drew a steady stream of onlookers to the Green River Monday afternoon.

Spectators gathered on both banks of the suddenly widened river to reminisce and snap pictures of the wreckage of the dam wall and the timber bridge, jutting precariously into the rushing water.

A 1972 reproduction of the historic original burned by vandals, the bridge has been closed to vehicular traffic since 2002, and the extent of the latest damage was not immediately clear.

All Greenfield roads and bridges with the exception of Eunice Williams were open by late Monday afternoon.

The emergency shelter at Greenfield Middle School saw about 100 displaced residents.

##### Davenport deluge

C.D. Davenport Trucking in Greenfield also took water damage from the Green River. Christopher Davenport, maintenance supervisor and co-owner, said damage to its Colrain Street headquarters is about double what it was last time it flooded about five years ago, Davenport said.

This time, however, the heavy equipment was transported to the Greenfield Community College campus in anticipation of Irene's arrival, said Davenport.

That equipment was dispatched throughout the county to assist in cleanup and repair efforts, Davenport said.

The biggest problems facing the 25-person cleanup crew is mud and silt that has gotten into everything.

The interiors of all the offices and shops have been stripped to remove the water and mud-damaged sections, and an electrician is working on the wiring for the building to repair the damage of the flood.

All of the computers were damaged and anything in the yard floated and moved when the waters rushed in, leaving items strewn about the yard, making maneuvering around them difficult when the waters receded.

Phone lines are also down, Davenport said, but the company is still up and running, he said, albeit "on a shoestring."

Davenport said that the building inspector has been on site to examine the offices. Davenport said it will probably be about 60 days until all of the cleanup and restoration work is done.

You can reach Chris Curtis at: [ccurtis@recorder.com](mailto:ccurtis@recorder.com) or 413-772-0261, ext. 257

## **I-91 southbound traffic still diverted through Greenfield**

From August 31, 2011

GREENFIELD — Traffic diverted from the southbound lanes of Interstate 91 was still causing headaches for Greenfield Tuesday and will probably continue to do so today.

Because of concern about the integrity of the bridge that carries I-91 south over the Deerfield River at Stillwater, officials closed the highway between exits 24 and 26 for the second day Tuesday.

"You can't have traffic move from 70 mph speeds to 30 mph through a town without experiencing delays," Greenfield Police Chief David Guilbault said Tuesday. "We've got it flowing so we can minimize a back up, but it is causing inconvenience everywhere. I'm encouraging local people to not go (to the rotary), but if they do to expect delays."

Traffic was being diverted at Exit 26, down River Street to Mill Street and connecting to Deerfield Street and Route 5 and 10 to South Deerfield.

After nightmarish traffic conditions Monday, Greenfield police set up more signs warning oncoming traffic on both I-91 south and Route 2 of the frustrating jam. Police also set all traffic lights to flashing yellow along the detour route in an attempt to move the flow of traffic. Police were stationed along the route to direct traffic. There was traffic on Federal Street as some motorists attempted to take advantage of the earlier Exit 27. Guilbault recommended that residents avoid the congested area as much as possible and try to plan alternate routes.

"Try to avoid it as best as you can," said Guilbault.

## Lt. gov., local, state officials view damage to Davenport Trucking

From September 6, 2011

### Say site will be put on FEMA itinerary

By CHRIS CURTIS

#### Recorder Staff

GREENFIELD — Lt. Gov. Timothy Murray and a group of local and state officials visited C.D. Davenport Trucking Thursday and left with the promise that the site would be added to the itinerary of state and FEMA inspectors checking out this part of the state.

Teams from the Federal Emergency Management Agency and the state equivalent are touring the state to determine whether the state and individual counties meet the monetary damage thresholds required for federal aid.

Bob Barry, local coordinator for the Massachusetts Emergency Management Agency, said that the two agencies were to conduct preliminary assessments Thursday and today to come up with a ballpark figure for damage.

Barry said the statewide threshold to qualify for federal intervention is \$8.2 million, and counties must meet individual thresholds.

After viewing the damage, Barry told company co-owner Clayton Davenport that the Colrain Street trucking yard would be added to the site-visit itinerary.

The trucking and construction company took a serious hit in Sunday's storm when the Green River, which normally winds its way peacefully past the property, overflowed its banks and flooded the property under 6 to 7 feet of rushing water.

Four days after the storm evidence of the flooding remained everywhere.

Drywall and insulation soaked by flood waters was ripped out of offices, a battered yellow bus and a shipping trailer hauled out of the water stood on the bank of the still swollen river.

Tables set up in the parking lot outside buildings held stacks of papers and office supplies laid out to dry, creating a flea market look to the yard.

All but one of 11 garage bay doors had been torn down or caved in by the water, and Davenport said much of the tools and equipment used every day had been destroyed.

Davenport showed Murray's group around the property, pointing out the damage.

This wasn't the first time the river had flooded and done damage to the property: Davenport showed Murray an office windowsill marked with the water level from a flood in 2005 and, about 2 feet higher, Sunday's.

"When it happened in '05 it was something that we had never seen before and thought we would never see again in our lifetime," Davenport said. Damage this time around was worse, Davenport said.

Both the company's administrative offices were flooded, damaging computers, all the company's paper files and the building interiors.

Drywall, insulation and wiring would have to be replaced "It's just incredible what water can do," Davenport said. "At this point, we're just trying to get back up and running so we can keep our guys at work."

Parked in the Greenfield Community College parking lot in anticipation of the storm, most of Davenport's work vehicles fared better than the old school bus and were back to work.

Crews were already off doing emergency work in Colrain, Charlemont and other towns hit especially hard by the storm.

Workers were still sorting through equipment and trying to clean up and repair buildings.

Murray said the purpose of his tour of damaged areas was to make sure people know about the process and what the state was doing in terms of restoring infrastructure and utilities, and to encourage affected towns, businesses and individuals to be as diligent as possible in recording damage and cleanup costs, cases that can be used by FEMA to determine if it will help.

Murray's group included local politicians like Franklin County Sheriff Christopher Donelan, former state Rep. John Merrigan, now register of probate, and Northwestern District Attorney David Sullivan.



**C.D. Davenport co-owner Clayton Davenport, right, points out flood damage in the company's office to Lt. Gov. Timothy Murray, including wet drywall and insulation in background that has already been ripped out.**

RecorderChris Curtis

From September 1, 2011

## Millions in damage

Roads, public housing, water treatment, dams, swimming pool all need extensive work

By ANITA PHILLIPS

Recorder Staff

GREENFIELD — It will most likely be weeks before the town knows just how much the damage done by Tropical Storm Irene will cost, but it will definitely be in the millions, according to the mayor.

Mayor William Martin, who received preliminary reports from all of his department heads Wednesday that include initial overtime figures and damage estimates, said considerable damage was done in some areas of Greenfield, including to its sewage treatment plant on Deerfield Street, where the river sent more than 20 feet of water into the sewage treatment building.

"The water we are releasing into the river at this point is disinfected, so anyone downstream doesn't have to worry," said Shields. "The public health piece is covered."

Martin said preliminary damage assessments will be followed by "refined and detailed assessments" and that is when the town will have a better idea of what the damage will cost.

"Our first priority is to get the sewer treatment plant back up and running like it was before the storm," said Martin. "That's where most of the damage happened. There was [See DAMAGE Page A8](#)

---

### ■ Damage

From Page A1

more than 20 feet of water in the building and a lot of equipment was lost or damaged."

Martin, who was away on vacation when the storm hit on Sunday and didn't return until Tuesday, said he kept constant phone contact with town and state officials on Sunday and Monday.

"I took a walk through the sewage treatment plant on (Tuesday) with Sandy (Shields) and EEA Secretary Richard Sullivan," said Martin. "It appears at this time that the town might well be eligible for 75 percent reimbursement from the state when all is said and done."

### Extensive damage

According to Sandra Shields, the town's public works director, the plant was still not fully operational on Wednesday and probably won't be for at least six to eight weeks.

Shields said flood water had receded from the high levels around the Water Pollution Control Plant on Deerfield Street by 7 a.m. on Tuesday, allowing operators to return to the main building to begin restoration of the "extensively damaged facility."

She said the four-story building, which was designed to withstand 100-year flood levels of 140 feet above sea level, was 2 feet above what it was built to withstand on Sunday as the storm hammered Greenfield.

The two lower stories, which contain pumping equipment, were inundated, while the main, or third floor, which contains the process control center, laboratory and offices, was covered with more than 30 inches of water.

Shields said the Massachusetts Emergency Management Agency brought Greenfield a pump with a 6-inch suction line that

removed most of the water from the bottom two floors. Shields said operators immediately began restoration of the most essential features and power has been restored to selected areas of the facility as safety allowed. By noon on Tuesday, a bar screen, which removes rags, large debris and sanitary products, was working and two primary settling tanks were back on line.

"All of this equipment had been completely submerged," said Shields.

Also on Tuesday, chlorine was being applied to flow entering the plant.

#### **Accomplishment**

Shields said that was quite an accomplishment, because the chlorine is a disinfectant that will greatly decrease bacterial levels in the wastewater entering the Green and Deerfield rivers.

"That level of treatment is referred to as 'primary treatment,'" said Shields. "It removes 50 to 60 percent of incoming pollutants. The disinfectant part of treatment is most important to public health, so we're good with that." She said full secondary treatment, which includes a biological treatment to reduce the oxygen demand on the river as it receives treated water, will take up to eight weeks because of the extensive damage to the main building.

"It is absolutely remarkable the progress the operators made in one day," said Shields. "Given the extensive damage we had, I had estimated it would be days before primary treatment could be restored."

Shields said operators worked under some of the worst conditions imaginable to get the plant running again.

"In addition to the water one expects with a flood, there were tremendous quantities of silt," she said. "As the flood water filled the building, oil for gear boxes leaked into the water. As the water was pumped down in the two bottom floors, the oil coated the silt clinging to the walls, floors and equipment. And of course, it is a sewage treatment plant, which brings obvious occupational hazards."

#### **Drinking water**

Shields said the other "big issue" the town faces is the loss of one of its three drinking water supplies. The Green River system at the pumping station at Eunice Williams Drive will probably not be providing water to residents for at least the next 18 to 24 months.

According to Shields, a concrete retaining wall by the dam at the pumping station was knocked over and swept aside by flood waters. The pipe at the wall behind the dam was also compromised, she said.

"My best guess is that it is going to take 18 to 24 months to repair that and it's going to cost between \$5 million and \$6 million," said Shields.

What the public works director wants to stress is that Greenfield will have plenty of drinking water without the Green River supply.

"We still have the Leyden Glen Reservoir and the Millbrook wells," she said.

"Unless we have a severe drought, we'll be fine."

Shields said the Green River supplies only about 20 percent of the town's water and only between May and November, when there is peak usage.

Martin said some of the other issues the town is dealing with in Irene's aftermath is the closing of the Green River Swimming and Recreation Area on Nashs Mill Road.

"There are broken fences and silt on the lawn and sand across the street and erosion along the bike path in that area," said Martin. "We'll need to deal with those things, but it will have to be at a later date. There are more important issues to deal with first."

Martin said the town, along with the electric and gas companies, is also checking all underground water, sewer, gas and utility lines.

#### **Traffic hassle**

"With an earthquake and tropical storm all in one week, we need to make sure everything's OK under the streets of Greenfield," said Martin.

He said one of the biggest inconveniences the town will face over the next few weeks will be traffic on its streets.

Traffic traveling on Interstate 91 has been detoured into Greenfield and Martin said with the paving going on along Main Street today and later on High Street, motorists are going to be frustrated at times. "I guess all I can advise is that residents avoid the hightraffic areas and use shortcuts, if they know them," he said. "We have to make sure the paving gets done before asphalt plants close for the winter, so we're going to stay on schedule."

Martin said paving will take about two days on Main Street and three days on High Street.

He said the other issue the town will eventually have to decide is whether to replace the covered bridge on Eunice Williams Drive.

"It has broken away from one abutment and is just hanging there," said Martin. "I believe some of it has gone into the Green River."

Martin said the bridge is an important landmark in Greenfield and should be replaced by the town. What he doesn't know is how and when. "We'll have to look into all sorts of funding, and it could take five years or more to move on the project," he said. "It's a symbol for us, though."

That bridge has been hit with logs, lightning, fire and now a flood. We don't want this to be the generation when it disappears."

Martin said the town fenced off the area leading to the pumping station, but people breached the fencing.

"They don't understand how dangerous it still is down there," he said. "Now we have unarmed guards at the entrance to the pumping station. We're only thinking about public safety."

Martin said as the week comes to a close, he will have a better idea about how Irene has affected other departments, including police who have been trying to ease the passage of Interstate traffic through Greenfield from Exit 26 to Exit 24 in Deerfield.



Recorder/Paul Franz

## River leaves mess on Deerfield St. in Greenfield

Longtime residents have never seen water so high

From August 30, 2011

By JOHN TILTON

Recorder Staff

GREENFIELD — Mud was the high-watermark on Deerfield Street Monday, in Irene's wake.

In some places, the foul-smelling-sludge reached the far side of the street opposite the swollen Deerfield River and was beginning to crack and cake in the late summer sun, filling the air with dust as traffic diverted from I-91 crawled forward. Lined up along the street, residents were all asking each other the same question: where do we begin the cleanup?

"I just never thought I would see this," said Marjorie Gamage who has lived at 288 Deerfield St. for 60 years. "I don't know where to begin and it is heartbreaking."

Gamage's lawn had disappeared beneath a thick soup of river sludge, and footprints leading from the back door down to the shattered remains of the garden shed recalled Armstrong's footprints on the moon and not a residential backyard. The picket fence on the right side was bowed in by about 6 feet from where it caught a neighbor's Dumpster as it began to float away.

Inside the house, the family room was unrecognizable under 2 inches of mud and water. The only thing disrupting the dark brown surface was a small mound where a floor rug had been.

"It's just a disaster, it really is," said Gamage. However, Gamage considers herself relatively lucky. She and her husband, Bill, were able to move furniture and valuables to a friend's house up on the hill, minimizing the damage to their property.

"It's the worst I've ever seen it," said Bill [See DEERFIELD STREET Page A7](#)

---

### ■ Deerfield Street

From Page A1

Gamage. "Water has come up the yard a few times but never like this. It's just something else."

Two houses down, Nicole Macheski was in shock. She was supposed to move from Easthampton into a first floor apartment at 290 Deerfield St. on Tuesday, but now she doesn't know what to do.

"I just started to cry when I drove by this morning," said Macheski. "I had to drive by the apartment and collect myself before I stopped."

Macheski was moving to Greenfield to begin school at Greenfield Community College and was bringing her 12-year-old son with her. The two were supposed to tour Greenfield Middle School Monday afternoon.

"This just has to happen," said Macheski about the move to Greenfield. "It has to be OK."

Across the street, George Thayer, who has lived at 295 Deerfield St. for 30 years, was sitting on his porch watching the river recede. Thayer spent the night in an emergency shelter at Greenfield Middle School after evacuating Sunday. In his basement the freezer was on its side in a foot of mud after falling over when the water began to rise.

"When you live on the Deerfield you've got to expect it," said Thayer. "This is New England. You've got to roll with the punches."

# Beavers costing town money, says DPW

By ANITA PHILLIPS  
Recorder Staff

GREENFIELD — Beavers have taken up residence for the third year in a row in a brook that runs along Wildwood Avenue and they continue to cause sewer system problems for the town.

At the same time, the Legislature is considering a bill that would give property owners more help in dealing with troublesome beavers.

The beavers have dammed up part of the Cherry Rum Brook, which runs from the rear of the Cherry Rum Plaza on Bernardston Road south to the end of Wildwood near French King Highway, causing a lot of extra water to go into the town's sewer line there, according to the town's public works director.

"It's costing the town money to treat swamp water that doesn't need to be treated," said DPW Director

Sandra Shields. "That's not a good thing, especially at a time when we're looking at all of the ways we can cut costs."

Alan Twarog, the town's assistant engineer, said the beavers keep coming back to that area and the town has had to remove a dam two years in a row and plans to do the same this week.

"Each time, the dams have impacted our sewer line," said Twarog. "Our sewer lines are old and have cracks and some open joints and the water is getting into the line. We're treating water that doesn't need to be treated."

Shields said the excess water increases pump costs at the treatment plant and decreases the plant's efficiency.

Twarog said the town plans to hire a contractor to line the inside of the sewer main at Wildwood, but until then, will have to breach the dam as part of a short-term solution.

The town has also hired a trapper, who has caught four beavers and removed them from the brook to date.

Shields said the dammed water typically backs up into Wildwood residents' yards, but the town has not heard about any serious problems in back yards this year.

"We're not getting phone calls about water in people's yards," she said.

## Change the rules

Rep. Stephen Kulik, D-Worthington, said he has co-sponsored a bill with state Rep. Anne Gobi that would give individuals and towns one more place to go when they are having problems with beavers.

Currently, an individual or town may only go to the local health department or state Department of Public Health for a special permit to deal with beavers that are causing

a public safety or health issue, said Stuart Loosemore, staff director and general counsel for Gobi.

Under the new bill filed by Gobi, a special permit could also be obtained from the state Department of Fisheries and Wildlife.

"This bill does not look to repeal the 1996 referendum that banned trapping," said Loosemore.

That bill banned hunting beaver with leghold traps and effectively stopped private trappers from controlling growing beaver populations.

"The new one would still allow someone to obtain an

emergency permit under the provisions allowed within the laws of the state, but the person could do so through fisheries and wildlife biologists."

Loosemore said the bill was created because Gobi has heard from many constituents over the years who have complained about beavers.

"They've complained about sections of their land being flooded because of beaver dams, state highways being compromised, wells and septic systems being flooded — it's a big problem and many times a public safety or health concern," said Loosemore,

who said under the new bill the state would also begin keeping better records of all permits issued and how many beavers are trapped each year.

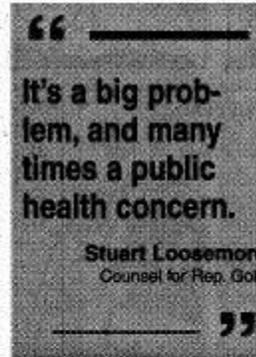
"Then we'd know exactly how big a problem we're talking about," said Loosemore.

The bill allows for a "balanced approach that encourages both regulated non-lethal and lethal management methods."

Beavers are protected under the state's Wetlands Protection Act for their ability to create wetlands. People caught destroying a beaver dam without a permit face up to a \$25,000 fine.

Mass. Wildlife provides technical information and legal avenues that enable landowners and others to deal with beaver-related issues.

For more information on problems with beavers, call Mass. Wildlife at 508-389-6300.



See pages 37-39 for photos and more information on beaver dams in Greenfield.

# THE RECORDER

---

'I was either sinking or the water was rising. I started to panic'

Driver tells harrowing tale of being trapped in mudslide

By **ANITA PHILLIPS**  
Recorder staff

GREENFIELD — As his car sank deeper into the mud and his panic rose with the rushing water, 40-year-old Soeurn Ven had one frightening thought as he sat alone on Meridian Street before dawn Monday morning: "Is this it?"

The brown-eyed, brawny, 5-foot-3-inch-tall Cambodian, who came to the United States 29 years ago, left his home on Laurel Street for work at 5:12 a.m. Just a few minutes later than normal, he followed his usual route from Laurel Street to Deerfield Street by way of Meridian.

"It had rained the day before and there was a lot of water on the roads, so I didn't think anything of it," said Ven. "As I headed down Meridian Street, I noticed a lot of rushing water on my left side. It was dark, so I couldn't really see anything."

# THE RECORDER

## Engineer says it's crucial to minimize water in cemetery

By **ANITA PHILLIPS**  
Recorder staff

July 8, 2011

GREENFIELD — A state geologist says short-term efforts by the Green River Cemetery board to secure the hill that sent about 3,000 cubic yards of mud and debris into neighbors' backyards on Monday are good, but the board will have to find a way to manage the water at the top of the hill to prevent a disaster like that from happening again.

Stephen Mabee, a geologist with the University of Massachusetts at Amherst, said digging a trench behind the houses at the bottom of the hill and cleaning out the drainage system there are good first steps, but are only short-term solutions.

## Appendix D: Town Correspondence, Public Outreach, Sign Ins, Agendas



**Office of the Mayor**  
William F. Martin, Mayor

Email me at: [mayor@greenfield-ma.gov](mailto:mayor@greenfield-ma.gov)

**Town of GREENFIELD, MASSACHUSETTS**  
Town Hall, 14 Court Square, Greenfield, MA 01301

Find us online at [www.greenfield-ma.gov](http://www.greenfield-ma.gov)  
Phone: 413-772-1560 Fax: 413-772-1519

July 7, 2011

Mary Praus  
Franklin Regional Council of Government  
425 Main St  
Greenfield, MA 01301

Re: Beavers

Dear Ms. Praus,

The purpose of the letter to support the efforts being put forth by FRCOG and our legislators regarding control of beavers. Since the relaxation of the trapping laws, beavers have become an increasingly serious problem and expense for our town and our residents. I have supported revision of the trapping laws for many years due to problems outlined below.

1. **WATER SUPPLY:**

Beavers are known carriers of the intestinal parasite *Giardia*. Although our potable water is well treated, water supply professionals have long known that the elimination of beaver populations from reservoirs is simply one more tool to protect public health. Yearly, the DPW must have beavers removed from our Leyden Glen Reservoir and also the Green River where they frequently attempt to plug the water supply intake.

2. **SEWER SYSTEM:**

In swampy areas of town beavers will construct dams which raise the water level to the point it starts to overtop sewer manholes. This is a near annual occurrence in the Cherry Rum Swamp and was the subject of a story on beaver problems run in the *Greenfield Recorder* 7/6/11. This overtopping results in surface water entering the sewer system where it then must be treated at the Water Pollution Control Plant, increasing treatment costs and compromising treatment efficiencies.

3. **RECREATION:**

Greenfield operates a very popular swimming site on the Green River. The feeder brooks upstream of the municipal swimming area are increasingly inhabited with beavers. Beavers are large mammals and consequently generate large quantities of wastes which accumulate behind

---

*The Town Of Greenfield is an Affirmative Action/Equal Opportunity Employer,  
a designated Green Community and a recipient of the "Leading By Example" Award*

their impoundments. During heavy rain events this waste is flushed downstream and results in elevated *E. Coli* levels at the town swimming area which then must be closed by our Board of Health.

**4. HOMEOWNERS:**

We frequently hear complaints from homeowners who are very frustrated by the fact that beavers impound water that starts encroaching their property and homes. This increases the mosquito population and potential for mold and mildew problems in homes. It also lowers property values due to wet yards, etc.

**5. COSTS**

With so many people no longer trapping the cost for beaver removal in terms of both staff time to complete all the necessary steps and paperwork and costs for actual removal has sky rocketed. Currently we are being charged between \$225 - \$250 for a set up fee and then \$120 - \$140 for each beaver removed. I need not tell you this is an expense towns can not afford in these tight financial times.

Thank you for your efforts in helping to resolve this problem which will only increase if changes are not made.

Sincerely,



William Martin  
Mayor

Xc: Rep. Stephen Kulik  
Rep. Anne Gobi  
Nicole Zabko, Dir of Health



*The Town Of Greenfield is an Affirmative Action/Equal Opportunity Employer,  
a designated Green Community and a recipient of the "Leading By Example" Award*

## **Greenfield Local Natural Hazards Mitigation Plan**

*The Greenfield Natural Hazards Mitigation Planning Committee, in partnership with the Franklin Regional Council of Governments (FRCOG), is currently updating a draft Hazard Mitigation Plan for Greenfield. The purpose of this Hazard Mitigation Plan update is to identify natural and other hazards that may impact the community; conduct a risk assessment to identify infrastructure at the highest risk for being damaged by hazards; inventory and assess current Town hazard mitigation policies, programs, and regulations; and identify action steps to prevent damage to property and loss of life.*

*Once the updated Plan is approved by FEMA and adopted by the Town, Greenfield will be eligible for state and federal grant monies to fund pre- and post-disaster mitigation projects.*

*A copy of the draft Local Natural Hazards Mitigation Plan is available at the Greenfield Town Hall and Greenfield Department of Planning and Development and is available online at [\(Insert link here\)](#) Comments are being accepted on the Plan until July 15, 2011.*

**Now available for your comments!**

For more information contact:

Eric Twarog, Director of Planning and Development, (413) 772-1549, [EricT@greenfield-ma.gov](mailto:EricT@greenfield-ma.gov)

Mary Praus, Land Use Planner, FRCOG, (413) 774-1194 X107, [mpraus@frcog.org](mailto:mpraus@frcog.org)

**Stakeholder Letter sent to:**

Greenfield High School  
Greenfield Community College  
Baystate Franklin Medical Center  
Stonely Burnham School  
FirstLight Power in Northfield  
The Towns of Deerfield, Gill, Bernardston and Montague

October 24, 2011

Dear **[Stakeholder Name]**,

The Town of Greenfield has been working with the Franklin Regional Council of Governments (FRCOG) Planning Department to update its Local Multi-Hazard Mitigation Plan, last completed in 2004. A Local Multi-Hazard Mitigation Planning Committee was created for the purpose of updating the plan, and is comprised of the Town of Greenfield Emergency Management Director, Department of Planning Director, Public Health Director, Planning Board Chair, Police Department, Department of Public Works and Historical Commission.

The Committee values and encourages input from members of the community and requests your involvement in the process. As such, a draft of the plan is available at the Town of Greenfield Planning Department. Please feel free to contact Eric Twarog, Director of Planning and Development at [EricT@greenfield-ma.gov](mailto:EricT@greenfield-ma.gov) or (413) 772-1549 to request a copy of the Plan.

We look forward to your review of the Draft Greenfield Local Natural Hazards Mitigation Plan and any feedback that you may have.

Sincerely,

**[Insert Name and Contact]**

Cc: Mary Praus, FRCOG

# FRANKLIN REGIONAL COUNCIL OF GOVERNMENTS

452 Main Street – Greenfield, Massachusetts 01301-3313  
Telephone 413-774-3167 – Fax 413-774-3169 – www.frcog.org  
Executive Director – Linda Dunlaw



## AGENDA

**Town of Greenfield  
Local Natural Hazards Mitigation Planning Committee Meeting  
Greenfield Town Hall  
14 Court Square  
August 18, 2010  
1:00 – 3:00 p.m.**

1. Introductions – Eric Twarog, Dept. of Planning & Development (1:00 p.m.)
2. Overview of the 2010 planning process from MEMA and the changes to the Greenfield Natural Hazards Mitigation Plan – Kimberly Noake MacPhee, FRCOG (1:10 p.m.)
3. General review of and comment on Draft of the Natural Hazards Mitigation Plan – Whit Sanford, FRCOG (1:30 p.m.)
4. Review of Draft of Chapter 3: Hazard Identification & Analysis\* – Whit Sanford, FRCOG (1:45 p.m.)
5. Review of Draft of Chapter 4: Mitigation Strategies – Kimberly Noake MacPhee, FRCOG (2:15 p.m.)
6. Review of Final Draft of Section 5: Plan Adoption and Maintenance – Whit Sanford, FRCOG (2:45 p.m.)
7. Review of Draft Critical Facilities Map – Kimberly Noake MacPhee, FRCOG (as time permits)
8. Next Steps (2:55 p.m.)

---

*\*Materials to be distributed at the meeting.*

# FRANKLIN REGIONAL COUNCIL OF GOVERNMENTS

452 Main Street – Greenfield, Massachusetts 01301-3313  
Telephone 413-774-3167 – Fax 413-774-3169 – [www.frcog.org](http://www.frcog.org)  
Executive Director – Linda Dunlaw



MEMORANDUM: August 13, 2010  
FROM: Whitty Sanford, Assistant Planner  
TO: Natural Hazards Mitigation Plan Committee  
RE: Meeting on August 18, 2010

Please read and be prepared to comment on the enclosed Greenfield Local Natural Hazards Mitigation Plan for our meeting on August 18 at 1:00 PM (see agenda). I sent most of you an electronic version earlier today, so that you would have an opportunity to read it over the weekend.

FRCOG needs you to comment on the whole plan, but also wants your specific input on the revised sections (new text = underlined; deleted text = strike through; highlighted text = needs your specific input and expertise or is text that has yet to be updated by FRCOG staff). If you have any questions as you are reading the Plan, please don't hesitate to call Kimberly or me.

We look forward to meeting with you and to discussing the Greenfield NHM Plan in depth this Wednesday.

Natural Hazard Mitigation Plan Update  
Minutes of the Greenfield Meeting  
August 18, 2010  
Planning & Development Office  
114 Main Street  
Greenfield, MA 01301

Present: Eric Twarog, Greenfield Planning Department; Robert Strahan, Greenfield Emergency Management Director; Nicole Zabko, Greenfield Health Department; Allen Twarog, Greenfield Department of Public Works; Roxann Wedegartner, Greenfield Planning Board; Kimberly MacPhee and Whit Sanford, Franklin Regional Council of Governments Planning Department

Eric Twarog opened the meeting with a round of introductions and an offer of providing feedback on the updated plan as it progresses because of his experience in developing hazard mitigation plans in New Hampshire.

Kimberly MacPhee presented an overview of the planning process to update the Greenfield Natural Hazard Mitigation Plan (NHMP). She described the changes that the Massachusetts Emergency Management Agency (MEMA) is proposing for the update and approaches FRCOG will use to improve and add new detail and information in Greenfield's plan. She asked the Advisory Committee to provide feedback on the Draft Plan as it is revised, especially on the Risk Assessment and Vulnerability Assessment section, and mapping of manmade and technological hazards in town.

Kimberly asked Committee members for suggestions of other organizations and business that should serve on the NHMP Advisory Committee. Three institutions were suggested the Greenfield Historical Commission (Marcia Starkey), Franklin Medical Center (Joe Zukowski), and Pan Am Railroad. Eric was appointed to follow-up with invitations.

The group discussed the need to hold a Public Meeting later in the fall to solicit input about the Draft Plan and Kimberly reminded the Committee that the Plan may not be adopted by the Town before it has been approved by MEMA.

Whitty Sanford led a general review and discussion on Greenfield's Draft NHM Plan. The Committee asked that wind storms and micro-bursts be added to the list of natural hazards. Members noted that these pose more problems for Greenfield than tornadoes and hurricanes because of their frequency and more widespread character.

### **Chapter 3: Hazard Identification & Analysis and Chapter 4: Mitigation Strategies Review**

Kimberly presented the Risk Assessment Evaluation to the Committee and asked them to complete the interactive table for her. See attached table in which the Committee rated each hazard on four criteria: Frequency of Occurrence, Severity of Occurrence, Area of Occurrence, and Preparedness.

The matrix precipitated a discussion about the May 26, 2010 wind storm that wrought considerable damage on Greenfield and other communities in Franklin County. Trees were down everywhere, power was lost for many hours, and debris was scattered widely.

The Committee identified thunder, wind, snow and ice storms as particularly problematic and the biggest risk to residents (the Risk Assessment Evaluation identified it with the highest Weighted Hazard Index at 6.8). Power issues can affect town services. More important, the group pointed out three areas for needed improvement in addressing storms: 1) Install a reverse 911 system; 2) Purchase equipment to remove fallen trees and debris; 3) Increase debris disposal site options.

The Committee thinks that a regional approach to debris management should be taken. Ideas offered include: Greenfield and other towns in the County could share equipment and identify sites for processing and disposal of the debris left by storms; the town could develop a city-wide and/or participate in the development of a regional debris management plan; the city could complete a hazardous tree assessment in concert with the area's Tree Wardens.

The Committee began developing a "regional wish list" for possible grants from MEMA and FEMA. Among the ideas that came up and which the Committee agreed to explore further with the Town department heads are: generators for the DPW, emergency back up generators for all emergency facilities (Greenfield High School and Middle School), and animal control and shelter during emergencies. The Committee will work with the departments in town to come up with a list of priorities and projects that could be funded.

The group identified the need to report on natural hazard events of consequence such as the May 2010 windstorm and 2005 flood. This information needs to be shared with the public so town residents can learn about the difficulties and support government action and budgeting to deal with natural hazard and pre-disaster mitigation, e.g. replacement of undersized culverts and purchasing equipment to improve debris management.

In discussing flooding the Mill and Meridian Street dams were identified as possible manmade hazards. At least one of the dams in Greenfield is in poor condition; all should be inspected by Greenfield as the Town owns the dams on the Green River. It was suggested that Emergency Action Plans should be tracked down for the big dams on the Connecticut and Deerfield Rivers. Also, FRCOG should check with the Department of Conservation and Recreation about the names and classification of the dams and to determine the inundation area for each dam. (These should include the large dams on the Connecticut and Deerfield River that are upstream of Greenfield as well as those on the smaller water bodies in the Town.) Areas that were affected during the 2005 flood included the Green River Cemetery, Factory Hollow Road along the Fall River and Brook and Shelburne Roads. Shelburne Road and Route 2 near Davenport's can be affected by ice jam flooding.

There was a discussion about putting together a rudimentary list of landslides and other natural hazards that have occurred for the Committee to review. Mudslides are mainly on the Green and Fall Rivers due to erosion and the grade along these streams. Kimberly asked that the Committee gather pictures and help FRCOG create the maps for the Plan.

**Action Items:**

1. Eric Twarog – invite representative from the following institutions to join the Advisory Committee: Greenfield Historical Commission (Marcia Starkey), Franklin Medical Center (Joe Zukowski), and Pan Am Railroad.

**DEPARTMENT OF PLANNING AND DEVELOPMENT**

**TOWN OF GREENFIELD, MASSACHUSETTS**  
**14 Court Square, Greenfield, MA 01301**

**413-772-1548**  
**413-772-1309 (fax)**



**MEETING NOTICE**

Date: August 30, 2011  
Time: 10:00 a.m.  
Location: Department of Planning & Development – 114 Main Street  
RE: Final Meeting of the Greenfield Hazard Mitigation Planning Committee

**AGENDA**

1. Introductions
2. Update on Current Status of Project
3. Review of Final Draft to Complete Missing Data
4. Questions and Answers
5. Adjourn

***In attendance:***

*Eric Twarog, Director of Planning and Development*  
*Alan Twarog, Department of Public Works*

## **Appendix E: Plan Approval and Adoption**

---