TOWN OF BRIDGEWATER HAZARD MITIGATION PLAN
BRIDGEWATER, CONNECTICUT

MARCH 2015

MMI # 3101-14

Prepared for the:

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LIST OF ACRONYMS

AEL	Annualized Earthquake Losses
ARC	American Red Cross
ASFPM	Association of State Floodplain Managers
BCA	Benefit Cost Analysis
BCR	Benefit-Cost Ratio
BFE	Base Flood Elevation
BOCA	Building Officials and Code Administrators
CLA	Candlewood Lake Authority
CLEAR	Center for Land Use Education and Research (University of Connecticut)
CM	Centimeter
CRS	Community Rating System
DEEP	Department of Energy & Environmental Protection
DEMHS	Department of Emergency Management and Homeland Security
DFA	Dam Failure Analysis
DMA	Disaster Mitigation Act
DOT	Department of Transportation
DPW	Department of Public Works
EAP	Emergency Action Plan
ECC	Emergency Communications Center
EOC	Emergency Operations Center
EOP	Emergency Operations Plan
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
GIS	Geographic Information System
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HURDAT	Hurricane Database (NOAA's)
HURISK	Hurricane Center Risk Analysis Program
HVCEO	Housatonic Valley Council of Elected Officials
ICC	International Code Council
IPCC	Intergovernmental Panel on Climate Change
ISO	Insurance Services Office, Inc.
KM	Kilometer
KT	Knot
LID	Low Impact Development
LOMC	Letter of Map Change
MM	Millimeter
MMI	Milone & MacBroom, Inc.
MPH	Miles per Hour
NAI	No Adverse Impact
NCDC	National Climatic Data Center
NESIS	Northeast Snowfall Impact Scale

LIST OF ACRONYMS (Continued)

NFIA	National Flood Insurance Act
NFIP	National Flood Insurance Program
NFIRA	National Flood Insurance Reform Act
NOAA	The National Oceanic and Atmospheric Administration
OPM	Office of Policy and Management
POCD	Plan of Conservation and Development
PDM	Pre-Disaster Mitigation
RFC	Repetitive Flood Claims
RLP	Repetitive Loss Property
SFHA	Special Flood Hazard Area
SLOSH	Sea, Lake and Overland Surges from Hurricanes
SRL	Severe Repetitive Loss
SSURGO	Soil Survey Geographic
STAPLEE	Social, Technical, Administrative, Political, Legal, Economic, and Environmental
TAHD	Torrington Area Health District
TNC	The Nature Conservancy
USACE	The United States Army Corps of Engineers
USD	United States Dollars
USDA	United States Department of Agriculture
USGS	United States Geological Survey

EXECUTIVE SUMMARY

The Town of Bridgewater has developed the subject hazard mitigation plan along with nine other communities in western Connecticut through a grant to the Housatonic Valley Council of Elected Officials (HVCEO[1]). Although each of the ten communities developed or updated a single-jurisdiction plan, certain components of the planning process were shared throughout the ten-town regional planning area.

Bridgewater is a rural community of 1,727 (2010 US Census) that is located on the east bank of Lake Lillinonah (an impounded section of the Housatonic River). The town is bisected from south to north by Connecticut Route 133 (Main Street) and residential neighborhoods are located throughout the town. Bridgewater occupies an area of ridges nestled between the Housatonic River and Lake Lillinonah to the west and the Shepaug River to the east.

Like other communities in Connecticut, Bridgewater has been impacted by recent disasters such as the winter storms of January 2011, Tropical Storm Irene of August 2011, Winter Storm Alfred of October 2011, Hurricane Sandy of 2012, and Winter Storm Nemo in 2013:

- The snow storms of January 2011 spurred the town to remove snow from many roofs, and several barns collapsed. The public assistance reimbursement was $21,279.
- Flooding from Tropical Storm Irene was moderate in populated areas, but the storm brought down many trees and power outages in the town lasted up to five days.
- Winter Storm Alfred caused more than a week without power, and significant quantities of tree and tree limb debris were generated.
- Hurricane Sandy caused minor damage and power outages that lasted three days. The total public assistance reimbursement was $24,707.
- The public reimbursement for Winter Storm Nemo in 2013 was $10,468, with much of that total related to snow removal.

Bridgewater experienced a more localized event in May 2011 that rivaled the damage caused by some of the statewide disasters. Straight-line winds blew through the town and caused a power outage of three to four days. This same type of event occurred again on May 27, 2014, causing many downed trees and loss of power for many residents.

Development is minimal in Bridgewater compared to other communities in Connecticut. From the 1980s through the early 2000s, a number of single family homes were constructed in Bridgewater. However, between 2007 and 2008 new construction virtually came to a standstill. Town personnel indicated that a 200 unit affordable housing project was recently proposed however the project was denied by the Town. The Town anticipates that the developer will return with a new proposal for the same piece of land. The Town is also planning to construct a new Police Station that will house the Emergency Operations Center (EOC). Additionally, there are plans for up to eight residential units to be constructed around the Senior Center for seniors.

[1] The planning area included the City of Danbury and the Towns of Bethel, Bridgewater, Bridgewater, Newtown, New Fairfield, New Milford, Redding, Ridgefield, and Sherman. Subsequent to the commencement of the planning process, HVCEO merged with the Southwestern Regional Planning Agency to form an 18-town regional planning organization known as the Western Connecticut Council of Governments.

The primary goal of this hazard mitigation plan is to prevent loss of lives and reduce the damage to property, infrastructure, and important economic resources from natural disasters. Flooding in Bridgewater is reportedly minor; however flooding does periodically occur along Clapboard Oak Brook, Wewaka Brook and Hop Brook. The house and mill adjacent to Route 133 on Wewaka Brook has occasional flooding. Clapboard Oak Brook has had severe eroding and scouring along its bank. In 2011, storms Irene and T.S. Lee caused many road wash outs, primarily along Clapboard Oak Brook at Hemlock Road and also along Wewaka Brook and Hop Brook.

The town's capabilities relative to winter storms are significant. However, several steep and winding roads in Bridgewater are at elevated risk to accidents during winter storms. Bridgewater received heavy snowfall in January 2011 as in many other areas of the Connecticut. Roof shoveling was necessary in town during this time. Two barns collapsed due to heavy snow. Icing is a problem on Route 133 due to lack of exposure to the sun. Five snow-plow trucks are used to cover 36 miles of public roadways in Bridgewater, but the Town does not plow any private roads in town. There are several areas in Town that have repetitive snowdrift accumulation such as Town Line Road, Keeler Road, Curtis Road, Second Hill Road, Northrup Street, Rocky Hill Road and Hut Hill Road.

Bridgewater has identified a number of mitigation strategies to decrease risks from future hazards. The town has also identified methods of increasing emergency service capabilities, such as securing standby power supplies and potentially having a fully functional EOC with better alert warning systems. When the town updates its hazard mitigation plan in five years[2], these mitigation strategies will be reviewed for progress and updated as needed.

A table of hazard mitigation strategies and actions is provided in Appendix A. The record of municipal adoption for this plan is provided in Appendix B. Appendix C contains a worksheet to be used by the town for annually documenting the status of potential mitigation actions. The remaining appendices include documentation of the planning process and other resources.

[2] Updates will be pursued by the town or in connection with the Western Connecticut Council of Governments.

1.0 INTRODUCTION

1.1 Background and Purpose

The goal of emergency management activities is to prevent loss of life and property. The four phases of emergency management include Mitigation, Preparedness, Response and Recovery. Mitigation differs from the remaining three phases in that hazard mitigation is performed with the goal to eliminate or reduce the need to respond. The term *hazard* refers to an extreme natural event that poses a risk to people, infrastructure, or resources. In the context of natural disasters, hazard mitigation is commonly defined as any sustained action that permanently reduces or eliminates long-term risk to people, property, and resources from hazards and their effects.

The primary purpose of a hazard mitigation plan (HMP) is to identify hazards and risks, existing capabilities, and activities that can be undertaken by a community or group of communities to prevent loss of life and reduce property damages associated with the identified hazards. This HMP is prepared specifically to identify hazards in the Town of Bridgewater, Connecticut. The HMP is relevant not only in emergency management situations but also should be used within the Town's land use, environmental, and capital improvement frameworks.

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The Disaster Mitigation Act of 2000 (DMA), commonly known as the 2000 Stafford Act amendments, was approved by Congress and signed into law in October 2000, creating Public Law 106-390. The purposes of the DMA are to establish a national program for pre-disaster mitigation and streamline administration of disaster relief. The DMA requires local communities to have a FEMA-approved mitigation plan in order to be eligible to apply for and receive Hazard Mitigation Assistance (HMA) grants.

The HMA "umbrella" contains several competitive grant programs designed to mitigate the impacts of natural hazards. This HMP was developed to be consistent with the general requirements of the HMA program as well as the specific requirements of the Hazard Mitigation Grant Program (HMGP) for post-disaster mitigation activities, as well as the Pre-Disaster Mitigation (PDM), Flood Mitigation Assistance (FMA) programs. These programs are briefly described below.

<u>Pre-Disaster Mitigation (PDM) Program</u>

The PDM Program was authorized by Part 203 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act), 42 U.S.C. 5133. The PDM program provides funds to states, territories, tribal governments, communities, and universities for hazard mitigation planning and implementation of mitigation projects prior to disasters, providing an opportunity to reduce the nation's disaster losses through PDM planning and the implementation of feasible, effective, and cost-efficient mitigation measures. Funding of pre-disaster plans and projects is meant to reduce overall risks to populations and facilities. PDM funds should be used primarily to support mitigation activities that address natural hazards. In addition to providing a vehicle for funding, the PDM program provides an opportunity to raise risk awareness within communities.

<u>Hazard Mitigation Grant Program (HMGP)</u>

The HMGP is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The HMGP provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. A key purpose of the HMGP is to ensure that any opportunities to take critical mitigation measures to protect life and property from future disasters are not "lost" during the recovery and reconstruction process following a disaster. The "5% Initiative" is a subprogram that provides the opportunity to fund mitigation actions that are consistent with the goals and objectives of the state and local mitigation plans and meet all HMGP requirements but for which it may be difficult to conduct a standard benefit-cost analysis (Section 1.5) to prove cost effectiveness. The grant to prepare the subject plan was funded through HMGP.

<u>Flood Mitigation Assistance (FMA) Program</u>

The FMA program was created as part of the National Flood Insurance Reform Act (NFIRA) of 1994 (42 U.S.C. 4101) with the goal of reducing or eliminating claims under the National Flood Insurance Program (NFIP). FEMA provides FMA funds to assist states and communities with implementing measures that reduce or eliminate the long-term risk of flood damage to buildings, homes, and other structures insurable under the NFIP. The long-term goal of FMA is to reduce or eliminate claims under the NFIP through mitigation activities.

The Biggert-Waters Flood Insurance Reform Act of 2012 eliminated the Repetitive Flood Claims (RFC) and Severe Repetitive Loss (SRL) programs and made the following significant changes to the FMA program:

- The definitions of repetitive loss and severe repetitive loss properties have been modified;
- Cost-share requirements have changed to allow more Federal funds for properties with repetitive flood claims and severe repetitive loss properties; and
- There is no longer a limit on in-kind contributions for the non-Federal cost share.

The NFIP provides the funding for the FMA program. The PDM and FMA programs are subject to the availability of appropriation funding, as well as any program-specific directive or restriction made with respect to such funds.

One potentially important change to the PDM, HMGP, and FMA programs is that "green open space and riparian area benefits can now be included in the project benefit cost ratio (BCR) once the project BCR reaches 0.75 or greater." The inclusion of environmental benefits in the project BCR is limited to acquisition-related activities.

Effective August 15, 2013, acquisitions and elevations will be considered cost-effective if the project costs are less than $276,000 and $175,000, respectively. Structures must be located in Special Flood Hazard Areas (the area of the 1% annual chance flood). The benefit-cost analysis (BCA) will not be required.

Table 1-1 presents potential mitigation project and planning activities allowed under each FEMA grant program described above as outlined in the most recent HMA Unified Guidance document.

Table 1-1
Eligible Mitigation Project Activities by Program

Eligible Activities	HMGP	PDM	FMA
Property Acquisition and Structure Demolition or Relocation	X	X	X
Structure Elevation	X	X	X
Mitigation Reconstruction			X
Dry Floodproofing of Historic Residential Structures	X	X	X
Dry Floodproofing of Non-residential Structures	X	X	X
Minor Localized Flood Reduction Projects	X	X	X
Structural Retrofitting of Existing Buildings	X	X	
Non-structural Retrofitting of Existing Buildings and Facilities	X	X	X
Safe Room Construction	X	X	
Wind Retrofit for One- and Two-Family Residences	X	X	
Infrastructure Retrofit	X	X	X
Soil Stabilization	X	X	X
Wildfire Mitigation	X	X	
Post-Disaster Code Enforcement	X		
Generators	X	X	
5% Initiative Projects	X		
Advance Assistance	X		

Source: Table 3 – HMA Unified Guidance document

Many of the strategies and actions developed in this plan fall within the above list of eligible activities.

1.2 Hazard Mitigation Goals

The primary goal of this HMP is to ***reduce the loss of or damage to life, property, infrastructure, and natural, cultural, and economic resources from natural disasters.*** This includes the reduction of public and private damage costs. Limiting losses of and damage to life and property will also reduce the social, emotional, and economic disruption associated with a natural disaster.

Developing, adopting, and implementing this HMP is expected to:

- ***Increase access to and awareness of funding sources for hazard mitigation projects.*** Certain funding sources, such as the PDM program and the HMGP, may be available if the HMP is in place and approved.

- ***Identify mitigation initiatives to be implemented if and when funding becomes available.*** This HMP will identify a number of mitigation recommendations that can be prioritized and acted upon as funding allows.

- ***Connect hazard mitigation planning to other community planning efforts.*** This HMP can be used to guide Bridgewater's development through interdepartmental and inter-municipal coordination.

- ***Improve the mechanisms for pre- and post-disaster decision making efforts.*** This Plan emphasizes actions that can be taken now to reduce or prevent future disaster damages. If the actions identified in this Plan are implemented, damage from future hazard events can be minimized, thereby easing recovery and reducing the cost of repairs and reconstruction.

- ***Improve the ability to implement post-disaster recovery projects*** through development of a list of mitigation alternatives ready to be implemented.

> ***Local Plan Development Process***
>
> ***Local governments are the primary decision makers for land use, using land use and planning documents to make decisions along with management measures, zoning, and other regulatory tools. Development of a HMP at the community level is vital if the community is to effectively address natural hazards. While communities cannot prevent disasters from occurring, they can lessen the impacts and associated damages from such disasters. Effective planning improves a community's ability to respond to natural disasters and documents local knowledge on the most efficient and effective ways to reduce losses. The benefits of effective planning include reduced social, economic, and emotional disruption; better access to funding sources for natural hazard mitigation projects; and improving the community's ability to implement recovery projects.***

- ***Enhance and preserve natural resource systems.*** Natural resources, such as wetlands and floodplains, provide protection against disasters such as floods. Proper planning and protection of natural resources can provide hazard mitigation at substantially reduced costs.

- ***Educate residents and policy makers about hazard risk and vulnerability.*** Education is an important tool to ensure that people make informed decisions that complement the Town's ability to implement and maintain mitigation strategies.

1.3 Identification of Hazards and Document Overview

As stated in Section 1.1, the term *hazard* refers to an extreme natural event that poses a risk to people, infrastructure, or resources. Based on a review of the 2014 Connecticut Natural Hazard Mitigation Plan and correspondence with local officials, the following have been identified as hazards that can potentially affect the Town of Bridgewater:

- Flooding
- Hurricanes and Tropical Storms
- Summer Storms (including lightning, hail, and heavy winds) and Tornadoes
- Winter Storms
- Earthquakes
- Dam Failure
- Wildfires

The only hazard given attention in the 2014 Connecticut Hazard Mitigation Plan Update but not addressed in the Bridgewater Hazard Mitigation Plan is drought. However, this is the lowest-ranked hazard of those discussed in the state's plan, with a "low" composite risk score for Litchfield County. In addition, the statewide and countywide annual estimated loss (AEL) for this hazard is $0 in the state plan. Thus, its inclusion was considered unnecessary.

This document has been prepared with the understanding that a single *hazard effect* may be caused by multiple *hazard events*. For example, flooding may occur as a result of frequent heavy rains, a hurricane, or a winter storm. Thus, Tables 1-2 and 1-3 provide summaries of the hazard events and hazard effects that impact the Town of Bridgewater and include criteria for characterizing the locations impacted by the hazard, the frequency of occurrence of the hazards, and the magnitude or severity of the hazards.

Notwithstanding their causes, the effects of several hazards are persistent and demand high expenditures from the Town. In order to better identify current vulnerabilities and potential mitigation strategies associated with other hazards, each hazard has been individually discussed in a separate chapter.

This document begins with a general discussion of Bridgewater's community profile, including the physical setting, demographics, development trends, governmental structure, and sheltering capacity. Next, each chapter of this Plan that is dedicated to a particular hazard event is broken down into six or seven different parts. These are *Setting*; *Hazard Assessment*; *Historic Record*; *Existing Capabilities*; *Vulnerabilities and Risk Assessment*; and *Potential Mitigation Strategies, and Actions*, and, for chapters with several recommendations, *a Summary of Strategies.* These are described below.

- ***Setting*** addresses the general areas that are at risk from the hazard and categorizes the overall effect of each hazard.

- ***Hazard Assessment*** describes the specifics of a given hazard, including characteristics and associated effects. Also defined are associated return intervals, probability and risk, and relative magnitude.

- ***Historic Record*** is a discussion of past occurrences of the hazard and associated damages when available.

- ***Existing Capabilities*** gives an overview of the measures that the Town is currently undertaking to mitigate the given hazard. These may take the form of ordinances and codes, structural measures such as dams, or public outreach initiatives.

- ***Vulnerabilities and Risk Assessment*** focuses on the specific areas at risk to the hazard. Specific land uses in the given areas are identified. Critical buildings and infrastructure that would be affected by the hazard are identified.

Table 1-2
Hazard Event Ranking

Natural Hazards	Location 1 = small 2 = medium 3 = large	Frequency of Occurrence 0 = unlikely 1 = possible 2 = likely 3 = highly likely	Magnitude/ Severity 1 = limited 2 = significant 3 = critical 4 = catastrophic	Rank
Winter Storms	3	3	2	8
Hurricanes	3	1	3	7
Summer Storms and Tornadoes	2	3	2	7
Earthquakes	3	1	2	6
Wildfires	1	2	1	4

- Each hazard may have multiple effects; for example, a hurricane causes high winds and flooding.
- Some hazards may have similar effects; for example, hurricanes and earthquakes may cause dam failure.

Location
1 = small: isolated to specific area during one event
2 = medium: multiple areas during one event
3 = large: significant portion of the town during one event

Frequency of Occurrence
0 = unlikely: less than 1% probability in the next 100 years
1 = possible: between 1 and 10% probability in the next year; or at least one chance in next 100 years
2 = likely: between 10 and 100% probability in the next year; or at least one chance in next 10 years
3 = highly likely: near 100% probability in the next year

Magnitude/Severity
1 = limited: injuries and/or illnesses are treatable with first aid; minor "quality of life" loss; shutdown of critical facilities and services for 24 hours or less; property severely damaged < 10%
2 = significant: injuries and/or illnesses do not result in permanent disability; shutdown of several critical facilities for more than one week; property severely damaged <25% and >10%
3 = critical: injuries and/or illnesses result in permanent disability; complete shutdown of critical facilities for at least two weeks; property severely damaged <50% and >25%
4 = catastrophic: multiple deaths; complete shutdown of facilities for 30 days or more; property severely damaged >50%

Table 1-3
Hazard Effect Ranking

Natural Hazard Effects	**Location** 1 = small 2 = medium 3 = large	**Frequency of Occurrence** 0 = unlikely 1 = possible 2 = likely 3 = highly likely	**Magnitude/ Severity** 1 = limited 2 = significant 3 = critical 4 = catastrophic	**Rank**
Nor'Easter Winds	3	3	2	8
Snow	3	3	2	8
Blizzard	3	3	2	8
Hurricane Winds	3	1	3	7
Ice	3	2	2	7
Falling Trees/Branches	2	3	2	7
Thunderstorm and Tornado Winds	2	2	2	6
Flooding from Dam Failure	1	1	4	6
Riverine Flooding	2	3	1	6
Shaking	3	1	2	6
Flooding from Poor Drainage	1	3	1	5
Lightning	1	3	1	5
Hail	1	2	1	4
Fire/Heat	1	2	1	4
Smoke	1	2	1	4

- Some effects may have a common cause; for example, a hurricane causes high winds and flooding.
- Some effects may have similar causes; for example, hurricanes and nor'easters both cause heavy winds.

Location
1 = small: isolated to specific area during one event
2 = medium: multiple areas during one event
3 = large: significant portion of the town during one event

Frequency of Occurrence
0 = unlikely: less than 1% probability in the next 100 years
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2 = significant: injuries and/or illnesses do not result in permanent disability; shutdown of several critical facilities for more than one week; property severely damaged <25% and >10%
3 = critical: injuries and/or illnesses result in permanent disability; complete shutdown of critical facilities for at least two weeks; property severely damaged <50% and >25%
4 = catastrophic: multiple deaths; complete shutdown of facilities for 30 days or more; property severely damaged >50%

- ***Potential Mitigation Strategies and Actions*** identifies mitigation alternatives, including those that may be the least cost effective or inappropriate for Bridgewater.

- ***Summary of Proposed Strategies and Actions*** provides a summary of the recommended courses of action for Bridgewater, which are included in the STAPLEE analysis described below.

This document concludes with a strategy for implementation of the HMP, including a schedule, a program for monitoring and updating the Plan, and a discussion of technical and financial resources.

1.4 Discussion of STAPLEE Ranking Method

To prioritize recommended mitigation measures, it is necessary to determine how effective each measure will be in reducing or preventing damage. A set of criteria commonly used by public administration officials and planners was applied to each proposed strategy. The method, called STAPLEE, is outlined in FEMA planning documents such as *Developing the Mitigation Plan* (FEMA 386-3) and *Using Benefit-Cost Review in Mitigation Planning* (FEMA 386-5). STAPLEE stands for the "Social, Technical, Administrative, Political, Legal, Economic, and Environmental" criteria for making planning decisions.

Benefit-cost review was emphasized in the prioritization process. Criteria were divided into potential benefits (pros) and potential costs (cons) for each mitigation strategy. The following questions were asked about the proposed mitigation strategies:

- **Social**:
  - <u>Benefits</u>: Is the proposed strategy socially acceptable to Bridgewater?
  - <u>Costs</u>: Are there any equity issues involved that would mean that one segment of Bridgewater could be treated unfairly? Will the action disrupt established neighborhoods, break up voting districts, or cause the relocation of lower-income people? Is the action compatible with present and future community values?

- **Technical**:
  - <u>Benefits</u>: Will the proposed strategy work? Will it reduce losses in the long term with minimal secondary impacts?
  - <u>Costs</u>: Is the action technically feasible? Will it create more problems than it will solve? Does it solve the problem or only a symptom?

- **Administrative**:
  - <u>Benefits</u>: Does the project make it easier for the community to administrate future mitigation or emergency response actions?
  - <u>Costs</u>: Does Bridgewater have the capability (staff, technical experts, and/or funding) to implement the action, or can it be readily obtained? Can Bridgewater perform the necessary maintenance? Can the project be accomplished in a timely manner?

- **Political**:
  - <u>Benefits</u>: Is the strategy politically beneficial? Is there public support both to implement and maintain the project? Is there a local champion willing to see the project to

completion? Can the mitigation objectives be accomplished at the lowest cost to the community (grants, etc.)?

- Costs: Have political leaders participated in the planning process? Do project stakeholders support the project enough to ensure success? Have the stakeholders been offered the opportunity to participate in the planning process?

- **Legal**:
  - Benefits: Is there a technical, scientific, or legal basis for the mitigation action? Are the proper laws, ordinances, and resolutions in place to implement the action?
  - Costs: Does Bridgewater have the authority to implement the proposed action? Are there any potential legal consequences? Will the community be liable for the actions or support of actions, or for lack of action? Is the action likely to be challenged by stakeholders who may be negatively affected?

- **Economic**:
  - Benefits: Are there currently sources of funds that can be used to implement the action? What benefits will the action provide? Does the action contribute to community goals, such as capital improvements or economic development?
  - Costs: Does the cost seem reasonable for the size of the problem and the likely benefits? What burden will be placed on the tax base or local economy to implement this action? What proposed actions should be considered but be tabled for implementation until outside sources of funding are available?

- **Environmental**:
  - Benefits: Will this action beneficially affect the environment (land, water, endangered species)?
  - Costs: Will this action comply with local, state, and federal environmental laws and regulations? Is the action consistent with community environmental goals?

Each proposed mitigation strategy presented in this plan was evaluated and quantitatively assigned a "benefit" score and a "cost" score for each of the seven STAPLEE criteria, as outlined below:

- For potential benefits, a score of "1" was assigned if the project will have a beneficial effect for that particular criterion; a score of “0.5” was assigned if there would be a slightly beneficial effect; or a "0" if the project would have a negligible effect or if the questions were not applicable to the strategy.

- For potential costs, a score of "-1" was assigned if the project would have an unfavorable impact for that particular criterion; a score of “-0.5” was assigned if there would be a slightly unfavorable impact; or a "0" if the project would have a negligible impact or if the questions were not applicable to the strategy.

- Technical and Economic criteria were double weighted (multiplied by two) in the final sum of scores.

- The total benefit score and cost score for each mitigation strategy was summed to determine each strategy's final STAPLEE score.

An evaluation matrix with the total scores from each strategy can be found in Appendix A. Strategies are prioritized according to final score in Section 10. The highest scoring is determined to be of more importance economically, socially, environmentally, and politically and, hence, is prioritized over those with lower scoring.

The highest-ranking proposed structural projects were additionally evaluated through qualitative methods. The results of the qualitative assessments are included in Appendix A. See Section 10.3 for details.

1.5 Discussion of Benefit-Cost Ratio

Although a community may implement recommendations as prioritized by the STAPLEE method, an additional consideration is important for those recommendations that may be funded under the FEMA mitigation grant programs. To receive federal funding, the mitigation action must have a benefit-cost ratio (BCR) that exceeds a value of 1.0. Calculation of the BCR is conducted using FEMA's Benefit Cost Analysis (BCA) toolkit. The calculation method may be complex and vary with the mitigation action of interest. Calculations are dependent on detailed information such as property value appraisals, design and construction costs for structural projects, and tabulations of previous damages or NFIP claims.

Although it is beyond the scope of this Plan to develop precise BCRs for each recommendation, the likelihood of receiving funding is estimated for each recommendation as presented in Appendix A. When pursuing grants for selected projects, this information can be used to help select the projects that have the greatest chance of successfully navigating through the application review process.

1.6 Documentation of the Planning Process

The Town is a member of the Housatonic Valley Council of Elected Officials (HVCEO) the regional planning body responsible for Bridgewater and nine other member municipalities: Bethel, Brookfield, Danbury, New Fairfield, New Milford, Newtown, Redding, Ridgefield, and Sherman. Three municipalities in the region (Danbury, New Fairfield, and Sherman) developed HMP's in 2011 and 2012. The remaining seven municipalities, including Bridgewater, participated in multi-jurisdictional planning from 2013 through 2014 to develop single-jurisdiction plans.

Mr. Curtis Read, First Selectman, coordinated the development of this HMP; the adoption of this plan in the Town of Bridgewater will be coordinated by Town personnel.

Milone & MacBroom, Inc. (MMI) prepared the subject Plan. The following individuals provided information, data, studies, reports, and observations and were involved in the development of the Plan:

- Anne Marie Lindblom, Assistant to First Selectman
- Brian Sullivan, Public Works Foreman
- Ron Rotter, Emergency Management Director
- David Hannon, Housatonic Valley Council of Elected Officials (HVCEO)

An extensive data collection, evaluation, and outreach program was undertaken to compile information about existing hazards and mitigation in the town, as well as to identify areas that should be prioritized for hazard mitigation. Appendix D contains copies of meeting minutes, the public information meeting presentation, and other records that document the development of this HMP. The following is a list of meetings that were held as well as other efforts to develop this plan:

- ❑ ***A project kickoff meeting with the First Selectman and Town personnel was held January 15, 2014.*** Necessary documentation was collected, and problem areas within the town were discussed.

- ❑ ***A public information meeting was held on March 11, 2014.*** Preliminary findings were presented and public comments solicited.

  The following individuals attended along with one additional resident who did not sign in:

  - David Hannon, Housatonic Valley Council of Elected Officials (HVCEO)
  - Curtis Read, First Selectman
  - Alan Brown, Selectman
  - Leo Null, Selectman
  - Ann Marie Lindblom, Assistant to the First Selectman
  - Ron Rotter, Emergency Management Director
  - Brian Sullivan, Public Works Foreman
  - AJ Murphy, Assistant Fire Chief
  - Rebecca Devine, Resident

  The following were points of discussion:

  - During a recent house fire, sources of water may not have been close by, contributing to a longer response time. Mr. Sullivan indicated that more proximate sources were present but not available during the fire.

  - A discussion regarding the resizing of culverts took place. Hemlock Road culverts may be undersized and attendees asked if grants could be used to upgrade them. Mr. Murphy indicated that culvert replacements are sometimes eligible for hazard mitigation grants.

  - Clapboard Oak Brook erosion and scour is a concern. Attendees asked if grants could be used for stabilizing stream banks. Mr. Murphy explained that stream bank projects are eligible, but without damage to roads or residents, it may be challenging to demonstrate cost effectiveness.

  - Attendees indicated that the town is “high and dry” for the most part.

  - The resident state trooper building experienced poor drainage but it has been remedied. However, mold is still present in the building.

  - One of the residents asked if mitigation grants could pay for shower or cooking facilities at the Senior Center, which is the shelter. Mr. Murphy explained that standby power could be sought if it is needed to make hot water and allow cooking.

- Attendees asked about what types of tree trimming, utility hardening, or undergrounding activities could be eligible for FEMA funds. Mr. Murphy explained that these projects can be challenging to demonstrate cost effectiveness, but targeting densely populated areas would help. He also noted that it would be less prudent to bury power lines in a location that would lose power by virtue of the transmission from elsewhere getting cut off. Town personal believe that the town center receives power from two directions.

- Residents inquired whether grants could be used to improve Northrup Street before the Route 133 project commences. Northrup Street will likely carry more traffic.

- Attendees asked if mitigation funds could be used to acquire equipment. Mr. Murphy explained that equipment was typically not eligible, but other grants (like Assistance to Firefighters) may be possible. Mr. Hannon asked that other grants be listed in the plan.

- Icing of Second Hill Road is a problem that could be addressed by installing new drainage. Water seeps from the road bank and freezes as it crosses the road. This road has higher traffic counts than anticipated. Mr. Sullivan would install about 200 feet of drainage along the side of the road and then discharge it somewhere. The town will forward a rough cost estimate and Mr. Murphy will use traffic counts from HVCEO to get a rough estimate of the benefit cost ratio.

- ❑ ***The Draft Plan was reviewed by the Town in summer2014.*** Town staff reviewed the Plan, discussed components with appropriate departments and provided detailed comments to improve the Plan.

- ❑ ***The Plan was reviewed by DEMHS in September 2014 and by FEMA in October and November 2014.***

Residents, business owners, and other stakeholders of Bridgewater, neighboring communities, and local and regional entities were invited to the public information meeting via two local newspapers (Danbury News Times and the Voices) and via the home page of the Town's website. Copies of these announcements are included in Appendix D.

Opportunities for the public to review the Plan were implemented in advance of the public hearing to adopt this plan in 2014. The draft Plan that was sent for FEMA review was posted on the Town website (bridgewatertownhall.org) and the HVCEO website (www.hvceo.org) to provide opportunities for public review and comment. In addition, a hard copy was made available in the Town Hall and Bridgewater Library.

1.7 Coordination with Neighboring Communities

Bridgewater has coordinated with neighboring municipalities both within and outside the HVCEO planning area in the past relative to hazard mitigation and emergency preparedness and will continue to do so. The Town of Brookfield and the Town of New Milford are the most suited to work with Bridgewater toward flood hazard mitigation, because the Housatonic River flows through all three communities.

Adjacent communities were given ample opportunity to review and comment on this HMP. For adjacent communities that are part of the HVCEO, the monthly HVCEO meetings provided a forum for towns to collaborate and share thoughts about hazards that may span municipal boundaries. For adjacent communities that are not part of the HVCEO, letters were mailed to these adjacent communities to invite them to participate in the planning process for this hazard mitigation plan. A copy of the letter is included in Appendix D. To date, none of the surrounding communities have responded or accepted the invitation to participate.

2.0 COMMUNITY PROFILE

2.1 Physical Setting

Incorporated in 1856, the Town of Bridgewater is located in southern Litchfield County and is home to a population of 1,727 (2010 U.S. Census). Bridgewater is bordered by the municipalities of New Milford to the north, Roxbury and Southbury to the east, Newtown to the south and Brookfield to the south-southwest. Refer to Figures 2-1 and 2-2 for maps showing the regional location of Bridgewater within the HEVCO region.

The topography of the town is characterized by a generally rolling terrain with high plateaus, steep slopes and river and stream valleys. The Housatonic River, Shepaug River, Clapboard Oak Brook, Wewaka Brook, Hop Brook and numerous other small rivers and streams course through the town. The varying terrain of Bridgewater makes the town vulnerable to an array of natural hazards.

2.2 Existing Land Use

Bridgewater is a rural municipality characterized by low density population and limited rural commercial uses. In general, land use in Bridgewater consists predominantly of residential and open space areas. Commercial uses are limited and are concentrated in the center of the Town. Much of Bridgewater consists of steep slopes, rock outcroppings and wetlands which severely impact development potential.

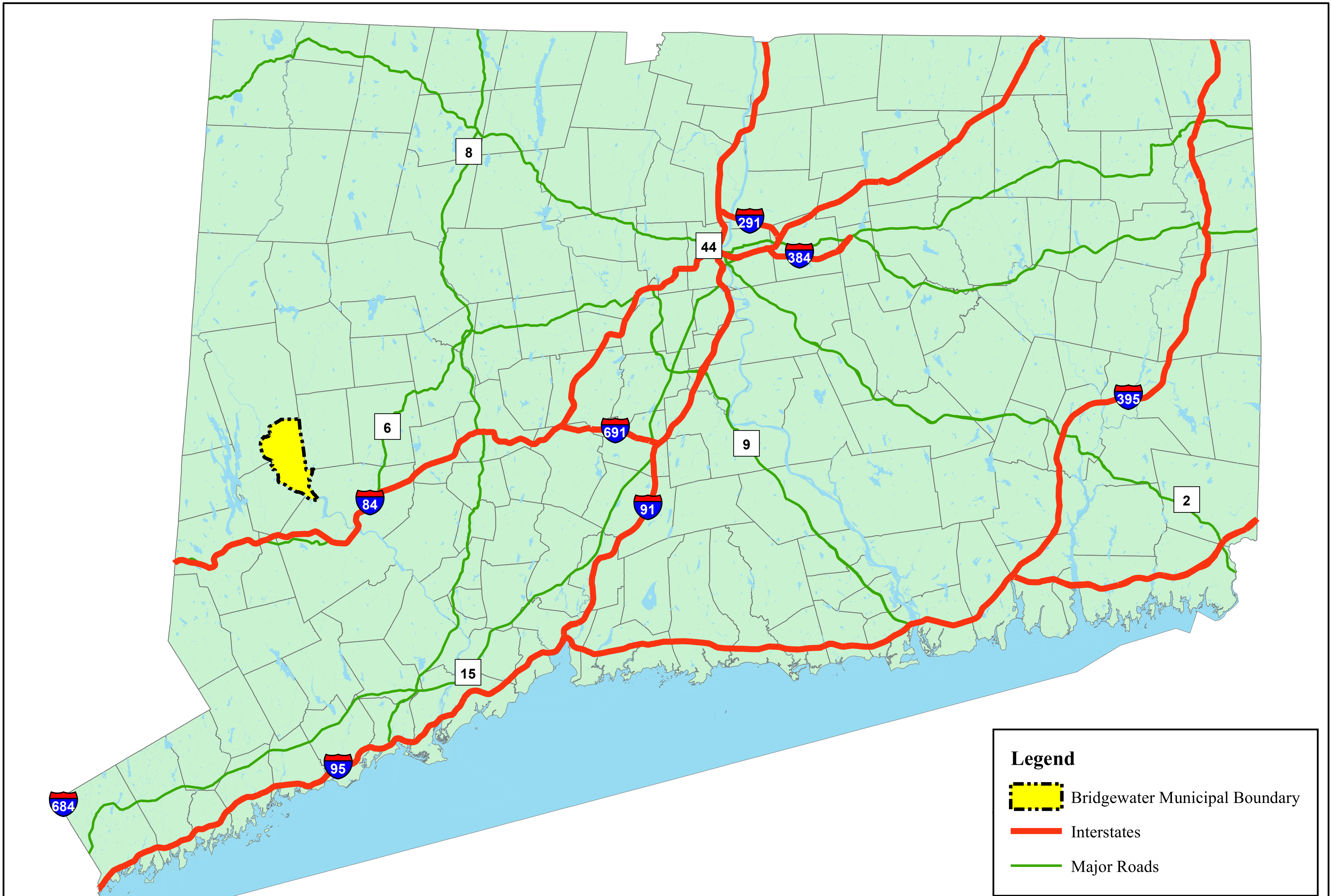
> ***From the 2012 Town of Bridgewater Plan of Conservation and Development (POCD):***
>
> ***"Despite significant growth in commercial and industrial land, for a town of Bridgewater's size, a relatively small percentage of land (632 acres or 6% of the total land area developed) is categorized as a commercial or industrial use."***

According to the 2012 Plan of Conservation and Development (POCD), the Town of Bridgewater consists of approximately 11,109 acres, most of which is dedicated to residential use. An estimate of permitted land uses is shown in Tables 2-1.

Table 2-1
Permitted Land Use

Permitted Land Use	Acres
Commercial/Industrial Zone	65.64 Acres
Town Green Zone	294.77 Acres
RR2 (2 acre zone)	772.40 Acres
RR3 (3 acre zone)	5,978.99 Acres
RR4 (4 acre zone)	3,024.34 Acres
Total Residential Zones	**9,775.73 Acres**

Source: 2012 Bridgewater Plan of Conservation and Development



SOURCE:
CT DEEP

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Figure 2-1: Location Map of Bridgewater

Town of Bridgewater
Hazard Mitigation Plan

LOCATION:
Bridgewater, CT

Map By: CPS
MMI#: 3101-14
MXD: P:\3101-14\Design\GIS\Fairfield County\Bridgewater\Maps\Figure 2-1 L
Date: 01/14/2014
Scale: 1 in = 11 miles

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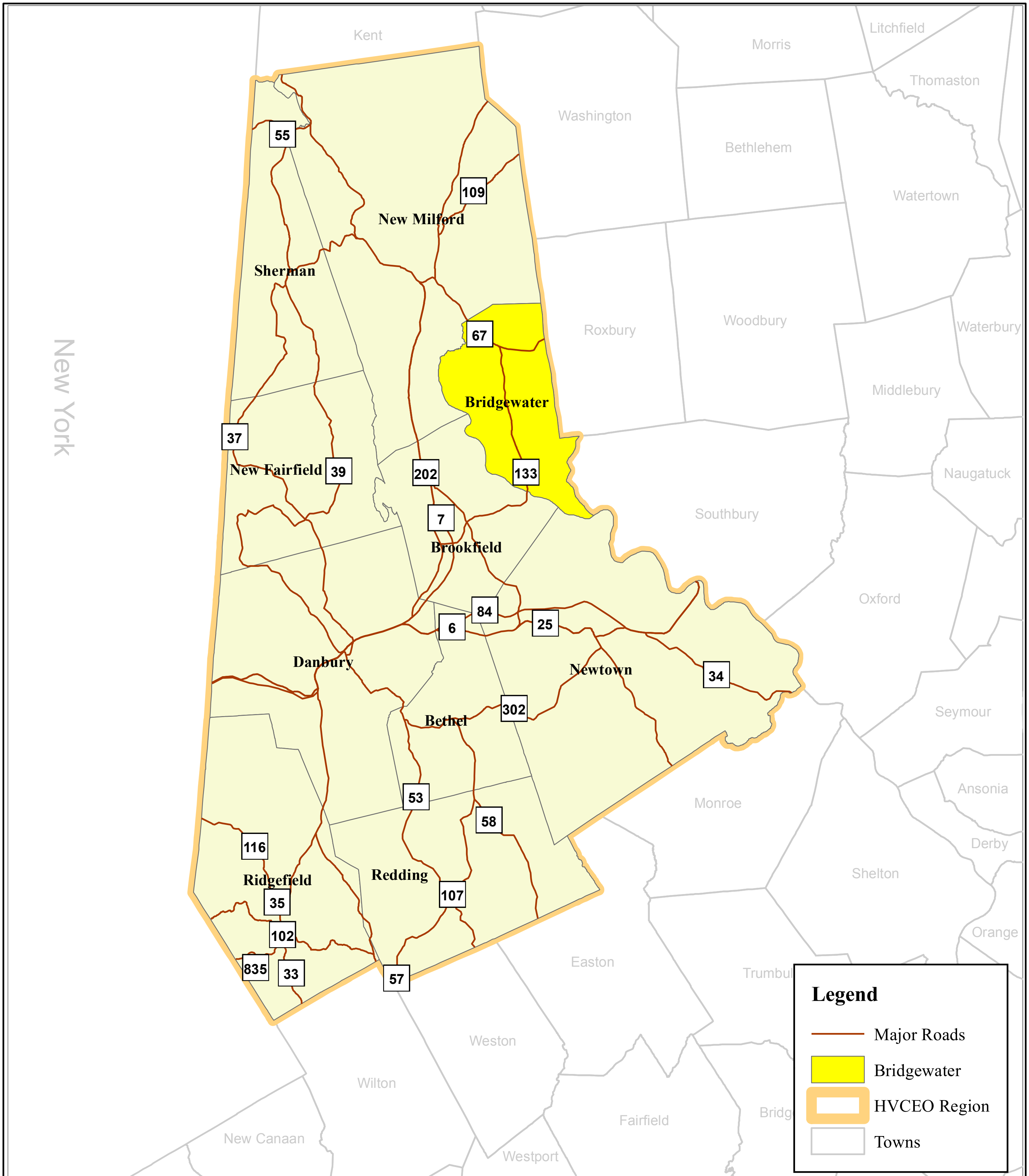

SOURCE(S):
CT DEEP

Figure 2-2: Bridgewater in the Multi Jurisdiction Planning Region

LOCATION:
Bridgewater, CT

N

Town of Bridgewater Hazard Mitigation Plan

MXD: P:\3101-14\Design\GIS\Fairfield County\Bridgewater\Maps\Figure 2-2- Bridgewater COG.mxd

Map By: JDW
MMI#: 3101-14
Original: 3/27/2014
Revision: 3/27/2014
Scale: 1 inch = 4 miles

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According to the POCD, "from the total residentially zoned lands, an estimated 448 acres are unprotected and 4,581 PA490 properties are temporarily protected, for a total of 5,029 acres that are potentially available for development. This land area constitutes approximately one-half of the Town and must be the focus of all future development considerations and preservation efforts."

The POCD also notes that open spaces, which cover over 2,200 acres, are managed by four conservancies: the Bridgewater Land Trust, The Nature Conservancy Sunny Valley Preserve, Weantinoge, and the Audubon Society. According to the town land records, approximately 2,246 acres of open space are owned by exempt organizations as shown in Table 2-2.

Table 2-2
Total Land owned by Exempt Organizations

Organizations	Number of Acres
Audubon Society	83
Bridgewater Land Trust	187
Connecticut Light & Power	265
First Light Hydro Generation	71
Nature Conservancy	1,442
Roxbury Land Trust	2
Weantinogue Heritage	196
Total	**2,246**

Source: 2012 Bridgewater Plan of Conservation and Development

Table 2-3 summarizes 2006 land cover data which was derived from satellite imagery. Areas shown as turf and grass are maintained grasses such as residential and commercial lawns or golf courses. Development is generally spread throughout the community and not particularly concentrated in any one area. According to this data, approximately 64% of Bridgewater is forested and approximately 7.8% is developed.

Table 2-3
2006 Land Cover by Area

Land Cover	Area within Town (acres)	Percent of Community
Deciduous Forest	5,886	53.0%
Developed	865	7.8%
Turf & Grass	401	3.6%
Coniferous Forest	1092	9.8%
Water	639	5.8%
Barren	10	0.1%
Agricultural Field	1987	17.9%
Forested Wetland	102	0.9%
Other Grasses	106	1.0%
Non-forested Wetland	4	0.0%
Utility (Forest)	17	0.2%
Tidal Wetland	0	0.0%
Total	**11,109**	**100%**

Source: UCONN Center for Land Use Education and Research (CLEAR)

2.3 Geology

Geology is important to the occurrence and relative effects of natural hazards such as floods and earthquakes. Thus, it is important to understand the geologic setting and variation of bedrock and surficial formations in Bridgewater. Geologic information discussed in the following section was acquired in Geographic Information System (GIS) format from the United States Geological Survey and the Connecticut DEEP.

Bridgewater is underlain by relatively hard metamorphic and igneous bedrock including a variety of gneiss and schist (Figure 2-3). The bedrock formations trend generally to the north-south. No mapped fault lines underlie Bridgewater.

> ***The amount of stratified glacial meltwater deposits present in a community is important as areas of stratified materials are generally coincident with inland floodplains. These materials were deposited at lower elevations by glacial streams, and these valleys were later inherited by the larger of our present day streams and rivers. Oftentimes these deposits are associated with public water supply aquifers or with wetland areas that provide significant floodplain storage. However, the smaller glacial till watercourses throughout Bridgewater can also cause flooding. The amount of stratified drift also has bearing on the relative intensity of earthquakes.***

Continental ice sheets moved across Connecticut at least twice in the late Pleistocene era. As a result, Bridgewater's surficial geology is characteristic of the depositional environments that occurred during glacial and postglacial periods. Refer to Figure 2-4 for a depiction of surficial geology.

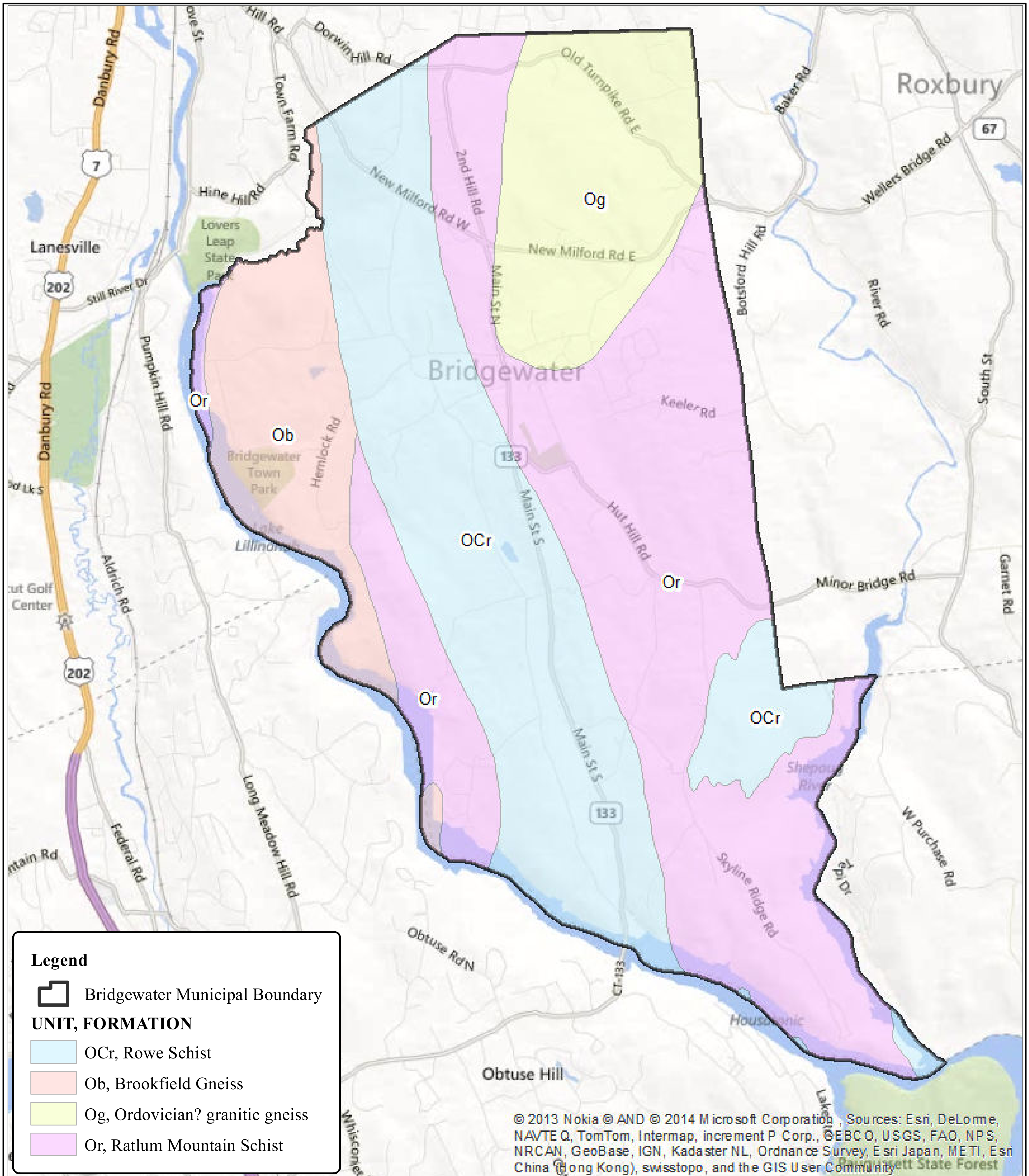
Bridgewater is covered primarily by glacial till. Glacial till contains an unsorted mixture of clay, silt, sand, gravel, and boulders deposited by glaciers as a ground moraine. The deposits are generally less than 50 feet thick although deeper deposits of till are scattered across the hillier sections of the town.

Stratified glacial meltwater deposits are related to the various water bodies in town, particularly the Housatonic and Shepaug Rivers. These deposits primarily contain stratified sands and gravels.

2.4 Current Climate Conditions and Climate Change

> ***The continued increase in precipitation only heightens the need for hazard mitigation planning as the occurrence of floods may change in accordance with the greater precipitation.***

Bridgewater has a climate characterized by moderate but distinct seasons. The mean annual temperature for the region is 52.4 degrees Fahrenheit based on temperature data compiled by the National Climatic Data Center (NCDC), Upper Shepaug Reservoir weather station, from 1981 to 2003. Summer high temperatures typically rise to the mid 80s, and winter temperatures typically dip into the mid-teens as measured in Fahrenheit. Extreme conditions raise summer temperatures to near 100 degrees and winter temperatures to below zero. Average annual snowfall is 44.6 inches per year. Mean annual precipitation from 1981 to 2010 is 43.6 inches.



SOURCE(S):
2013 CT DEEP

Figure 2-3: Bedrock Geology

LOCATION:
Bridgewater, CT

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Town of Bridgewater
Hazard Mitigation Plan

MXD: P:\3101-14\Design\GIS\Fairfield County\Bridgewater\Maps\Figure 2-3 Bridgewater Bedrock Geology.mxd

Map By: CPS
MMI#: 3101-14
Original: 1/14/2014
Revision: 1/14/2014
Scale: 1 inch = 0.82 miles

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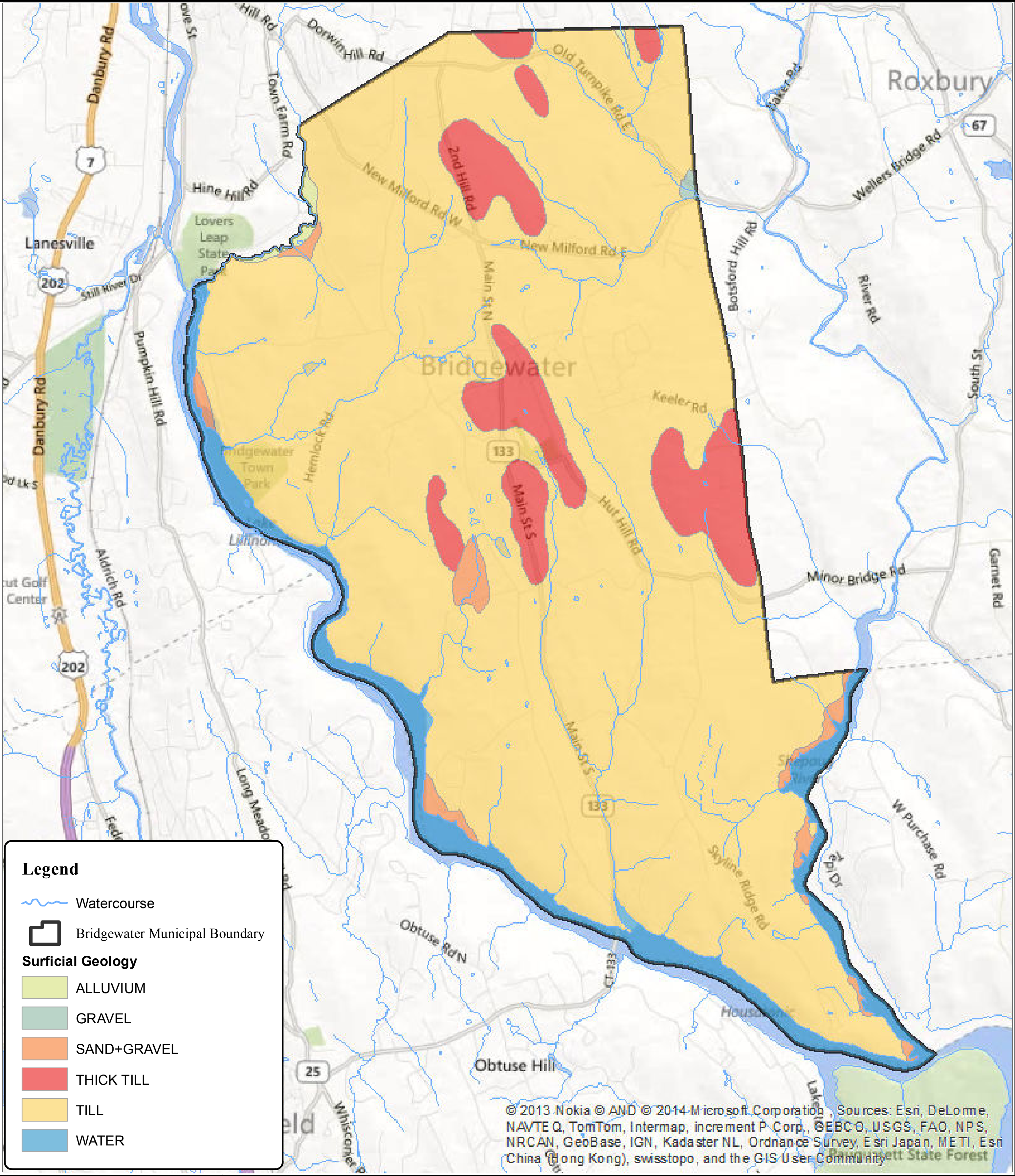

SOURCE(S): 2013 CT DEEP

Figure 2-4: Surficial Geology

LOCATION: Bridgewater, CT

N

Town of Bridgewater
Hazard Mitigation Plan

MXD: P:\3101-14\Design\GIS\Fairfield County\Bridgewater\Maps\Figure 2-4 Bridgewater Surficial Geology.mxd

Map By: CPS
MMI#: 3101-14
Original: 1/14/2014
Revision: 1/14/2014
Scale: 1 inch = 0.82 miles

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By comparison, average annual statewide precipitation based on more than 100 years of record is less at 45 inches. However, average annual precipitation in Connecticut has been increasing by 0.95 inches per decade since the end of the 19^{th} century (Miller et. al., 1997; NCDC, 2005). Likewise, annual precipitation in the town has increased over time.

Like many rural towns, Bridgewater experienced a minor population boom following World War II. This population increase led to minor yet concomitant increases in impervious surfaces and infrastructure. Many new storm drainage systems and culverts were likely designed using rainfall data published in "Technical Paper No. 40" by the U.S. Weather Bureau (now the National Weather Service) (Hershfield, 1961). The rainfall data in this document dates from the years 1938 through 1958. These values are the standard used in the current *Connecticut DOT Drainage Manual* (2000) and have been the engineering standard in Connecticut for many years.

This engineering standard was based on the premise that extreme rainfall series do not change through time such that the older analyses reflect current conditions. Recent regional and state-specific analyses have shown that this is not the case as the frequency of two-inch rainfall events has increased, and storms once considered a one-in-100 year event are now likely to occur twice as often. As such, the Northeast Regional Climate Center (NRCC) has partnered with the Natural Resources Conservation Service (NRCS) to provide a consistent, current regional analysis of rainfall extremes (http://precip.eas.cornell.edu/) for engineering design. The availability of updated data has numerous implications for natural hazard mitigation as will be discussed in Section 3.0.

DOT commenced a “Climate Change and Extreme Weather Pilot Project” in 2013 using a grant from the Federal Highway Administration. The project will include vulnerability assessments of culverts and bridges in Litchfield County that are between six and 20 feet in length, with regard to flooding caused by increasing precipitation and extreme rainfall events. The assessment will evaluate the existing storm event design standards, the recent (ten year) historic actual rainfall intensity and frequency, and evaluate the hydraulic capacity of these structures using the projected increases in rainfall based on best available data and studies. Litchfield County was selected due to the inland flood damages observed in the northwest corner of the state over the last few years. The scope of this project was identified in the Connecticut Climate Change Preparedness Plan which was a product of a statewide effort that took place from 2005 through 2011.

Along with the vulnerability assessment, the project will include a process that assigns a criticality value to the risk of failure. This will assist the Department in prioritizing replacement and reconstruction efforts to these structures where they pose the greatest risk to human health and safety, public and private property loss, and the economic risk of replacement after failure versus proactive replacement. This project will add to the existing framework by providing a model process for assessing the hydraulic capacity of smaller structures in the rural urban fringe and the criticality of those assets in similar geographies.

In addition, The Housatonic River Valley Association has been funded to conduct stream habitat continuity assessments in the Connecticut portion of the Housatonic River Watershed. The purpose of the assessment is to identify road crossings that may be barriers for fish and wildlife, public hazards or impediments to emergency services during flood events as outlined in Appendix D.

2.5 Drainage Basins and Hydrology

Bridgewater is divided in two sub-regional drainage basins: Housatonic River and Shepaug River. The drainage basins are shown on Figure 2-5 and described in detail below. The majority of the drainage basins have FEMA-defined Special Flood Hazard Areas (SFHAs) along the primary watercourses. Such areas consist of 1% annual chance storm floodplains without elevations, 1% annual chance storm floodplains with elevations, and 0.2% annual chance floodplains. Refer to Section 3 for more detail regarding SFHAs.

Housatonic River

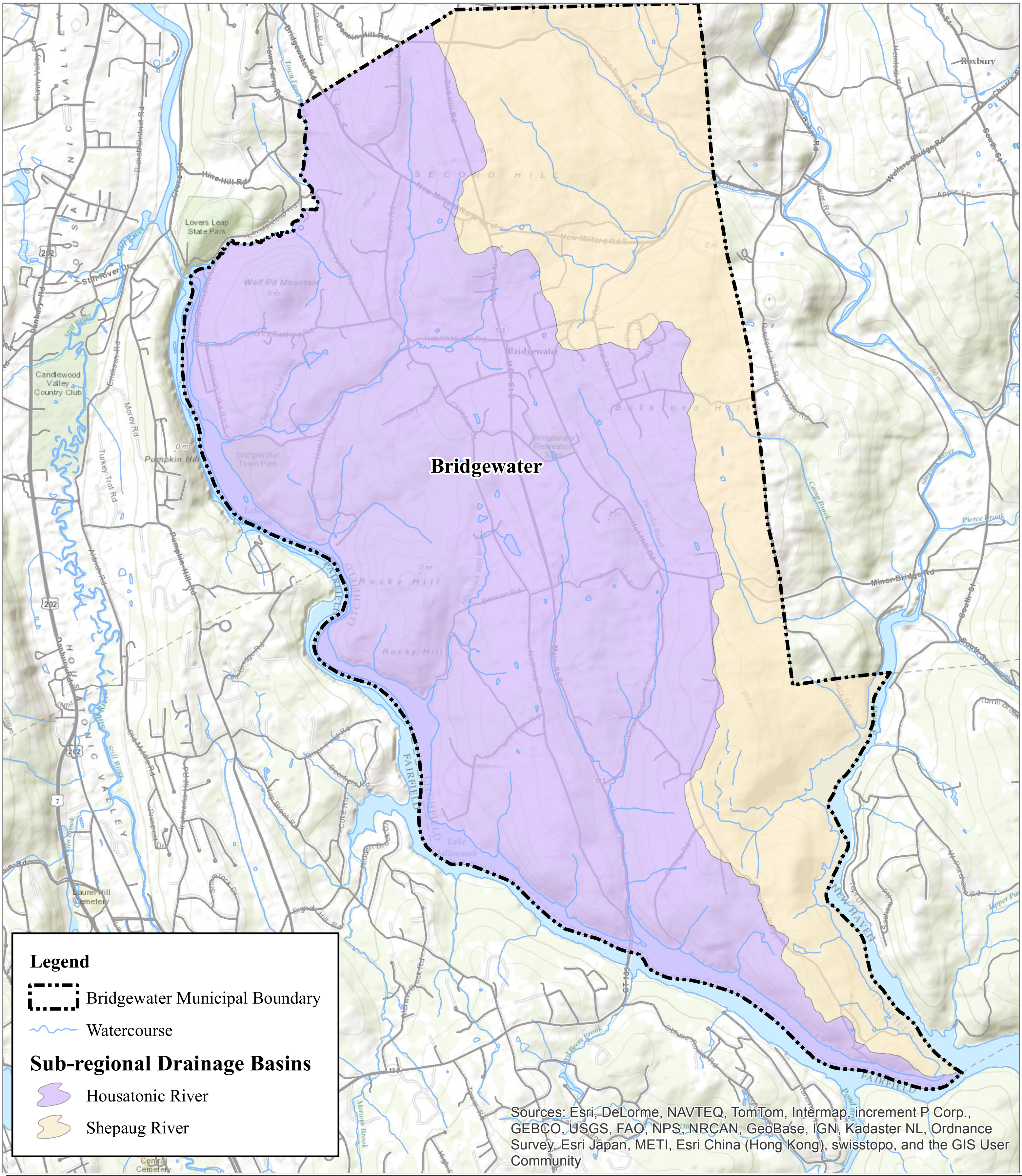
The Housatonic River drains an area of 1,948 square miles from Pittsfield, Massachusetts to Milford, Connecticut where it empties into Long Island Sound. The river flows a total of 134 miles from its upper reach to the sound with 1,234 square mile of the total drainage area existing in Connecticut. After crossing into Connecticut, the river creates the border for several towns as it flows south through the northwestern part of the state. Once into the lower Housatonic Valley region, the river breaks to the southeast flowing through New Milford and cutting between Bridgewater, Bridgewater, Southbury, Newtown and into Long Island Sound. Many of the sub-regional drainages in these towns flow into the Housatonic River along with small tributaries that flow directly into the river, which make up the Housatonic sub-regional drainage basin. The main channel of the Housatonic is lined with 1% annual chance storm floodplains that extend on either side of the river with areas that further extend making up the 0.2% annual chance floodplains.

Shepaug River

Originating at the Shepaug Reservoir, the Shepaug River flows directly south creating the lower eastern boarder of Bridgewater. The Shepaug Reservoir is held back by the Shepaug River Dam which is classified as a high hazard dam. The Shepaug River continues to meander south through Washington and Roxbury with input from many streams and rivers including Bantam River, Bee Brook, Mallory Brook and other tributaries. The River flows through the eastern portion of Bridgewater before entering the Housatonic River. The entire river from start to finish is bordered by 100-year floodplains generally widening as the channel gets closer to the mouth.

2.6 Population and Demographic Setting

According to the 2010 U.S. Census, Bridgewater had a population of 1,727 with 109 persons per square mile. As noted in Table 2-4, Bridgewater has both the least population and the lowest population density in the HVCEO region. The Connecticut State Data Center predicts that population growth in Bridgewater will decrease over the next twelve years. The population in 2025 is projected to be 1,462.



SOURCE(S):
CT DEEP

Figure 2-5: Sub-Regional Drainage Basins

LOCATION:
Bridgewater, CT

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Town of Bridgewater
Hazard Mitigation Plan

MXD: P:\3101-14\Design\GIS\Fairfield County\Bridgewater\Maps\Figure 2-5 Bridgewater Sub-Regional Drainage Basins.mxd

Map By: CPS
MMI#: 3101-14
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Table 2-4
Population Density by Municipality, Region and State, 2010

Municipality	Total Population	Land Area (square miles)	Population Density per Square Mile
Bethel	18,584	16.94	1,094
Bridgewater	1,727	17.36	109
Brookfield	16,452	20.37	819
Danbury	80,893	43.93	1,815
New Fairfield	13,881	25.16	560
New Milford	28,142	63.88	446
Newtown	27,560	58.90	425
Redding	9,158	32.03	276
Ridgefield	24,638	34.86	695
Sherman	3,581	23.39	176
HVCEO Region	224,616	336.82	658
Connecticut	3,574,097	4,844.80	738

Source: United States Census Bureau, 2013

According to the 2012 Plan of Conservation and Development population in Bridgewater has declined 5.3% since the 2000 census and "this recent population decline reflects the recession, decreased in-migration due to limited employment opportunities in surrounding areas and rising costs for land and housing. It also indicates some out-migration as residents moved and the inevitably higher death rate among older residents."

2.7 Governmental Structure

The Town of Bridgewater is governed by a Selectman-Town Meeting form of government in which legislative responsibilities are shared by the Board of Selectmen and the Town Meeting. The First Selectman serves as the chief executive.

In addition to Board of Selectmen and the Town Meeting, there are boards, commissions and committees providing input and direction to Town administrators. Also, Town departments provide municipal services and day-to-day administration. Many of these commissions and departments play a role in hazard mitigation, including the Planning and Zoning Commission, Conservation & Inland Wetland Commission, the Building Official, the Land Use Office, the Fire Department, Emergency Management, and the Public Works Department.

Town officials have indicated that due to limited flooding concerns, there is not really a need to track drainage complaints. However, if a complaint is received it is investigated as necessary until remediation surrounding the individual complaint is concluded.

2.8 Development Trends

The history of Bridgewater is described on the Town website and states that "in 1722 Samuel Clark, an original proprietor of New Milford, had a portion of his land surveyed in the southerly part of that town known as Shepaug Neck. Although this later became known as Bridgewater, it was not incorporated as a separate town until 1856. Among the earliest settlers was Joseph Treat, grandson of Robert Treat, a colonial governor of Connecticut. Others included the four sons of Jeremiah Canfield, Sr. Descendants of these families played a prominent role in the early history of the area. The first school district was established in 1758.

By the latter part of the 18th century, petitions were made to New Milford for a separate ecclesiastical society, a request was granted in 1803. A meetinghouse, the present Congregational Church, was erected in 1807. Most early settlers were Congregationalists, but other faiths were represented as well. Until about 1800 a Baptist church stood on what is now called Christian Street. Episcopal worship began in private homes around 1810, and a church was built in 1836. The present St. Mark's Church was erected in 1859.

Early Bridgewater was divided into several districts, each having its own store, school, mills, and blacksmith and woodworking shops. Sheep were raised and tobacco grown. Dairy farming developed in the 19th century. Hat making flourished 1823 to 1870, when Glover Sanford & Sons had a factory on Hat Shop Hill. For some years Bridgewater was the boyhood home of Captain William D. Burnham, founder of the American Hawaiian Steamship Company. His generous bequests made possible the library and the school on Main Street that bear his name. The town was also the birthplace and place of business of Charles B. Thompson, a leading pioneer in mail-order selling. Bridgewater today is largely residential."

In the 1980s, Bridgewater saw a rise in the number of single family homes constructed. However, around 2007 -2008 new construction virtually came to a standstill. Town personnel indicated that a 200 unit affordable housing project was recently proposed but the project was denied by the Town. The Town anticipates that the developer will return with a new proposal for the same piece of land. In addition, town officials indicated that potential development includes the construction of up to eight residential units adjacent to the Senior Center, and converting vacant banks into restaurants.

The town encourages development of homes outside the floodplain, although recreational areas of lots may be within floodplains. However, the town is open to considering changes to its Flood Prevention Ordinance in order to put additional restrictions on floodplain development.

2.9 Critical Facilities, Sheltering Capabilities, and Emergency Response

Bridgewater has identified several critical facilities throughout the town. Table 2-5 identifies those critical facilities in Bridgewater. The Town considers its police, fire, governmental, and major transportation arteries to be its most important critical facilities since these are needed to ensure that emergencies are addressed while day-to-day management of Bridgewater continues.

Sheltering Capabilities

Emergency shelters are an important subset of critical facilities as they are needed in many emergency situations. There are three identified shelters in the town that are also considered critical facilities. The Senior Center on Hut Hill Road is the primary shelter for the town. The Fire Department on Main Street is considered the backup shelter. The Village Store on Main Street is considered a temporary warming shelter which provides wireless internet, phone service, and food. All three facilities have backup generators.

Table 2-5
Critical Facilities

Facility	Address or Location	Comment	Emergency Power?	Shelter?	In 1% Annual Chance Floodplain?
Senior Center	132 Hut Hill Road	Emergency Operations Center (EOC) and the Primary Shelter	✓	✓	No
Bridgewater Volunteer Fire Department	100 Main Street South	Emergency Response	✓	✓	No
Bridgewater Public Works Highway Garage	324 Hut Hill Road	Emergency Assistance	✓		No
The Village Store	27 Main Street South	Emergency Supplies and back-up shelter	✓		No
Bridgewater Police Department	152 Hut Hill Road	Emergency Response			No
Bridgewater Town Hall	44 Main Street South	Secondary Shelter and Back-up EOC	✓		No
Burnham Elementary School	80 Main Street South	School			No
Mobil Gas Station	11 New Milford Road	Provides fuel for Emergency Response			No

In case of a sustained power outage, it is anticipated that 10 to 20% of the population would relocate, although not all of those relocating would necessarily utilize the shelter facilities.

Bridgewater is part of the Region Twelve School District. Burnham Elementary School on Main Street is considered a critical facility. The elementary school needs a generator and once acquired it may serve as a shelter.

Emergency Response Capabilities

The Emergency Management Director coordinates emergency preparedness in the Town of Bridgewater. The Town's Emergency Operations Center (EOC) is located in the Bridgewater Senior Center. The EOC's goal is to provide citizens with the highest level of emergency preparedness before, during, and after disasters or emergencies. The backup EOC is the Town Hall. The Town coordinates with all departments internally to develop plans, protocols, and procedures that assure the safety of Bridgewater's citizens. It also provides technical assistance to state and local emergency response agencies and public officials. The Town's EOP guides its response to emergencies arising from both natural and anthropogenic hazards.

Although the town has an EOC and backup EOC, the town administration desires construction of a new Police Station that can house the EOC. This would allow Bridgewater to have an EOC with the level of technology available at the City of Danbury EOC and Town of New Fairfield EOC. The town would also like sufficient dedicated Internet Protocol addresses (IP address) for the EOC.

The Town is interested in obtaining grants to acquire generators capable of providing power to the local Mobil gas station and other important or critical facilities. Although the town recognizes that the gas station is a privately owned, it is vital to residents in need of gas during severe storm events. For emergency personnel, the Public Works Highway Garage has 500 gallons of reserve gas stored at its location in time of emergencies. Acquisition of portable generators would greatly assist the town in providing emergency power when needed.

The town is also interested in pursuing funding to purchase new equipment to enhance emergency response capabilities through the Assistance to Firefighters grant program. According to the FEMA website, "the primary goal of the Assistance to Firefighters Grant (AFG) is to meet the firefighting and emergency response needs of fire departments and nonaffiliated emergency medical service organizations. Since 2001, AFG has helped firefighters and other first responders to obtain critically needed equipment, protective gear, emergency vehicles, training and other resources needed to protect the public and emergency personnel from fire and related hazards."

The Town's Public Works Department performs tree and shrub removal and trimming on Town-owned lands and rights-of-way. During emergencies and following storms, the Public Works Department responds to calls related to downed trees.

Road closures are a major concern to town officials. Main Street (Route 133) has occasionally been closed due to snow, ice, or fallen trees. Reportedly CT DOT and CL&P do not address this area in an expeditious manner and road closures can result in extended response times for emergency personnel. Bridgewater staff notifies CT DOT when accumulation is building, and local Public Works staff will clear Route 133 during emergencies when absolutely necessary.

Town officials have indicated that CT DOT is proposing to perform maintenance and safety improvements to Route 133, which would include a lengthy retaining wall. The town would like to coordinate with CT DOT on the improvement process and ensure that the roadway improvements are consistent with the goals of this HMP.

<u>Communications</u>

In Connecticut, the Department of Emergency Services and Public Protection (DESPP) has a regional focus. DESPP has divided Connecticut into five emergency planning regions and as part of this new view, the DEMHS subsection of DESPP has been partnering with HVCEO and other regional planning organizations to strengthen emergency response. Bridgewater is located in Region 5, consisting of 43 towns in western Connecticut.

The Town utilizes a program known as "CT Alert" to direct geographically specific emergency notification telephone calls into affected areas. The local radio station, WLAD is also utilized for notifications purposes. The town can send emails with emergency notifications, and the school system maintains a separate email notification system that can also be used.

3.0 FLOODING

3.1 Setting

According to FEMA, most municipalities in the United States have at least one clearly recognizable floodprone area around a river, stream, or large body of water. These areas are outlined as SFHAs and delineated as part of the NFIP. Floodprone areas are addressed through a combination of floodplain management criteria, ordinances, and community assistance programs sponsored by the NFIP and individual municipalities.

Many communities also have localized flooding areas outside the SFHA. These floods tend to be shallower and chronically reoccur in the same area due to a combination of factors. Such factors can include ponding, poor drainage, inadequate storm sewers, clogged culverts or catch basins, sheet flow, obstructed drainageways, or simply overbank flooding from minor streams.

Despite the town's reputation for being "high and dry," the *potential* for flooding is widespread in Bridgewater with the majority of major flood risk along established SFHAs. The areas impacted by overflow of river systems are generally limited to river corridors and floodplains. Indirect flooding that occurs outside floodplains and localized nuisance flooding along tributaries are also potential problems in the town. This type of flooding occurs particularly along roadways as a result of inadequate drainage and other factors. The frequency of flooding in Bridgewater is considered likely for any given year.

3.2 Hazard Assessment

Flooding is the most common and costly natural hazard in Connecticut. The state typically experiences floods in the early spring due to snowmelt and in the late summer/early autumn due to frontal systems and tropical storms although localized flooding caused by thunderstorm activity can be significant. Flooding can occur as a result of other natural hazards, including hurricanes, summer storms, and winter storms. Flooding can also occur as a result of ice jams or dam failure (Section 8.0) and may also cause landslides and slumps in affected areas. According to FEMA, there are several different types of inland flooding:

- **Riverine Flooding**: Also known as overbank flooding, it occurs when channels receive more rain or snowmelt from their watershed than normal, or the channel becomes blocked by an ice jam or debris. Excess water spills out of the channel and into the channel's floodplain area.

- **Flash Flooding:** A rapid rise of water along a water channel or low-lying urban area, usually a result of an unusually large amount of rain and/or high velocity of water flow (particularly in hilly areas) within a very short period of time. Flash floods can occur with limited warning.

- **Shallow Flooding:** Occurs in flat areas where a lack of a water channel results in water being unable to drain away easily. The three types of shallow flooding include:
  - **Sheet Flow:** Water spreads over a large area at uniform depth.
  - **Ponding:** Runoff collects in depressions with no drainage ability.
  - **Urban Flooding:** Occurs when man-made drainage systems are overloaded by a larger amount of water than the system was designed to accommodate.

Flooding presents several safety hazards to people and property and can cause extensive damage and potential injury or loss of life. Floodwaters cause massive damage to the lower levels of buildings, destroying business records, furniture, and other sentimental papers and artifacts. In addition, floodwaters can prevent emergency and commercial egress by blocking streets, deteriorating municipal drainage systems, and diverting municipal staff and resources.

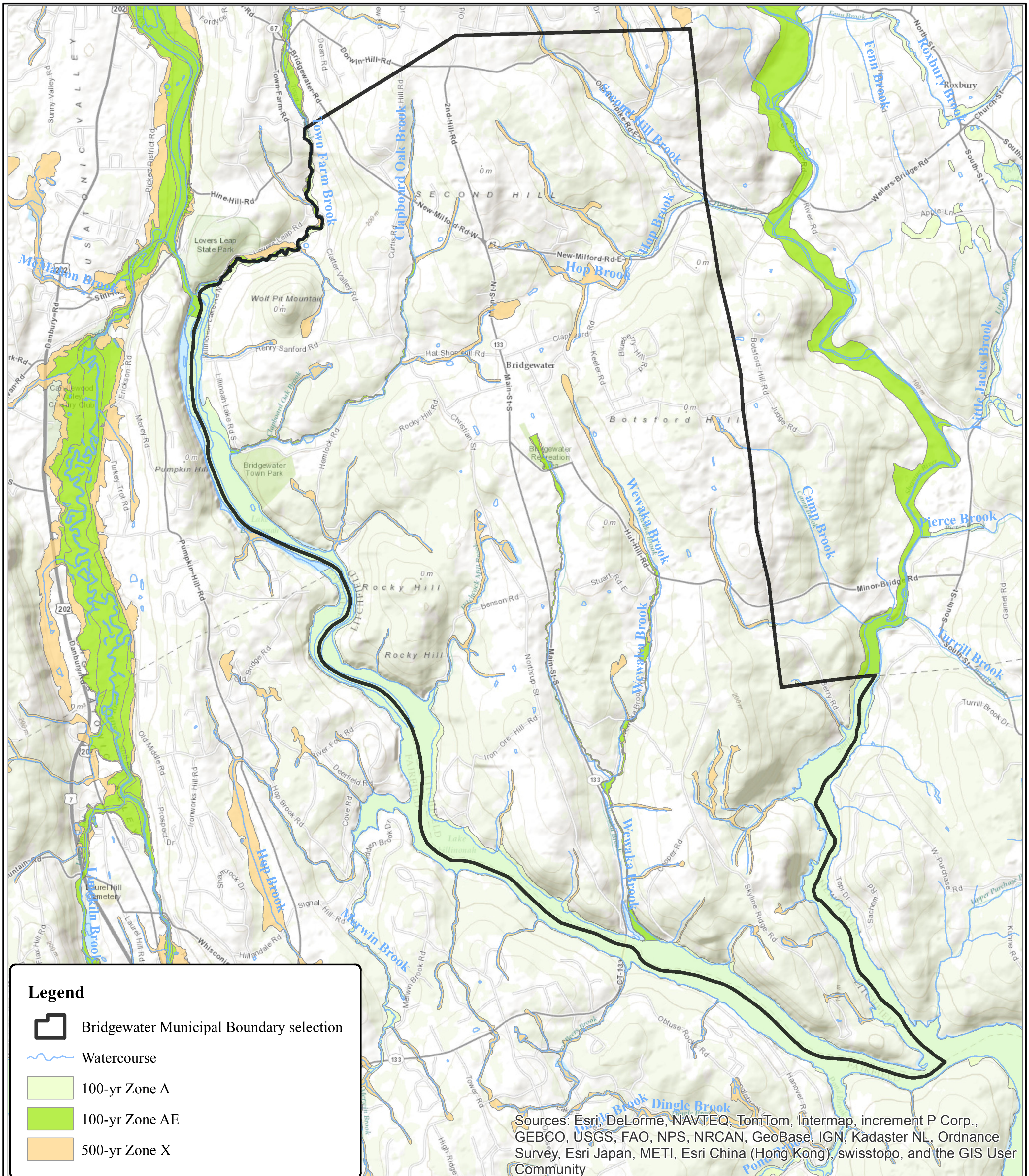
Furthermore, damp conditions trigger the growth of mold and mildew in flooded buildings, contributing to allergies, asthma, and respiratory infections. Snakes and rodents are forced out of their natural habitat and into closer contact with people, and ponded water following a flood presents a breeding ground for mosquitoes. Gasoline, pesticides, poorly treated sewage, and other aqueous pollutants can be carried into areas and buildings by floodwaters and soak into soil, building components, and furniture.

Floodplains* are lands along watercourses that are subject to periodic flooding; *floodways* are those areas within the floodplains that convey the majority of flood discharge. Floodways are subject to water being conveyed at relatively high velocity and force. The *floodway fringe* contains those areas of the 1% annual chance floodplain that are outside the floodway and are subject to inundation but do not convey the floodwaters at a high velocity.

In order to provide a national standard without regional discrimination, the 1% annual chance flood has been adopted by FEMA as the base flood for purposes of floodplain management and to determine the need for insurance. The risk of having a flood of this magnitude or greater increases when periods longer than one year are considered. For example, FEMA notes that a structure located within a 1% annual chance flood zone has a 26% change of suffering flood damage during the term of a 30-year mortgage. Similarly, a 500-year flood has a 0.2% chance of occurring in a given year. The 500-year floodplain indicates areas of moderate flood hazard.

The Town has consistently participated in the NFIP since November 1, 1979 and intends to continue participation in the NFIP. SFHAs in Bridgewater are delineated on a Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS). The FIRM delineates areas within Bridgewater that are vulnerable to flooding. The original FIS and FIRMs for flooding sources in the town were published in November 1, 1979.

A regulatory floodplain with AE designation has been mapped along the Housatonic River, Shepaug River, Wewaka Brook, Clapboard Brook and Hop Brook. Areas identified as providing flood storage are identified with A Zone designations, meaning they are regulated as floodplain, but flood elevations have not been established. Refer to Figure 3-1 for the areas of Bridgewater susceptible to flooding based on FEMA flood zones. Table 3-1 describes the various zones depicted on the FIRM panel for Bridgewater.



SOURCE(S):	Figure 3-1: FEMA Special Flood Hazard Areas	LOCATION: Bridgewater, CT
2013 CT DEEP	**Town of Bridgewater Hazard Mitigation Plan**	Map By: CPS MMI#: 3101-14 Original: 1/14/2014 Revision: 1/14/2014 Scale: 1 inch = 0.82 miles

N

MXD: P:\3101-14\Design\GIS\Fairfield County\Bridgewater\Maps\Figure 3-1 Bridgewater FEMA Special Flood Hazard Areas.mxd

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Table 3-1
FIRM Zone Descriptions

Zone	Description
A	An area with a 1% chance of flooding in any given year for which no base flood elevations (BFEs) have been determined.
AE	An area with a 1% chance of flooding in any given year for which BFEs have been determined. This area may include a mapped floodway.
Area Not Included	An area that is located within a community or county that is not mapped on any published FIRM.
X	An area that is determined to be outside the 1% and 0.2% annual chance floodplains.
X500	An area with a 0.2% chance of flooding in any given year, for which no base flood elevations have been determined.

Flooding can occur in some areas with a higher frequency than those mapped by FEMA. This flooding occurs during heavy rains with a much higher frequency than those used to calculate the 1% annual chance flood event and often in different areas than those depicted on the FIRM panels. These frequent flooding events occur in areas with insufficient drainage; where conditions may cause flashy, localized flooding; and where poor maintenance may exacerbate drainage problems (see Section 3.5).

During large storms, the recurrence interval level of a flood discharge on a tributary tends to be greater than the recurrence interval level of the flood discharge on the main channel downstream. In other words, a 1% annual chance flood event on a tributary may only contribute to a 2% annual chance flood event downstream. This is due to the distribution of rainfall throughout large watersheds during storms and the greater hydraulic capacity of the downstream channel to convey floodwaters. Dams and other flood control structures can also reduce the magnitude of peak flood flows if pre-storm storage is available.

The recurrence interval level of a precipitation event also generally differs from the recurrence interval level of the associated flood. An example would be Tropical Storm Floyd in 1999, which caused rainfall on the order of a 250-year event while flood frequencies were slightly greater than a 10-year event on the Naugatuck River in Beacon Falls, Connecticut. Flood events can also be mitigated or exacerbated by in-channel and soil conditions, such as low or high flows, the presence of frozen ground, or a deep or shallow water table, as can be seen in the following historic record.

3.3 Historic Record

Although town officials often describe the town of Bridgewater as “high and dry,” the town has experienced various degrees of flooding throughout its history. Melting snow combined with early spring rains has caused spring flooding. Flood events have also occurred in late summer to early autumn resulting from storms of tropical origin moving northeast along the Atlantic coast. Winter floods result from the occasional thaw, particularly during years of heavy snow or periods of rainfall on frozen ground. Other flood events have been caused by excessive rainfalls upon saturated soils, yielding greater than normal runoff.

According to the October 2013 FIS for Fairfield County (located downstream of Bridgewater), at least 26 major storms occurred in the Housatonic River basin since 1693. The notable historical floods in the early 20th century occurred in March 1936, September 1938, January 1949, August 1955, October 1955, and September 1960.

Flooding on the Housatonic River and its tributaries can be experienced during all seasons as a result of either intensive rainfall during the coastal storm and hurricane season from June to October or because of rain combined with melting snow which caused the flood of 1936.

According to the NCDC Storm Events Database, there have been approximately 24 flooding and 46 flash flooding events in Litchfield County since 1996. The following are descriptions of historic floods in the vicinity of the Town of Bridgewater based on historic records and information in the NCDC storm Events Database, supplemented by correspondence with municipal officials. Note that flooding was not necessarily limited to the described areas.

- April 16, 1996: Rain on already saturated soil caused small stream and street flooding in New Milford, just north of Bridgewater. The East Aspetuck River spilled over its banks and flooded some areas in New Milford.

- July 13, 1996: The remnants of Hurricane Bertha tracked from the Mid-Atlantic region northeast to Quebec, Canada. Three to five inches of rain was common across Litchfield County. Several roads and streams were flooded throughout the county. Scattered power outages also occurred across Litchfield County, when strong winds downed water-laden tree branches onto wires.

- July 9, 1997- A cold front moving across Litchfield County initiated severe thunderstorms with damaging winds. Torrential rain in New Milford caused flash flooding along the Aspetuck River including flooding of several homes along secondary roads.

- September 16, 1999: The remnants of Hurricane Floyd moved up the eastern seaboard. The storm brought both high winds and exceptionally heavy rainfall to northwestern Connecticut, which included a large swath of 5 to 8 inch amounts. The rain produced widespread flooding across the region, which proved very destructive. Significant flooding was noted on many tributaries, including the Housatonic, and Shepaug Rivers in addition to many smaller streams. The rains not only flooded many roadways but washed out portions of them. Many communities declared a State of Emergency. Winds from the passage of Floyd were estimated to have gusted to over 60 mph across mainly the hilltowns. The combination of the wind and very saturated ground produced widespread downing of trees and power lines across much of Litchfield County. Some of the trees fell on vehicles and houses. The rain and wind produced power outages across the region with as many as 5,000 left in the dark.

- June 17, 2001- The remnants of tropical storm Allison combined with a slow westerly moving cold front produced torrential rainfall over much of Litchfield County. Between 2 and 6 inches of rain fell in a short period of time over central and southeastern portions of the county, with the maximum amounts located near the East Aspetuck River Basin. The East Aspetuck River went over bank from New Preston south through Northville and New Milford. In New Milford the river came up to the same level as a bridge on Welles Road with several other roads flooding as well.

- February 14, 2008: This complex storm system brought a significant wintry mix to much of east central New York and adjacent western New England. As milder air moved north, heavy rainfall occurred across much of the region, with 1 to 3 inches of rainfall reported. This heavy rainfall, combined with clogged storm drains, antecedent heavy snow and sleet, and snowmelt led to widespread ponding of water across the region. In addition, flooding was reported along portions of the East Aspetuck River near New Milford.

- March 7, 2011: After a combination of heavy rainfall and snowmelt due to mild temperatures, the result was widespread flooding of rivers, streams, roads and basements. Evacuations occurred in areas due to communities being cut off by flood waters from access to main roads. Sections of Route 7 were closed from the overflow of the Housatonic River from Kent to just south of the Veterans Bridge, Route 202, in New Milford.

- August 28-29, 2011: Tropical Storm Irene moved in north northeast across eastern New York and western New England producing widespread flooding due to extreme rainfall and heavy winds. Moderate flooding occurred in Bridgewater. Numerous road closures were reported due to flooding, downed trees and power lines causing some evacuations and widespread, long duration power outages.

  In Bridgewater, impacts from Hurricane Irene and Tropical Storm Lee were primarily due to flooding of the Housatonic River. The storms caused many roads to wash out, mostly along Clapboard Oak Brook at Hemlock Road and also along Wewaka Brook and Hop Brook.

3.4 Existing Capabilities

Bridgewater has Ordinances and Regulations that regulate development and Inland Wetland Regulations that regulate activities near wetlands. While regulations have not been updated to specifically address hazard mitigation, the DEEP’s model regulations were used to update flood damage prevention regulations as necessary.

Ordinances, Regulations, and Plans

Regulations, codes, and ordinances that apply to flood hazard mitigation in conjunction with and in addition to NFIP regulations include:

- ***Zoning Regulations*****:** The Town of Bridgewater Zoning Regulations were updated on January 1, 1995. The regulations have been enacted to “protect and promote the public health, safety, welfare, convenience, and property values; to lessen congestion in the streets; to secure safety from fire, panic, flood, environmental damage, and other dangers; to provide adequate light, air, and water, to prevent overcrowding of land; to avoid undue concentration of population; to facilitate adequate provisions for transportation, water, sewerage, schools, parks, and other public requirements; to preserve and protect the unique character of the Town of Bridgewater; to protect site and features of historic and archaeological significance; to conserve and protect existing and potential surface-water and groundwater drinking supplies, inland wetlands and watercourses, and other valuable natural resources; to prevent unnecessary soil erosion and sedimentation; and to provide adequate housing opportunities' for all citizens of Bridgewater consistent with soil types, terrain, infrastructure capacity, and the rural character of the Town.” Section 5.09 states that all uses in floodprone areas shall conform to the terms of the Bridgewater Flood damage Prevention Ordinance, as amended.

- ❑ ***Chapter 155 Flood Damage Prevention Ordinance:*** The 1993 Ordinance is essentially the local version of the NFIP regulations and was enacted "to promote the public health, safety and general welfare and to minimize public and private losses due to flood conditions in specific areas by provisions designed to (1) restrict or prohibit uses which are dangerous to health, safety and property due to water or erosion hazards, or which result in damaging increases in erosion or in flood heights or velocities (2) require that uses vulnerable to floods, including facilities which serve those uses, be protected against flood damage at the time of initial construction (3) Control the alteration of natural floodplains, stream channels and natural protective barriers which are involved in the accommodation of flood waters (4) Control filling, grading, dredging and other development which may increase erosion or flood damage; and (5) Prevent or regulate the construction of flood barriers which will unnaturally divert flood waters or which may increase flood hazards to other lands.

    - Section 155.05(1) states that residential, non-residential and substantial improvements located in Zones A1-30, AE and AH shall have the lowest floor, including basement, elevated at least to one foot above the base flood elevation.

    - Section 155.05(7)(a) prohibits encroachments within floodways unless certification by a registered professional engineer is provided demonstrating that encroachments shall not result in any (0.00) increase in flood levels during occurrence of the base flood discharge.

    - Section 155.06 outlines the standards for subdivision proposals. Specifically, the following requirements shall apply in all special flood hazard areas (a) all subdivision proposals shall be consistent with the need to minimize flood damage; (b) all subdivision proposals shall have public utilities and facilities such as sewer, gas, electrical and water systems located and constructed to minimize flood damage; (c) all subdivision proposals shall have adequate drainage provided to reduce exposure to flood hazards and (d) in Zone A base flood elevation data shall be provided for subdivision proposals and other proposed developments (including manufactured home parks and subdivisions) which are five acres or 50 lots, whichever occurs first.

- ❑ ***Wetlands and Watercourse Regulations***. The Bridgewater Inland Wetland and Watercourse Regulations were adopted in July 1998 and were most recently updated in October 2011. The purpose of the Regulations is to protect the quality of the inland wetlands and watercourses within the Town of Bridgewater by making provisions for the protection, preservation, maintenance, and use of inland wetlands and watercourses, including deterring and inhibiting the danger of flood and pollution.

    - Section 2.1defines "Regulated Activity" as (a) any operation within or use of a wetland or watercourse involving removal or deposition of material, or any obstruction, construction, alteration or pollution, of such wetlands or watercourses; (b) any activity in a wetland, watercourse or buffer that involves excavating, mining, grading, filling, placing or removing earth materials (including pond spoils); constructing, installing or repairing buildings, septic systems or other man-made structures; clear cutting or grubbing land; storing petroleum based product in a storage container that is affixed to the ground or placed below the surface of the ground; disposing, treating, storing or managing hazardous wastes; Any activity located outside of a wetland, watercourse, or buffer area if the Commission determines that such activity is causing or is likely to cause the obstruction, alteration or pollution of a wetland or watercourse, provided that the Commission may make such determination only after providing an opportunity for a hearing, as well as at least ten days prior written notice of the hearing, to the owner of the land on which the activity is being conducted or is proposed to be conducted.

- Section 6 states that no person may conduct or maintain a regulated activity without obtaining a permit. Section 7 outlines the permit application requirements.

- ***Subdivision Regulations.*** The Town's Subdivision Regulations, effective May 1997, establish minimum acceptable standards of street construction, regulate the layout and development of lots and streets, and outline measures to prevent degradation of potable water sources, control erosion and siltation, preserve adequate and convenient open spaces, and retain the natural features of the land.

  - Section 5.1 states that subdivisions shall be designed in a manner that avoids development within SFHAs, inland wetlands and watercourses, streambelt land areas, and public water supply watershed associated with the Shepaug River.

  - Section 5.6 requires applicants to demonstrate compliance with the Town Flood Damage Prevention Ordinance.

  - Section 5.7 requires up to 15% on land within a proposed subdivision to be preserved for open space, park or playground use.

  - Section 7.1 outlines design standards and states that drainage systems shall provide for the prevention of flooding and soil erosion and protection of wetlands and watercourses.

- ***Plan of Conservation and Development.*** This 2012 document is the Town's vision statement for future development. It is updated every 10 years. The plan “strongly affirms the goals of preserving the rural character of the Town, protecting its natural resources, preserving farm and open land, and promoting community facilities and services.” Specific recommendations regarding conservation and natural resources include but are not limited to the following:

  - protection of surface and ground water
  - protection of flood plains, wetlands, streambelts and waterways
  - use of scenic easements and open space acquisition to protect environmental features as ridges and scenic vistas
  - discouragement of development in fragile environmental areas
  - use of environmental impact studies for major development or land use activity
  - encouragement of conservation and preservation efforts

  The plan also outlines the following implementation measures:

  - increasing open space requirements,
  - developing buffer zone requirements for land adjacent to water
  - developing an open space acquisition program
  - inspecting septic systems near the lake and river

Overall, the intent of these plans and regulations is to promote the public health, safety, and general welfare and to minimize public and private losses due to flood conditions in specific areas of the Town of Bridgewater by the establishment of standards designed to:

- Protect human life and public health
- Minimize expenditure of money for costly flood control projects
- Minimize the need for rescue and relief efforts associated with flooding
- Minimize prolonged business interruptions
- Minimize damage to public facilities and utilities such as water and gas mains; electric, telephone, and sewer lines; and streets and bridges located in floodplains
- Maintain a stable tax base by providing for the sound use and development of floodprone areas in such a manner as to minimize flood blight areas
- Ensure that purchasers of property are notified of special flood hazards
- Ensure the continued eligibility of owners of property in Bridgewater for participation in the NFIP

Floodplain Management, NFIP and CRS

Mr. Curtis Read, the Town First Selectman is currently the NFIP administrator for the Town and oversees the enforcement of NFIP regulations. The degree of flood protection established by the variety of regulations in the Town exceeds the minimum reasonable for regulatory purposes under the NFIP because the town requires freeboard of one foot. The Town discourages new construction and substantial reconstruction within the 1% annual chance floodplain by raising concerns during the floodplain permit process. New development is strictly managed through the Town's land use process. The Town is not enrolled in the Community Rating System (CRS) program, as CRS is not considered to be a cost-effective program due to the small number of flood insurance policies in the town.

Drainage and Street Flooding

Drainage and flooding complaints are typically routed to the Fire Department; however the number of complaints received is reportedly minimal. The Town Department of Public Works (DPW) is in charge of the maintenance of the town's drainage systems and performs clearing of bridges and culverts and other maintenance as needed. The Town uses these reports to identify potential problems and plan for maintenance and upgrades.

Town officials have indicated that they have recently replaced and increased the capacity of a few metal culverts throughout Bridgewater.

Communications

The Departments of Fire and Emergency Services are responsible for monitoring local flood warnings. The Town can access the National Weather Service website at http://www.weather.gov/ to obtain the latest flood watches and warnings before and during precipitation events.

The National Weather Service issues a flood watch or a flash flood watch for an area when conditions in or near the area are favorable for a flood or flash flood, respectively. A flash flood watch or flood watch does not necessarily mean that flooding will occur. The National Weather Service issues a flood warning or a flash flood warning for an area when parts of the area are either currently flooding, highly likely to flood, or when flooding is imminent.

Bridgewater subscribes to the State's CT Alert emergency notification system. Finally, the Town receives regular weather updates through Division of Emergency Management and Homeland Security (DEMHS) Region 5 email alerts as well as watches and warnings through the National Weather Service.

3.5 Vulnerabilities and Risk Assessment

This section discusses specific areas at risk to flooding within the Town. As shown in the historic record, flooding can impact a variety of river corridors and cause severe damages in the Town of Bridgewater but most often occurs in the Housatonic River watershed. Flooding due to poor drainage and streambank erosion are other hazards in the town and can cause minor infrastructure damage and create nuisance flooding of yards and basements.

3.5.1 Vulnerability Analysis of Repetitive Loss Properties

Based on correspondence with the State of Connecticut NFIP Coordinator at the Connecticut DEEP, no repetitive loss properties (RLPs) are located in Bridgewater.

3.5.2 Vulnerability Analysis of Critical Facilities

The list of critical facilities provided by the Town (Section 2.9) was used with the parcel data to accurately locate each critical facility throughout the town. None of the critical facilities were found to lie within the 1% annual chance floodplain.

Town officials have noted that the resident state trooper building experienced water damage in the past due to poor drainage but it has been remedied.

3.5.3 Vulnerability Analysis of Areas Along Watercourses

According to town officials, significant damaging floods in Bridgewater are not common. The main sources of flood risk are Clapboard Oak Brook, Wewaka Brook, Hop Brook, Housatonic River and Shepaug River. Periodic flooding does occur along Clapboard Oak Brook, Wewaka Brook and Hop Brook. Known problem areas include:

- ❑ A house and mill adjacent to Route 133 on Wewaka Brook.
- ❑ Clapboard Oak Brook has had severe eroding and scouring along its bank. DOT has reportedly contributed to heavy runoff with successive improvements to Route 133 that did not take stormwater detention into account.
- ❑ Scouring and wash-outs around undersized culverts have occasionally occurred. For example, during the public meeting it was noted that the Hemlock Road culverts may be undersized.
- ❑ Wewaka Brook and Clapboard Oak Brook have experienced previous flooding problems at their confluences with the Housatonic River.
- ❑ Wewaka Brook has also experienced flooding problems downstream of its confluence with Wewaka Brook Tributary and the Wewaka Road crossing.

The two priority areas of concern are clearly Wewaka Brook and Clapboard Oak Brook:

- Wewaka Brook – This area was cited as a flood prone area during the data collection meeting. Specifically, town officials indicated that the single family home and mill adjacent to Route 133 has occasional flooding. In addition, portions of roadways are at risk of flooding during extreme events. The areas of concern are shown on Figure 3-2.

- Clapboard Oak Brook – This brook has suffered severe erosion and scouring along its bank. DOT has reportedly contributed to heavy runoff with more impervious area and improvements being installed along Route 133. The areas west of Route 133 have the potential for landslides due to the steep topography and erosion from runoff. The areas of concern are shown of Figure 3-3.

3.5.4 Vulnerability of Other Areas

There are other areas around the town that suffer from street flooding due to undersized culverts. These are addressed on a case-by-case basis through system maintenance and/or upgrades as necessary. Scouring and wash-outs around undersized culverts have occasionally occurred. Minor repairs and replacements with larger pipe diameters have been completed; however Bridgewater could encourage the CT DOT to apply for funding to remediate these areas, since State agencies may apply for grants.

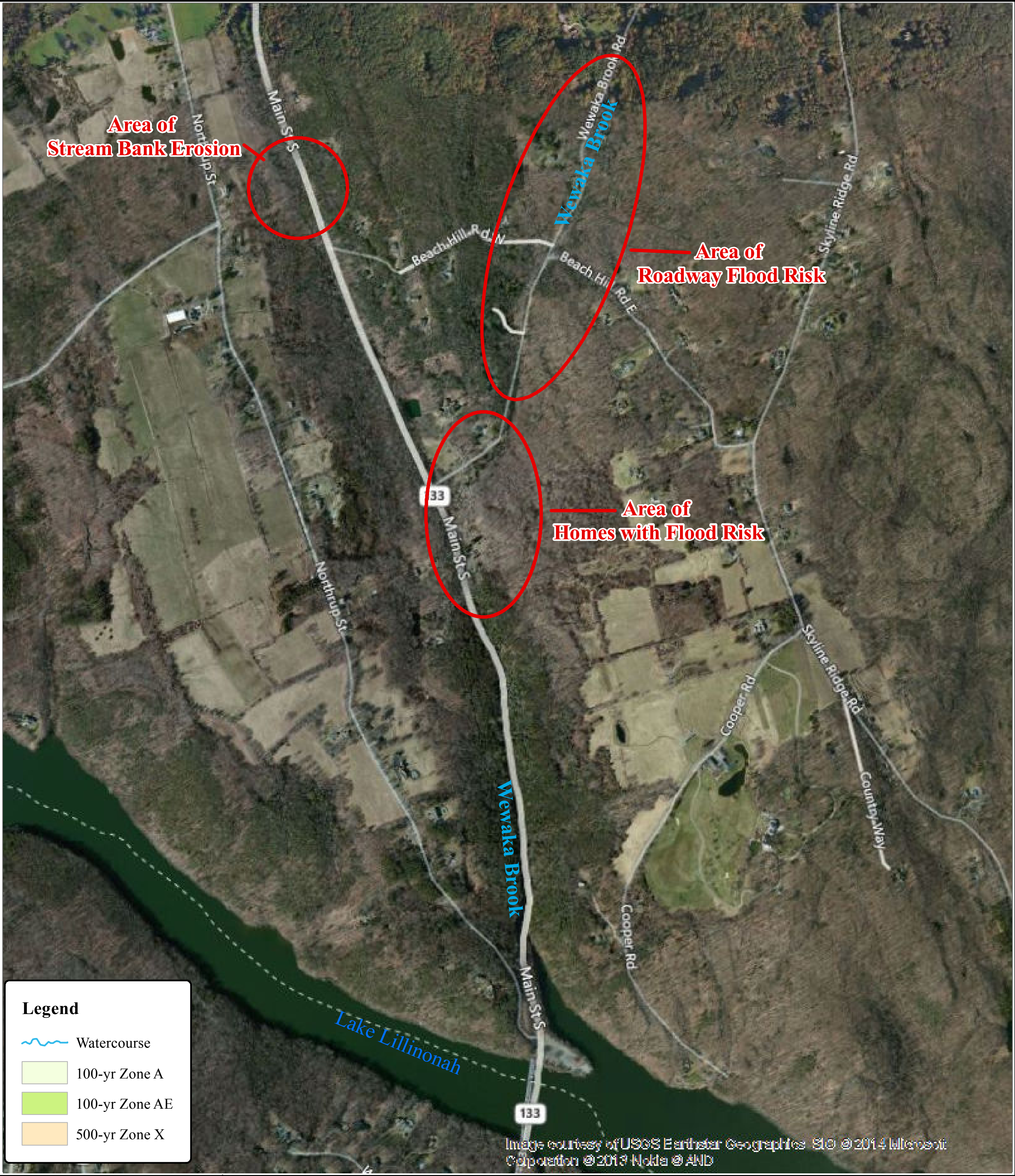
3.5.5 HAZUS-MH Vulnerability Analysis and Loss Estimates

HAZUS-MH is FEMA's loss estimation methodology software for flood, wind, and earthquake hazards. The software utilizes year 2000 U.S. Census data and a variety of engineering information to calculate potential damages (specified in year 2006 United States dollars [USD]) to a user-defined region. The software was used to perform a basic analysis and generate potential damages to Bridgewater from a 1% annual chance riverine flood event simultaneously occurring along Clapboard Oak Brook, Wewaka Brook, and a Wewaka Brook Tributary. Hydrology and hydraulics for the streams and rivers were generated utilizing the Connecticut LiDAR 10-foot Digital Elevation Model based on LiDAR collected in the year 2000. The summary report is included in Appendix E. The following paragraphs discuss the results of the *HAZUS-MH* analysis.

The FEMA default values were used for each of the town's census blocks in the *HAZUS* simulation. Approximately $198 million of total building replacement value were estimated to exist within the Town of Bridgewater. Of that total, the HAZUS 1% annual chance riverine flood event estimates a total building-related loss of $0.07 million. A summary of the default building values is shown in Table 3-2.

Table 3-2
***HAZUS-MH* Flood Scenario – Basic Information**

Occupancy	Dollar Exposure (2006 USD)
Residential	$ 161,450,000
Commercial	$ 20,101,000
Other	$ 15,961,000
Total	**$ 197,512,000**



SOURCE(S):
2014 CT DEEP

Figure 3-2:
Wewaka Brook | FEMA Special Flood Hazard Areas

LOCATION:
Bridgewater, CT

N

Town of Bridgewater
Hazard Mitigation Plan

MXD: P:\3101-14\Design\GIS\Fairfield County\Bridgewater\Maps\Figure 3-2 Wewaka Brook Corridor Bridgewater FEMA Special Flood Hazard Areas.mxd

Map By: CPS
MMI#: 3101-14
Original: 1/14/2014
Revision: 3/13/2014
Scale: 1 inch = 0.22 miles

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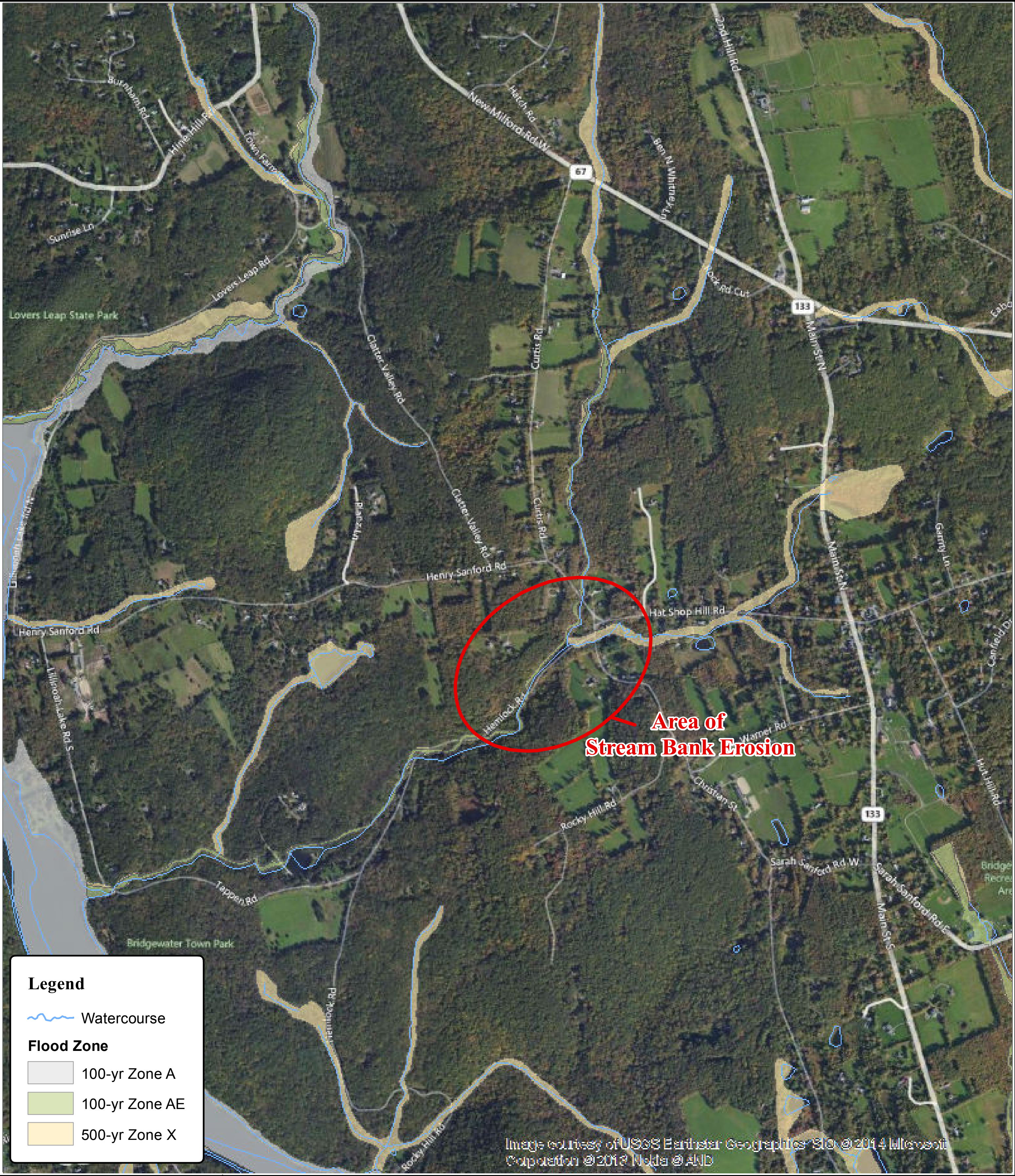

SOURCE(S):	Figure 3-3: Clapboard Oak Brook | FEMA Special Flood Hazard Areas	LOCATION: Bridgewater, CT
2014 CT DEEP		

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Town of Bridgewater
Hazard Mitigation Plan

MXD: P:\3101-14\Design\GIS\Fairfield County\Bridgewater\Maps\Figure 3-3 Clapboard Brook Corridor Bridgewater FEMA Special Flood Hazard Areas.mxd

Map By: CPS
MMI#: 3101-14
Original: 1/14/2014
Revision: 3/13/2014
Scale: 1 inch = 0.29 miles

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The *HAZUS-MH* simulation estimates that during a 1% annual chance flood event, no buildings will be at least moderately damaged in the town from flooding.

HAZUS-MH utilizes a subset of critical facilities known as "essential facilities" that are important following natural hazard events. These include one police station, one fire station, and one school. The software noted that under the 1% annual chance flood event, no essential facilities would suffer damage.

The *HAZUS-MH* simulation estimated that a total of five tons of debris would be generated by flood damage for the 1% annual chance flood scenario. It is estimated that one truckload (at approximately 25 tons per truck) will be required to remove the debris. The breakdown of anticipated debris is as follows:

- Finishes (drywall, insulation, etc.) comprise 92% of this total.
- Structural material (wood, brick, etc.) comprise 5% of the total.
- Foundation material (concrete slab, concrete block, rebar, etc.) would comprise the remaining 3%.

HAZUS-MH calculated the potential sheltering requirement for the 1% annual chance flood event. The model estimates that one household will be displaced due to flooding. Displacement includes households evacuated from within or very near to the inundated areas. Of these households, no people are projected to seek temporary shelter in public shelters.

HAZUS-MH also calculated the predicted economic losses due to the 1% annual chance flood event. Economic losses are categorized as either building-related losses or business interruption losses. Building-related losses (damages to building, content, and inventory) are the estimated costs to repair or replace the damage caused to the building and its contents. Business interruption losses are those associated with the inability to operate a business because of the damage sustained during the flood and include lost income, relocation expenses, lost rental income, lost wages, and temporary living expenses for displaced people.

- A total of $0.07 million of building-related losses is expected. Building losses account for the building structure, contents, and inventory. As such, residential losses accounted for a total of $0.05 million and other (municipal and industrial) losses totaled $0.02 million.
- No business interruption losses are predicted.

In summary, flooding has the potential to affect the town of Bridgewater although damages would be more limited than typical for most towns in Connecticut due to the rural nature of the community. Based on the historic record, the *HAZUS-MH* simulations of the 1% annual chance flood events, and the distribution of the SFHAs and other areas are vulnerable to flooding, the town is vulnerable to flooding and at risk to moderate flood damage.

3.6 Potential Mitigation Strategies and Actions

A number of measures can be taken to reduce the impact of a local or nuisance flood event. These include measures that prevent increases in flood losses by managing new development, measures that reduce the exposure of existing development to flood risk, and measures to preserve and restore natural resources. These are listed below under the categories of *prevention*, *property protection*, *structural projects*, *public education and awareness*, *natural resource* *protection*, and *emergency services*. All of the recommendations discussed in the subsections below are reprinted in a bulleted list in Section 3.7.

3.6.1 <u>Prevention</u>

> ***It is important to promote coordination among the various departments that are responsible for different aspects of flood mitigation. Coordination and cooperation among departments should be reviewed every few years as specific responsibilities and staff change.***

Prevention of damage from flood losses often takes the form of floodplain regulations and redevelopment policies that restrict the building of new structures within defined areas. These are usually administered by building, zoning, planning, and/or code enforcement offices through capital improvement programs and through zoning, subdivision, floodplain, and wetland regulations. It also occurs when land is prevented from being developed through the use of conservation easements or conversion of land into open space. Ordinances pertinent to the Town were discussed in Section 3.4. The following are general recommendations for flood damage prevention:

<u>Open Space Creation and Preservation:</u> The 2012 Plan of Conservation and Development promotes open space objectives and states that approximately 2,200 acres in Bridgewater consist of open space. These areas are managed by the Bridgewater Land Trust, The Nature Conservancy Sunny Valley Preserve, Weantinoge, and the Audubon Society. The plan recommends the following measures with regard to open space:

- ❑ Institute a plan to map vulnerable land, vistas, ridgelines, and arterial roads that are appropriate for open space and walking or hiking.
- ❑ Prioritize open space needs on arterial and main roads and for scenic areas and vistas.
- ❑ Coordinate with land trusts and conservancies on goals, strategies, and plans.
- ❑ Research the concept of a small dedicated fee, one percent or one/half percent, of a land sale, to be held in trust for the purchase of open space; if recommended, this plan should be introduced as the economy and housing market improves.

<u>Planning and Zoning</u>: Zoning and Subdivision ordinances in Bridgewater regulate development in flood hazard areas. Flood hazard areas should reflect a balance of development and natural areas although ideally they will be free from development. Policies also require the design and location of utilities to areas outside of flood hazard areas when applicable and the placement of utilities underground when possible. The Subdivision Regulations include extensive criteria for stormwater management planning.

<u>Floodplain Development Regulations</u>: The Town's floodplain ordinance requires engineering review of all development applications in the floodplain. Site plan and new subdivision regulations include the following:

- ❑ Requirements that every lot have a buildable area above the flood level
- ❑ Construction and location standards for the infrastructure built by the developer, including roads, sidewalks, utility lines, storm sewers, and drainageways

Adherence to the State Building Code requires that the foundation of structures will withstand flood forces and that all portions of the building subject to damage are above or otherwise protected from flooding. Floodplain ordinances in the town meet minimum requirements of the NFIP for subdivision and building codes.

Adoption of a different floodplain map is allowed under NFIP regulations as long as the new map covers a larger floodplain than the FIRM. It should be noted that the community's map will not affect the current FIRM or alter the SFHA used for setting insurance rates or making map determinations; it can only be used by the community to regulate floodplain areas. The FEMA Region I office has more information on this topic. Contact information can be found in Section 11.

FEMA encourages communities to use more accurate topographic maps to expand upon the FIRMs published by FEMA. This is because many FIRMs were originally created using USGS quadrangle maps with 10-foot contour intervals, but many municipalities today have contour maps of one- or two-foot intervals that show more recently constructed roads, bridges, and other anthropologic features. An alternate approach is to record high water marks and establish those areas inundated by a recent severe flood to be the new regulatory floodplain.

Reductions in floodplain area or revisions of a mapped floodplain can only be accomplished through revised FEMA-sponsored engineering studies or Letters of Map Change (LOMC).

<u>Stormwater Management Policies</u>: Development and redevelopment policies to address the prevention of flood damage must include effective stormwater management policies. Developers in Bridgewater are required to build detention and retention facilities where appropriate, and criteria for design are outlined in the Town's Subdivision Regulations. Additional techniques include enhancing infiltration to reduce runoff volume through the use of swales, infiltration trenches, vegetative filter strips, and permeable paving blocks. The goal is that post development stormwater does not leave a site at a rate higher than under predevelopment conditions.

Standard engineering practice is to avoid the use of detention measures if the project site is located in the lower one-third of the overall watershed. The effects of detention are least effective and even detrimental if used at such locations because of the delaying effect of the peak discharge from the site that typically results when detention measures are used. By detaining stormwater in close proximity to the stream in the lower reaches of the overall watershed, the peak discharge from the site will occur later in the storm event, which will more closely coincide with the peak discharge of the stream, thus adding more flow to the peak discharge during any given storm event.

<u>Drainage System Maintenance</u>: An effective drainage system must be continually maintained to ensure efficiency and functionality. The use of GIS technology can greatly aid the identification and location of problem areas. The Town currently has an "as-needed" schedule of drainage system maintenance. Maintenance includes programs to clean out blockages caused by overgrowth and debris. The Connecticut Department of Transportation (CTDOT) is responsible for maintenance along the state roadways.

<u>Education and Awareness</u>: Other prevention techniques include the promotion of awareness of natural hazards among citizens, property owners, developers, and local officials. Technical assistance for local officials, including workshops, can be helpful in preparation for dealing with the massive upheaval that can accompany a severe flooding event. Research efforts to improve knowledge, develop standards, and identify and map hazard areas will better prepare a

community to identify relevant hazard mitigation efforts. The Town has a variety of information available to citizens regarding flooding and flood damage prevention.

Wetlands: The Town Inland Wetlands and Watercourse Commission administers the Wetland Regulations, and the Planning and Zoning Commission administers the Zoning Regulations. The regulations simultaneously restrict development in floodplains, wetlands, and other floodprone areas. The Town Planner's office is charged with ensuring that development follows the Zoning Regulations and Inland Wetlands Regulations. The Town may consider developing a checklist that cross references the bylaws, regulations, and codes related to flood damage prevention that may be applicable to a proposed project and make this list available to potential applicants.

3.6.2 Property Protection

A variety of steps can be taken to protect existing public and private properties from flood damage. Potential measures for property protection include:

- ***Acquisition and demolition of floodprone structures with conversion of the lot to open space***. This open space could then become a new town park or be merged into an existing town park. This type of project eliminates future flooding damage potential to the structure, and such a project could be designed to increase floodplain storage, which would reduce future flooding potential to remaining properties.

- ***Relocation of structures at risk for flooding to a higher location on the same lot or to a different lot outside of the floodplain***. Moving an at-risk structure to a higher elevation can reduce or eliminate flooding damages to the structure. If the structure is relocated to a new lot, the former lot can be converted to open space in a manner similar to that described under the Acquisition section above.

- ***Elevation of the structure***. Home elevation involves the removal of the building structure from the basement and elevating it on piers to a height such that the first floor is located above the 1% annual chance flood level. The basement area is abandoned and filled to be no higher than the existing grade. All utilities and appliances located within the basement must be relocated to the first floor level.

- ***Construction of property improvements such as barriers, floodwalls, and earthen berms***. Such structural projects can be used to prevent shallow flooding. There may be properties within the town where implementation of such measures will serve to protect structures.

- ***Performing structural improvements that can mitigate flooding damage***. Such improvements can include:

  - ***Dry floodproofing of the structure to keep floodwaters from entering***. Walls may be coated with compound or plastic sheathing. Openings such as windows and vents would be either permanently closed or covered with removable shields. Flood protection should extend only two to three feet above the top of the concrete foundation because building walls and floors cannot withstand the pressure of deeper water.

> ***Dry floodproofing*** ***refers to the act of making areas below the flood level watertight.***
>
> ***Wet floodproofing*** ***refers to intentionally letting floodwater into a building to equalize interior and exterior water pressures.***

- ⇨ ***Wet floodproofing of the structure to allow floodwaters to pass through the lower area of the structure unimpeded***. Wet floodproofing should only be used as a last resort. If considered, furniture and electrical appliances should be moved away or elevated above the 1% annual chance flood elevation.

- ⇨ ***Performing other potential home improvements to mitigate damage from flooding***. FEMA suggests several measures to protect home utilities and belongings, including:

    - Relocate valuable belongings above the 1% annual chance flood elevation to reduce the amount of damage caused during a flood event.
    - Relocate or elevate water heaters, heating systems, washers, and dryers to a higher floor or to at least 12 inches above the high water mark (if the ceiling permits). A wooden platform of pressure-treated wood can serve as the base.
    - Anchor the fuel tank to the wall or floor with noncorrosive metal strapping and lag bolts.
    - Install a backflow valve to prevent sewer backup into the home.
    - Install a floating floor drain plug at the lowest point of the lowest finished floor.
    - Elevate the electrical box or relocate it to a higher floor and elevate electric outlets to at least 12 inches above the high water mark.

- ❑ ***Encouraging property owners to purchase flood insurance under the NFIP and to make claims when damage occurs***. While having flood insurance will not prevent flood damage, it will help a family or business put things back in order following a flood event. Property owners should be encouraged to submit claims under the NFIP whenever flooding damage occurs in order to increase the eligibility of the property for projects under the various mitigation grant programs.

All of the above *property protection* mitigation measures may be useful for Town of Bridgewater residents to prevent damage from inland and nuisance flooding. The Building Official should be prepared to provide outreach and education in these areas where appropriate.

3.6.3 Emergency Services

A hazard mitigation plan addresses actions that can be taken before a disaster event. In this context, emergency services that would be appropriate mitigation measures for flooding include:

- ❑ Forecasting systems to provide information on the time of occurrence and magnitude of flooding
- ❑ A system to issue flood warnings to the community and responsible officials
- ❑ Emergency protective measures, such as an Emergency Operations Plan outlining procedures for the mobilization and position of staff, equipment, and resources to facilitate evacuations and emergency floodwater control
- ❑ Implementing an emergency notification system that combines database and GIS mapping technologies to deliver outbound emergency notifications to geographic areas or specific groups of people, such as emergency responder teams

Some of these mitigation measures are already in place in the Town. Additional proposals common to all hazards in this Plan for improving emergency services are recommended in Section 10.1.

3.6.4 Public Education and Awareness

The objective of public education is to provide an understanding of the nature of flood risk and the means by which that risk can be mitigated on an individual basis. Public information materials should encourage individuals to be aware of flood mitigation techniques, including discouraging the public from modifying channels and/or detention basins in their yards and dumping in or otherwise altering watercourses and storage basins. Individuals should be made aware of drainage system maintenance programs and other methods of mitigation. The public should also understand what to expect when a hazard event occurs and the procedures and time frames necessary for evacuation.

Based on the above guidelines, a number of specific proposals for improved *public education* are recommended to prevent damage from inland and nuisance flooding. These are common to all hazards in this Plan and are listed in Section 10.1.

3.6.5 Natural Resource Protection

Floodplains can provide a number of natural resources and benefits, including storage of floodwaters, open space and recreation, water quality protection, erosion control, and preservation of natural habitats. Retaining the natural resources and functions of floodplains can not only reduce the frequency and consequences of flooding but also minimize stormwater management and nonpoint pollution problems. Through natural resource planning, these objectives can be achieved at substantially reduced overall costs.

> ***Measures for preserving floodplain functions and resources typically include:***
>
> - ***Adoption and enforcement of floodplain regulations to control or prohibit development that will alter natural resources***
> - ***Development and redevelopment policies focused on resource protection***
> - ***Information and education for both community and individual decision makers***
> - ***Review of community programs to identify opportunities for floodplain preservation***

Projects that improve the natural condition of areas or to restore diminished or destroyed resources can reestablish an environment in which the functions and values of these resources are again optimized. Acquisitions of floodprone property with conversion to open space are the most common of these types of projects. Administrative measures that assist such projects include the development of land reuse policies focused on resource restoration and review of community programs to identify opportunities for floodplain restoration.

Based on the above guidelines, the following specific *natural resource protection* mitigation measures are recommended to help prevent damage from inland and nuisance flooding:

- Pursue additional open space properties in floodplains by purchasing floodprone structures and converting the parcels to open space.
- Pursue the acquisition of additional municipal open space properties as discussed in the *Plan of Conservation and Development.*

- ❑ Selectively pursue conservation objectives listed in the Plan of Conservation and Development and/or more recent planning studies and documents.
- ❑ Continue to regulate development in protected and sensitive areas, including steep slopes, wetlands, and floodplains.

3.6.6 Structural Projects

Structural projects include the construction of new structures or modification of existing structures (e.g., floodproofing) to lessen the impact of a flood event. Examples of structural projects include:

- ❑ Stormwater controls such as drainage systems, detention dams and reservoirs, and culvert resizing can be employed to modify flood flow rates.
- ❑ On-site detention can provide temporary storage of stormwater runoff.
- ❑ Barriers such as levees, floodwalls, and dikes physically control the hazard to protect certain areas from floodwaters.
- ❑ Channel alterations can be made to confine more water to the channel and modify flood flows.
- ❑ Individuals can protect private property by raising structures and constructing walls and levees around structures.

Care should be taken when using these techniques to ensure that problems are not exacerbated in other areas of the impacted watersheds.

3.7 Summary of Specific Strategies and Actions

While many potential mitigation activities were addressed in Section 3.6, the recommended mitigation strategies for addressing inland flooding problems in the Town of Bridgewater are listed below.

Prevention

- ❑ Consider updating the Town Floodplain Ordinance in order to put additional restrictions on floodplain development.
- ❑ Require developers to demonstrate whether detention or retention of stormwater is the best option for reducing peak flows downstream of a project and provide a design for the appropriate alternative.

Property Protection

- ❑ Consider conducting a Wewaka Brook flood mitigation study to identify appropriate methods of reducing flood risk along the stream corridor.
- ❑ Evaluate the small number of floodprone properties along Wewaka Brook to determine potential flood damage reduction methods for these properties.
- ❑ Provide technical assistance regarding floodproofing measures to interested residents. Pursue funding for home elevations should any residents become interested.

Public Education

- Compile a checklist that cross-references the bylaws, regulations, and codes related to flood damage prevention that may be applicable to a proposed project and make this list available to potential applicants. The information in Section 3.4 provides a starting point for this list.

Natural Resource Protection

- Develop an open space acquisition program as recommended in the POCD.
- Pursue the acquisition of additional municipal open space inside SFHAs and set it aside as greenways, parks, and undeveloped land.
- Develop buffer zone requirements for land adjacent to water as recommended in the POCD.

Structural Projects

- Identify locations for stormwater detention/retention in the town center area and alond Route 133 to reduce peak flows that cause flash flood conditions and streambank erosion along Clapboard Oak Brook.
- Pursue streambank stabilization improvements along Clapboard Oak Brook.
- Review culvert conveyances based on existing hydrology and Northeast Regional Climate Center guidance and develop a priority list of culverts for replacement.
- When replacing or upgrading culverts, work with CT DOT to incorporate findings of the climate change pilot study.

In addition, mitigation strategies important to all hazards are included in Section 10.1.

4.0 HURRICANES

4.1 Setting

Several types of hazards may be associated with tropical storms and hurricanes including heavy or tornado winds, heavy rains, and flooding. While only some of the areas of Bridgewater are susceptible to flooding damage caused by hurricanes, wind damage can occur anywhere in the town. Hurricanes, therefore, have the potential to affect any area within the Town of Bridgewater. A hurricane striking Bridgewater is considered a possible event each year and could cause critical damage to the town and its infrastructure.

4.2 Hazard Assessment

Hurricanes are a class of tropical cyclones that are defined by the National Weather Service as warm-core, nonfrontal, low-pressure, large-scale systems that develop over tropical or subtropical water and have definite organized circulations. Tropical cyclones are categorized based on the speed of the sustained (one-minute average) surface wind near the center of the storm. These categories are Tropical Depression (winds less than 39 miles per hour [mph]), Tropical Storm (winds 39-74 mph, inclusive), and Hurricanes (winds at least 74 mph).

The geographic areas affected by tropical cyclones are called tropical cyclone basins. The Atlantic tropical cyclone basin is one of six in the world and includes much of the North Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico. The official Atlantic hurricane season begins on June 1 and extends through November 30 of each year although occasionally hurricanes occur outside this period.

Inland Connecticut is vulnerable to hurricanes despite moderate hurricane occurrences when compared with other areas within the Atlantic tropical cyclone basin. Since hurricanes tend to weaken within 12 hours of landfall, inland areas are relatively less susceptible to hurricane wind damages than coastal areas in Connecticut; however, the heaviest rainfall often occurs inland as was seen in Tropical Storm Irene in 2011. Therefore, inland areas are vulnerable to riverine and urban flooding during a hurricane.

<u>The Saffir-Simpson Scale</u>

The "Saffir-Simpson Hurricane Scale" was used prior to 2009 to categorize hurricanes based upon wind speed, central pressure, and storm surge, relating these components to damage potential. In 2009, the scale was revised and is now called the "Saffir-Simpson Hurricane Wind Scale." The modified scale is more scientifically defensible and is predicated only on surface wind speeds. The following descriptions are from the 2014 *Connecticut Natural Hazard Mitigation Plan Update*.

A <u>Hurricane Watch</u> is an advisory for a specific area stating that a hurricane poses a threat to coastal and inland areas. Individuals should keep tuned to local television and radio for updates.

A <u>Hurricane Warning</u> is then issued when the dangerous effects of a hurricane are expected in the area within 24 hours.

- **Category One Hurricane:** Sustained winds 74-95 mph (64-82 kt). Minimal Damage: Damage is primarily to shrubbery, trees, foliage, and unanchored mobile homes. No real damage occurs in building structures. Some damage is done to poorly constructed signs.

- **Category Two Hurricane:** Sustained winds 96-110 mph (83-95 kt). Moderate Damage: Considerable damage is done to shrubbery and tree foliage, some trees are blown down. Major structural damage occurs to exposed mobile homes. Extensive damage occurs to poorly constructed signs. Some damage is done to roofing materials, windows, and doors; no major damage occurs to the building integrity of structures.

- **Category Three Hurricane:** Sustained winds 111-130 mph (96-113 kt). Extensive damage: Foliage torn from trees and shrubbery; large trees blown down. Practically all poorly constructed signs are blown down. Some damage to roofing materials of buildings occurs, with some window and door damage. Some structural damage occurs to small buildings, residences and utility buildings. Mobile homes are destroyed. There is a minor amount of failure of curtain walls (in framed buildings).

- **Category Four Hurricane:** Sustained winds 131-155 mph (114-135 kt). Extreme Damage: Shrubs and trees are blown down; all signs are down. Extensive roofing material and window and door damage occurs. Complete failure of roofs on many small residences occurs, and there is complete destruction of mobile homes. Some curtain walls experience failure.

- **Category Five Hurricane:** Sustained winds greater than 155 mph (135 kt). Catastrophic Damage: Shrubs and trees are blown down; all signs are down. Considerable damage to roofs of buildings. Very severe and extensive window and door damage occurs. Complete failure of roof structures occurs on many residences and industrial buildings, and extensive shattering of glass in windows and doors occurs. Some complete buildings fail. Small buildings are overturned or blown away. Complete destruction of mobile homes occurs.

4.3 Historic Record

Through research efforts by the National Oceanic and Atmospheric Administration's (NOAA) National Climate Center in cooperation with the National Hurricane Center, records of tropical cyclone occurrences within the Atlantic cyclone basin have been compiled from 1851 to present. These records are compiled in NOAA's hurricane database (HURDAT), which contains historical data recently reanalyzed to current scientific standards as well as the most current hurricane data. During HURDAT's period of record (1851-2011), two Category Three Hurricanes, seven Category Two Hurricanes, seven Category One Hurricanes, and 39 tropical storms have tracked within a 150-nautical-mile radius of Bridgewater. The representative storm strengths were measured as the peak intensities for each individual storm passing within the 150-mile radius. The 16 hurricanes noted above occurred in August through October as noted in Table 4-1.

Table 4-1
Tropical Cyclones by Month Within 150 Miles of Bridgewater Since 1851

Category	July	August	September	October
Tropical Storm[1]	6	13	12	5
One	0	2	3	2
Two	0	3	3	1
Three	0	0	2	0
Total	**6**	**18**	**20**	**8**

[1]One tropical storm occurred in May, one occurred in June, and one occurred in November.

A description of the historic record of tropical cyclones near Bridgewater follows:

- The most devastating hurricane to strike Connecticut, and believed to be the strongest hurricane to hit New England in recorded history, is believed to have been a Category Three Hurricane at its peak. Dubbed the "Long Island Express of September 21, 1938," this name was derived from the unusually high forward speed of the hurricane (estimated to be 70 mph). As a Category Two Hurricane, the center of the storm passed over Long Island, made landfall near Milford, Connecticut, and moved quickly northward into northern New England.

  The majority of damage was caused from storm surge and wind damage. Surges up to 18 feet were recorded along portions of the Connecticut coast, and 130 mile per hour gusts flattened forests, destroyed nearly 5,000 cottages, farms, and homes, and damaged an estimated 15,000 more throughout New York and southern New England. The storm resulted in catastrophic fires in New London and Mystic, Connecticut. Fourteen to 17 inches of rain were reported in central Connecticut, causing severe flooding. Overall, the storm left an estimated 564 dead, 1,700 injured, and caused physical damages in excess of $38 million (1938 USD).

- The "Great Atlantic Hurricane" hit the Connecticut coast in September 1944. This storm was a Category Three Hurricane at its peak intensity but was a Category One Hurricane when its center passed over eastern Long Island and made landfall near New London, Connecticut. The storm brought rainfall in excess of six inches to most of the state and rainfall in excess of eight to 10 inches in Fairfield County. Most of the wind damage from this storm occurred in southeastern Connecticut although wind gusts of 109 mph were reported in Hartford, Connecticut. Injuries and storm damage were lower in this hurricane than in 1938 because of increased warning time and fewer structures located in vulnerable areas due to the lack of rebuilding after the 1938 storm.

- Another Category Two Hurricane, Hurricane Carol (naming of hurricanes began in 1950), made landfall near Clinton, Connecticut in late August of 1954 shortly after high tide and produced storm surges of 10 to 15 feet in southeastern Connecticut. This storm was also a Category Three Hurricane at peak intensity. Rainfall amounts of six inches were recorded in New London, and wind gusts peaked at over 100 mph. Near the coast, the combination of strong winds and storm surge damaged or destroyed thousands of buildings, and the winds toppled trees that left most of the eastern part of the state without power. Overall damages in the northeast were estimated at one billion dollars (1954 USD), and 48 people died as a direct result of the hurricane.

- Hurricane Edna was a Category Two Hurricane when its center passed southeast of Long Island in September 1954.

- The year 1955 was a devastating year for flooding in Connecticut. Connie was a declining tropical storm over the Midwest when its effects hit Connecticut in August 1955, producing heavy rainfall of four to six inches across the state. The saturated soil conditions exacerbated the flooding caused by Tropical Storm Diane five days later, the wettest tropical cyclone on record for the northeast. The storm produced 14 inches of rain in a 30-hour period, causing destructive flooding conditions along nearly every major river system in the state. When heavy rains caused the flood of October 1955, serious flooding was reported along Harbor Brook in downtown Bridgewater.

- Hurricane Donna of 1960 was a Category Four Hurricane when it made landfall in southwestern Florida and weakened to a Category Two hurricane when it made landfall near Old Lyme, Connecticut.

- Hurricane Belle of August 1976 was a Category One Hurricane as it passed over Long Island but was downgraded to a tropical storm before its center made landfall near Stratford, Connecticut. Belle caused five fatalities and minor shoreline damage.

- Hurricane Gloria of September 1985 was a Category Three Hurricane when it made landfall in North Carolina and weakened to a Category Two Hurricane before its center made landfall near Bridgeport, Connecticut. The hurricane struck at low tide, resulting in low to moderate storm surges along the coast. The storm produced up to six inches of rain in some areas and heavy winds that damaged structures and uprooted thousands of trees. The amount and spread of debris and loss of power were the major impacts from this storm, with over 500,000 people suffering significant power outages.

- Hurricane Bob was a Category Two Hurricane when its center made landfall in Rhode Island in August 1991. The hurricane caused storm surge damage along the Connecticut coast but was more extensively felt in Rhode Island and Massachusetts. Heavy winds were felt across eastern Connecticut with gusts up to 100 mph and light to moderate tree damage. The storm was responsible for six deaths in the state. Total damage in southern New England was approximately $680 million (1991 USD).

- Tropical Storm Floyd seriously impacted Connecticut in 1999. Floyd was formerly the storm of record in the Connecticut Natural Hazard Mitigation Plan and is discussed in more detail in Section 3.3 due to heavy rainfall that caused widespread flood damage. The winds associated with Tropical Storm Floyd also caused power outages throughout New England and at least one death in Connecticut.

- Hurricane Irene peaked as a Category Three storm before it made landfall in North Carolina and tracked northward along the Delmarva Peninsula and New Jersey before the remnants of the eye crossed over New York Town on Sunday, August 28, 2011. Moderate flooding occurred in central Bridgewater but major flooding occurred along the Housatonic River. More than half of the state (over 754,000 customers) was without power following the storm, with some areas not having electricity restored for more than a week. Ten deaths were attributed to the storm in Connecticut. In Bridgewater, power outages lasted approximately five days and tree damage and damage to power lines were the biggest impact. Bridgewater worked with CL&P and expressed concern that shutting off downed live wires and clearing roads for emergency purposes was more important than restoring power.

- Hurricane Sandy struck the Connecticut shoreline as a Category 1 Hurricane in late October 2012, causing power outages for 600,000 customers and at least $360 million in damages in Connecticut. Bridgewater fared well during Hurricane Sandy and no major damages were reported; however power outages lasted approximately three days. Bridgewater's public assistance reimbursement for this storm totaled $24,707.

4.4 Existing Capabilities

Flooding

Existing mitigation measures appropriate for flooding were discussed in Section 3.0. These include the ordinances, codes, and regulations that have been enacted to minimize flood damage. In addition, various structures exist to protect certain areas, including dam and local flood protection projects.

Wind

Wind loading requirements are addressed through the state building code. The 2005 Connecticut State Building Code was amended in 2011 and adopted with an effective date of October 6, 2011, and subsequently amended to adopt the 2009 International Residential Code (IRC) effective February 28, 2014. The code specifies the design wind speed for construction in all the Connecticut municipalities, with the addition of split zones for some towns. For example, for towns along the Merritt Parkway such as Fairfield and Trumbull, wind speed criteria are different north and south of the parkway in relation to the distance from the shoreline. Effective December 31, 2005, the design wind speed for Bridgewater is 95 miles per hour. Bridgewater has adopted the Connecticut Building Code as its building code.

Connecticut is located in FEMA Zone II regarding maximum expected wind speed. The maximum expected wind speed for a three-second gust is 160 mph. This wind speed could occur as a result of either a hurricane or a tornado in western Connecticut and southeastern New York. The American Society of Civil Engineers recommends that new buildings be designed to withstand this peak three-second gust.

Parts of tall and older trees may fall during heavy wind events, potentially damaging structures, utility lines, and vehicles. Therefore, Bridgewater maintains an aggressive tree and tree limb trimming program. The town Tree Warden is Bud Wright and the tree trimming budget is $30,000 a year to subcontract trimming. The Tree Warden is aware of approximately ten to twelve dead trees in Bridgewater that must be addressed.

Connecticut Light & Power, the local electric utility, provides tree maintenance near its power lines and was under intense scrutiny after storms Irene and Alfred in 2011. The utility has reportedly done an adequate job trimming trees since 2011.

During emergencies, the Town currently has three designated emergency shelters available for residents as discussed in Section 2.9. During Tropical Storm Irene, the Town used the CT Alert system to notify all residents in the SFHA that they may evacuate and use one of the shelters.

The Board of Education used its notification system to notify people on its list of emergency procedures. Prior to severe storm events, the Town ensures that warning/notification systems and communication equipment are working properly and prepares for the possible evacuation of impacted areas.

4.5 Vulnerabilities and Risk Assessment

NOAA issues an annual hurricane outlook to provide a general guide to each upcoming hurricane season based on various climatic factors. However, it is impossible to predict exactly when and where a hurricane will occur. NOAA believes that "hurricane landfalls are largely determined by the weather patterns in places the hurricane approaches, which are only predictable within several days of the storm making landfall."

NOAA has utilized the National Hurricane Center Risk Analysis Program (HURISK) to determine return periods for various hurricane categories at locations throughout the United States. As noted on the NOAA website, hurricane return periods are the frequency at which a certain intensity or category of hurricane can be expected with 75 nautical miles of a given location. For example, a return period of 20 years for a particular category storm means that on average during the previous 100 years a storm of that category passed within 75 nautical miles of that location five times. Thus, it is expected that similar category storms would pass within that radius an additional five times during the next 100 years.

Table 4-2 presents return periods for various category hurricanes to impact Connecticut. The nearest two HURISK analysis points were New York Town and Block Island, Rhode Island. For this analysis, these data are assumed to represent western Connecticut and eastern Connecticut, respectively.

Table 4-2
Return Period (in Years) for Hurricanes to Strike Connecticut

Category	New York City (Western Connecticut)	Block Island, Rhode Island (Eastern Connecticut)
One	17	17
Two	39	39
Three	68	70
Four	150	160
Five	370	430

According to the 2014 *Connecticut Natural Hazard Mitigation Plan Update*, hurricanes have the greatest destructive potential of all natural disasters in Connecticut due to the potential combination of high winds, storm surge and coastal erosion, heavy rain, and flooding that can accompany the hazard. It is generally believed that New England is long overdue for another major hurricane strike. As shown in Table 4-2, NOAA estimates that the return period for a Category Two or Category Three storm to strike Litchfield County to be 39 years and 68 years, respectively. The last major hurricane to impact Connecticut was Hurricane Bob in 1991. Category One Hurricane Earl in 2010 and Tropical Storm Irene in 2011 were reminders that hurricanes do track close to Connecticut.

The 2014 *Connecticut Natural Hazard Mitigation Plan Update* also notes that some researchers have suggested that the intensity of tropical cyclones has increased over the last 35 years, with some believing that there is a connection between this increase in intensity and climate change. While most climate simulations agree that greenhouse warming enhances the frequency and intensity of tropical storms, models of the climate system are still limited by resolution and computational ability. However, given the past history of major storms and the possibility of increased frequency and intensity of tropical storms due to climate change, it is prudent to expect that there will be hurricanes impacting Connecticut in the near future that may be of greater frequency and intensity than in the past.

<u>Tropical Cyclone Vulnerability</u>

In general, as the residents and businesses of the state of Connecticut become more dependent on the internet and mobile communications, the impact of hurricanes on commerce will continue to increase. A major hurricane has the potential of causing complete disruption of power and communications for up to several weeks, rendering electronic devices and those that rely on utility towers and lines inoperative.

Debris such as signs, roofing material, and small items left outside become flying missiles in hurricanes. Extensive damage to trees, towers, aboveground and underground utility lines (from uprooted trees or failed infrastructure), and fallen poles cause considerable disruption for residents. Streets may be flooded or blocked by fallen branches, poles, or trees, preventing egress. Downed power lines from heavy winds can also start fires during hurricanes with limited rainfall.

The Town of Bridgewater is vulnerable to hurricane damage from wind and flooding and from any tornadoes accompanying the storm. In fact, most of the damage to the town from historical tropical cyclones has been due to the effects of flooding. Factors that influence vulnerability to tropical cyclones in the town include building codes currently in place, local zoning and development patterns, and the age and number of structures located in highly vulnerable areas of the community. Bridgewater town officials report that the large southerly and westerly exposures in the town create significant wind vulnerabilities.

The population of the Town of Bridgewater is not estimated to grow, and development pressures are low. Even minor areas of growth and development increase the town's vulnerability to natural hazards such as hurricanes, although new development is expected to mitigate potential damage by meeting the standards of the most recent building code.

Bridgewater's housing stock consists of historic buildings greater than 50 and sometimes 100 years old, relatively younger buildings built before 1990 when the building code changed to address wind damage, and relatively recent buildings that utilize the new code changes. Since most of the existing housing stock in the town predates the recent code changes, many structures are highly susceptible to roof and window damage from high winds.

Some critical facilities are more susceptible than others to flooding damage associated with hurricane rainfall. Such facilities susceptible to flooding were discussed in Section 3.5.

As the Town of Bridgewater is not affected by storm surge, hurricane sheltering needs have not been calculated by the U.S. Army Corps of Engineers for the town. The Town determines sheltering need based upon areas damaged or needing to be evacuated within the town. Under limited emergency conditions, a high percentage of evacuees will seek shelter with friends or relatives rather than go to established shelters. During extended power outages, it is believed that only 10% to 20% of the affected population of the town will relocate while most will stay in their homes until power is restored. In the case of a major (Category Three or above) hurricane, it is likely that the Town will depend on state and federal aid to assist sheltering displaced populations until normalcy is restored.

Loss Estimates

In order to quantify potential hurricane damage, HAZUS-MH simulations were run for historical and probabilistic storms that could theoretically affect Bridgewater. For the historical simulations, the results estimate the potential maximum damage that would occur in the present day (based on year 2006 dollar values using year 2000 census data) given the same storm track and characteristics of each event. The probabilistic storms estimate the potential maximum damage that would occur based on wind speeds of varying return periods. Note that the simulations calculate damage for wind effects alone and not damages due to flooding or other non-wind effects. Thus, the damage and displacement estimates presented below are likely lower than would occur during a hurricane associated with severe rainfall. Results are presented in Appendix E and summarized below.

Figure 4-1 depicts the spatial relationship between the two historical storm tracks used for the HAZUS simulations (Hurricane Gloria in 1985 and the 1938 hurricane) and Bridgewater. These two storm tracks produced the highest winds to affect Bridgewater out of all the hurricanes in the HAZUS-MH software.

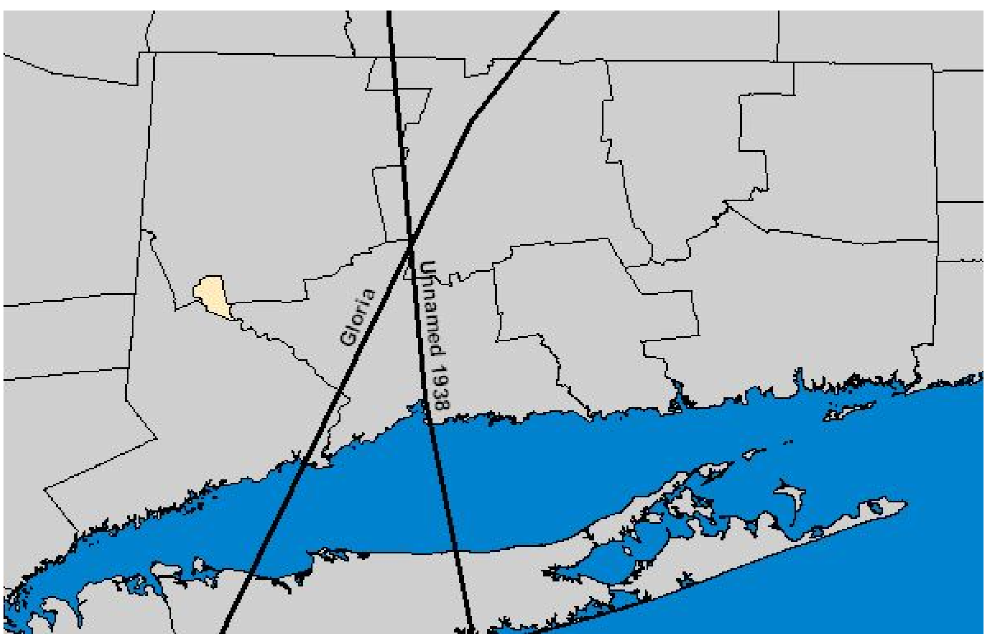


Figure 4-1: Historical Hurricane Storm Tracks

The FEMA default values were used for each census tract in the HAZUS simulations. A summary of the default building counts and values was shown in Table 3-3.

The FEMA *Hurricane Model HAZUS-MH Technical Manual* outlines various damage thresholds to classify buildings damaged during hurricanes. The five classifications are summarized below:

- **No Damage or Very Minor Damage**: Little or no visible damage from the outside. No broken windows or failed roof deck. Minimal loss of roof cover, with no or very limited water penetration.
- **Minor Damage**: Maximum of one broken window, door, or garage door. Moderate roof cover loss that can be covered to prevent additional water entering the building. Marks or dents on walls requiring painting or patching for repair.
- **Moderate Damage**: Major roof cover damage, moderate window breakage. Minor roof sheathing failure. Some resulting damage to interior of building from water.
- **Severe Damage**: Major window damage or roof sheathing loss. Major roof cover loss. Extensive damage to interior from water. Limited, local joist failures. Failure of one wall.
- **Destruction:** Essentially complete roof failure and/or more than 25% of roof sheathing. Significant amount of the wall envelope opened through window failure and/or failure of more than one wall. Extensive damage to interior.

Table 4-3 presents the peak wind speeds during each wind event simulated by HAZUS for Bridgewater. The number of expected residential buildings to experience various classifications of damage is presented in Table 4-3, and the total number of buildings expected to experience various classifications of damage is presented in Table 4-4. Minimal damage is expected to buildings for wind speeds less than 72 mph, with overall damages increasing with increasing wind speed.

Table 4-3
HAZUS Hurricane Scenarios – Number of Residential Buildings Damaged

Return Period or Storm	Peak Wind Gust (mph)	Minor Damage	Moderate Damage	Severe Damage	Total Destruction	Total
10-Years	40	None	None	None	None	None
20-Years	54	None	None	None	None	None
Gloria (1985)	60	None	None	None	None	None
50-Years	71	1	None	None	None	1
100-Years	83	17	None	None	None	17
200-Years	93	66	4	None	None	70
Unnamed (1938)	96	86	6	None	None	92
500-Years	105	178	25	1	1	205
1000-Years	114	279	69	6	5	359

Table 4-4
HAZUS Hurricane Scenarios – Total Number of Buildings Damaged

Return Period or Storm	Minor Damage	Moderate Damage	Severe Damage	Total Destruction	Total
10-Years	None	None	None	None	None
20-Years	None	None	None	None	None
Gloria (1985)	None	None	None	None	None
50-Years	2	None	None	None	2
100-Years	18	None	None	None	18
200-Years	71	5	None	None	76
Unnamed (1938)	92	7	None	None	99
500-Years	193	28	1	1	223
1000-Years	304	79	8	5	396

The HAZUS simulations consider a subset of critical facilities termed "essential facilities" which are important during emergency situations. Note that the essential facilities in HAZUS-MH may not necessarily be the same today as they were in 2000. Nevertheless, the information is useful from a planning standpoint. As shown in Table 4-5 minor damage to schools occurs at wind speeds of approximately 105 mph and greater with loss of use to all schools.

Table 4-5
HAZUS-MH Hurricane Scenarios – Essential Facility Damage

Return Period or Storm	Fire Stations (1)	Police Stations (1)	Schools (1)
10-Years	None or Minor	None or Minor	None or Minor
20-Years	None or Minor	None or Minor	None or Minor
Gloria (1985)	None or Minor	None or Minor	None or Minor
50-Years	None or Minor	None or Minor	None or Minor
100-Years	None or Minor	None or Minor	None or Minor
200-Years	None or Minor	None or Minor	None or Minor
Unnamed (1938)	None or Minor	None or Minor	None or Minor
500-Years	None or Minor	None or Minor	Minor damage with loss of use to all schools
1000-Years	None or Minor	None or Minor	Minor damage with loss of use to all schools

Table 4-6 presents the estimated tonnage of debris that would be generated by wind damage during each HAZUS storm scenario. The model breaks the debris into four general categories based on the different types of material handling equipment necessary for cleanup. As shown in Table 4-6, minimal debris are expected for storms less than the 50-year event, and reinforced concrete and steel buildings are not expected to generate debris. Much of the debris that is generated is structure-related.

Table 4-6
HAZUS-MH Hurricane Scenarios – Debris Generation (Tons)

Return Period or Storm	Brick / Wood	Reinforced Concrete / Steel	Eligible Tree Debris	Other Tree Debris	Total
10-Years	None	None	None	None	None
20-Years	None	None	None	None	None
Gloria (1985)	None	None	None	None	None
50-Years	4	None	None	None	4
100-Years	37	None	298	3,010	3,345
200-Years	113	None	546	5,518	6,177
Unnamed (1938)	150	None	595	6,021	6,766
500-Years	360	None	992	10,034	11,386
1000-Years	835	None	2,233	22,576	25,644

Table 4-7 presents the potential sheltering requirements based on the various wind events simulated by HAZUS. No sheltering requirements are predicted in the model for Bridgewater until the 500 year storm; however, it is likely that hurricanes will also produce heavy rain and flooding that will increase the overall sheltering need in Bridgewater.

Table 4-7
HAZUS Hurricane Scenarios – Shelter Requirements

Return Period or Storm	Number of Displaced Households	Short Term Sheltering Need (Number of People)
10-Years	None	None
20-Years	None	None
Gloria (1985)	None	None
50-Years	None	None
100-Years	None	None
200-Years	None	None
Unnamed (1938)	None	None
500-Years	None	None
1000-Years	6	1

Table 4-8 presents the predicted economic losses due to the various simulated wind events. Property damage loss estimates include the subcategories of building, contents, and inventory damages. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building or its contents. Business interruption loss estimates include the subcategories of lost income, relocation expenses, and lost wages. The business interruption losses are associated with the inability to operate a business due to the damage sustained during a hurricane, and also include temporary living expenses for those people displaced from their home because of the storm.

Table 4-8
HAZUS Hurricane Scenarios – Economic Losses

Return Period or Storm	Residential Property Damage Losses	Total Property Damage Losses	Business Interruption (Income) Losses	Total Losses
10-Years	None	None	None	None
20-Years	None	None	None	None
Gloria (1985)	$15,640	$15,640	None	$15,640
50-Years	$109,420	$112,820	$20	$112,840
100-Years	$456,310	$469,310	$24,270	$493,580
200-Years	$1,050,170	$1,098,840	$44,780	$1,143,630
Unnamed (1938)	$1,307,170	$1,373,890	$48,640	$1,422,540
500-Years	$2,925,060	$3,163,640	$234,030	$3,397,660
1000-Years	$7,678,550	$8,408,310	$946,460	$9,354,780

Losses are minimal for storms with return periods of less than 20-years (54 mph) but increase rapidly as larger storms are considered. For example, a reenactment of the 1938 hurricane would cause approximately $1.4 million in wind damages to Bridgewater. As these damage values are based on 2006 dollars, it is likely that these estimated damages will be higher today due to inflation.

In summary, hurricanes are a very real and potentially costly hazard to Bridgewater. Town officials have indicated that due to their location, south and west wind exposures and very high, making the town extremely vulnerable to wind damage. However based on the historic record and HAZUS-MH simulations of various wind events, the entire community is vulnerable to wind damage from hurricanes. These damages can include direct structural damages, interruptions to business and commerce, emotional impacts, and injury and possibly death.

4.6 Potential Mitigation Strategies and Actions

Many potential mitigation measures for hurricanes include those appropriate for inland flooding. These were presented in Section 3.6. However, hurricane mitigation measures must also address the effects of heavy winds that are inherently caused by hurricanes. Mitigation for wind damage is therefore emphasized in the subsections below.

4.6.1 Prevention

Although hurricanes and tropical storms cannot be prevented, a number of methods are available to continue preventing damage from the storms and perhaps to mitigate damage. The following actions have been identified as potential preventive measures:

- ❑ Perform periodic tree limb inspection and maintenance programs to ensure that the potential for downed power lines is diminished.
- ❑ Continue requiring the location of utilities underground in new developments or during redevelopment whenever possible.
- ❑ Continue to review and update the currently enacted Emergency Operations Plan, evacuation plans, supply distribution plans, and other emergency planning documents for the town as appropriate.

- Develop a phased approach to replacing aboveground utility lines with underground utility lines, taking advantage of opportunities such as streetscaping projects.

4.6.2 Property Protection

Most people perform basic property protection measures in advance of hurricanes, including cutting dangerous tree limbs, boarding windows, and moving small items inside that could be carried away by heavy winds. Property protection measures for hurricanes include those described for flooding in Section 3.6.2 due to the potential for heavy rainfall to accompany the storm. In terms of new construction and retrofits, various structural projects for wind damage mitigation on buildings are described in Section 4.6.5.

The local tree warden should attempt education and outreach regarding dangerous trees on private property, particularly for trees near homes with dead branches overhanging the structure or nearby power lines. These limbs are the most likely to fall during a storm.

4.6.3 Emergency Services

The EOP of the Town includes guidelines and specifications for communication of hurricane warnings and watches as well as for a call for evacuation. The public needs to be made aware of evacuation routes and the locations of public shelters in advance of a hurricane event, which can be accomplished (1) by placing this information on the Town website, (2) by creating informational displays in local municipal buildings and high traffic businesses such as supermarkets, and (3) through press releases to local radio and television stations and local newspapers. Bridgewater should identify and prepare additional facilities for evacuation and sheltering needs. The Town should also continue to review its mutual aid agreements and update as necessary to ensure that help is available as needed and that the town is not hindered responding to its own emergencies as it assists with regional emergencies.

4.6.4 Public Education and Awareness

Tracking of hurricanes has advanced to the point where areas often have one week of warning time or more prior to a hurricane strike. The public should be made aware of available shelters prior to a hurricane event, as well as potential measures to mitigate personal property damage. This was discussed in Section 4.6.3 above. A number of specific proposals for improved public education are recommended to prevent damage and loss of life during hurricanes. These are common to all hazards in this Plan and are listed in Section 10.1.

4.6.5 Structural Projects

While structural projects to completely eliminate wind damage are not possible, potential structural mitigation measures for buildings include designs for hazard-resistant construction and retrofitting techniques. These generally take the form of increased wind and flood resistance as well as the use of storm shutters over exposed glass and the inclusion of hurricane straps to hold roofs to buildings. The four categories of structural projects for wind damage mitigation in private homes and critical facilities include the installation of shutters, load path projects, roof projects, and code plus projects and are defined below.

- Shutter mitigation projects protect all windows and doors of a structure with shutters, lamentations, or other systems that meet debris impact and wind pressure design requirements. All openings of a building are to be protected, including garage doors on residential buildings, large overhead doors on commercial buildings, and apparatus bay doors at fire stations.
- Load path projects improve and upgrade the structural system of a building to transfer loads from the roof to the foundation. This retrofit provides positive connection from the roof framing to the walls, better connections within the wall framing, and connections from the wall framing to the foundation system.
- Roof projects involve retrofitting a building's roof by improving and upgrading the roof deck and roof coverings to secure the building envelope and integrity during a wind or seismic event.
- Code plus projects are those designed to exceed the local building codes and standards to achieve a greater level of protection.

Given the relative infrequency of hurricane wind damage in the Town of Bridgewater, it is unlikely that any structural project for mitigating wind damage would be cost effective unless it was for a critical facility. The Town should encourage the above measures in new construction and require it for new critical facilities. Continued compliance with the amended Connecticut Building Code for wind speeds is necessary. Literature should be made available by the Building Department to developers during the permitting process regarding these design standards.

4.7 Summary of Specific Strategies and Actions

While many potential mitigation activities were addressed in Section 4.6, the recommended mitigation strategies for mitigating hurricane and tropical storm winds in the Town of Bridgewater are listed below.

- Develop a plan to address dead trees throughout the town in an effort to minimize damage from falling trees.
- Work with CL&P to determine the feasibility of placing non-conducting steel cables above the power lines to protect them from falling branches and trees.
- Encourage the use of structural techniques related to mitigation of wind damage in new residential and commercial structures to protect new buildings to a standard greater than the minimum building code requirements. Require such improvements for new municipal critical facilities, for example if the new EOC is constructed.

In addition, important recommendations that apply to all hazards are listed in Section 10.1.

5.0 SUMMER STORMS AND TORNADOES

5.1 Setting

Like hurricanes and winter storms, summer storms and tornadoes have the potential to affect any area within the Town of Bridgewater. Furthermore, because these types of storms and the hazards that result (flash flooding, wind, hail, and lightning) might have limited geographic extent, it is possible for a summer storm to harm one area within the town without harming another. The entire Town of Bridgewater is therefore susceptible to summer storms (including heavy rain, flash flooding, wind, hail, and lightning) and tornadoes.

Based on the historic record, it is considered highly likely that a summer storm that includes lightning will impact the Town of Bridgewater each year although lightning strikes have a limited effect. Strong winds and hail are considered likely to occur during such storms but also generally have limited effects. A tornado is considered a possible event in Litchfield County each year that could cause significant damage to a small area.

5.2 Hazard Assessment

Heavy wind (including tornadoes and downbursts), lightning, heavy rain, hail, and flash floods are the primary hazards associated with summer storms. Flooding caused by heavy rainfall was covered in Section 3.0 of this Plan and will not be discussed in detail herein.

Tornadoes

NOAA defines a tornado as "a violently rotating column of air extending from a thunderstorm to the ground." The two types of tornadoes include those that develop from supercell thunderstorms and those that do not. While the physics of tornado development are fairly well understood, there are many unknowns still being studied regarding the exact conditions in a storm event required to trigger a tornado, the factors affecting the dissipation of a tornado, and the effect of cloud seeding on tornado development.

Supercell thunderstorms are long lived (greater than one hour) and highly organized storms feeding off an updraft that is tilted and rotating. This rotation is referred to as a "mesocyclone" when detected by Doppler radar. The figure below is a diagram of the anatomy of a supercell that has spawned a supercell tornado. Tornadoes that form from a supercell thunderstorm are a very small extension of the larger rotation; they are the most common and the most dangerous type of tornado as most large and violent tornadoes are spawned from supercells.

Non-supercell tornadoes are defined by NOAA as circulations that form without a rotating updraft. Damage from these types of tornadoes tends to be F2 or less (see Fujita Scale, below). The two types of non-supercell tornadoes are gustnadoes and landspouts.

- A gustnado is a whirl of dust or debris at or near the ground with no condensation tunnel that forms along the gust front of a storm.

- A landspout is a narrow, ropelike condensation funnel that forms when the thunderstorm cloud is still growing and there is no rotating updraft. Thus, the spinning motion originates near the ground. Waterspouts are similar to landspouts but occur over water.

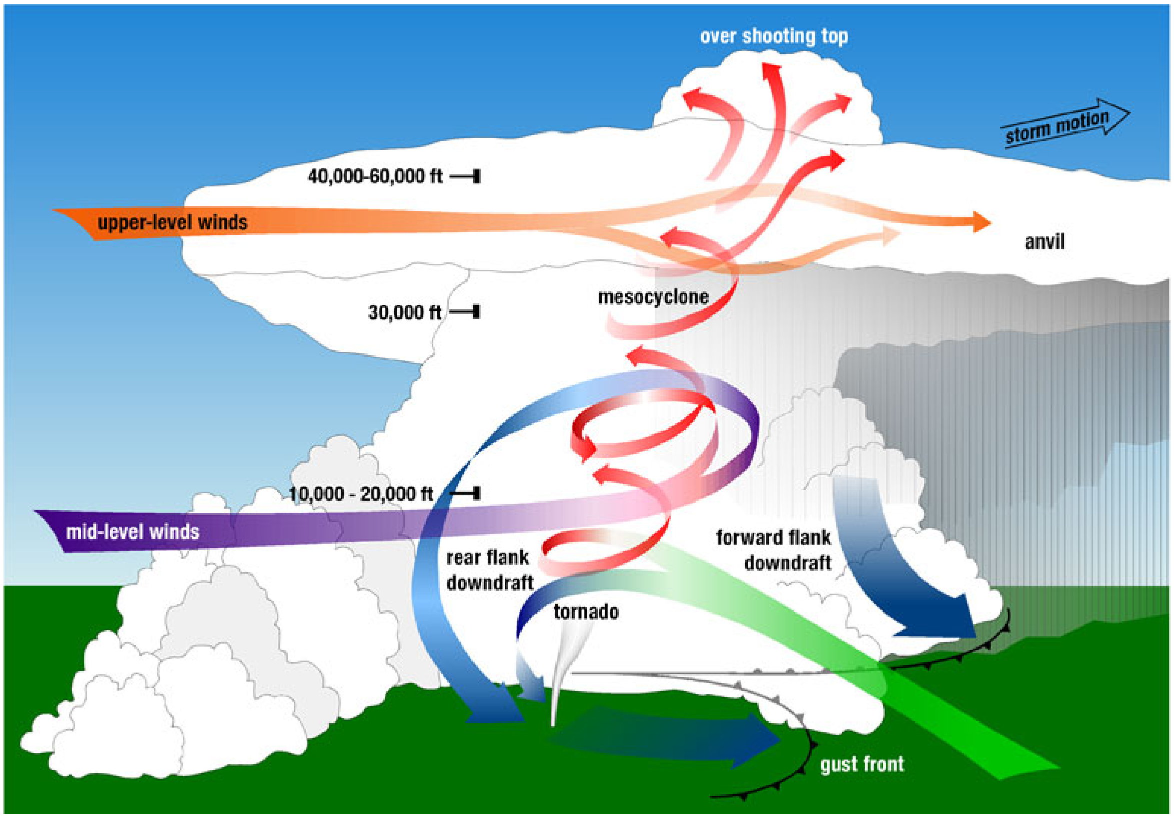
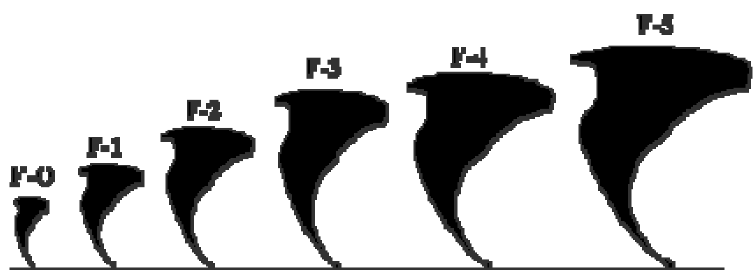


Figure 5-1: Anatomy of a Tornado. Image from NOAA National Severe Storms Laboratory.



Fujita Tornado Scale. Image courtesy of FEMA.

The Fujita Scale was accepted as the official classification system for tornado damage for many years following its publication in 1971. The Fujita Scale rated the intensity of a tornado by examining the damage caused by the tornado after it has passed over a man-made structure. The scale ranked tornadoes using the now-familiar notation of F0 through F5, increasing with wind speed and intensity. A description of the scale follows in Table 5-1.

Table 5-1
Fujita Scale

F-Scale Number	Intensity	Wind Speed	Type of Damage Done
F0	Gale tornado	40-72 mph	Some damage to chimneys; branches broken off trees; shallow-rooted trees knocked over; damage to sign boards.
F1	Moderate tornado	73-112 mph	Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off for some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile-sized missiles fly through the air in excess of 100 meters; trees de-barked; steel-reinforced concrete structures badly damaged.

According to NOAA, weak tornadoes (F0 and F1) account for approximately 69% of all tornadoes. These tornadoes last an average of five to 10 minutes and account for approximately 3% of tornado-related deaths. Strong tornadoes (F2 and F3) account for approximately 29% of all tornadoes and approximately 27% of all tornado deaths. These storms may last for 20 minutes or more. Violent supercell tornadoes (F4 and above) are extremely destructive but rare and account for only 2% of all tornadoes. These storms sometimes last over an hour and result in approximately 70% of all tornado-related deaths.

The Enhanced Fujita Scale was released by NOAA for implementation on February 1, 2007. According to the NOAA website, the Enhanced Fujita Scale was developed in response to a number of weaknesses to the Fujita Scale that were apparent over the years, including the subjectivity of the original scale based on damage, the use of the worst damage to classify the tornado, the fact that structures have different construction depending on location within the United States, and an overestimation of wind speeds for F3 and greater.

Similar to the Fujita Scale, the Enhanced Fujita Scale is also a set of wind estimates based on damage. It uses three-second gusts estimated at the point of damage based on a judgment of eight levels of damage to 28 specific indicators. Table 5-2 relates the Fujita and Enhanced Fujita Scales.

Table 5-2
Enhanced Fujita (EF) Scale

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

Official records of tornado activity date back to 1950. According to NOAA, an average of 1,000 tornadoes is reported each year in the United States. The historic record of tornadoes near Bridgewater is discussed in Section 5.3. Tornadoes are most likely to occur in Connecticut in June, July, and August of each year.

Lightning

Lightning is a discharge of electricity that occurs between the positive and negative charges within the atmosphere or between the atmosphere and the ground. According to NOAA, the creation of lightning during a storm is a complicated process that is not fully understood. In the initial stages of development, air acts as an insulator between the positive and negative charges. However, when the potential between the positive and negative charges becomes too great, a discharge of electricity (lightning) occurs.

Image courtesy of NOAA.

In-cloud lightning occurs between the positive charges near the top of the cloud and the negative charges near the bottom. Cloud-to-cloud lightning occurs between the positive charges near the top of the cloud and the negative charges near the bottom of a second cloud. Cloud-to-ground lightning is the most dangerous. In summertime, most cloud-to-ground lightning occurs between the negative charges near the bottom of the cloud and positive charges on the ground.

According to NOAA's National Weather Service, there is an average of 100,000 thunderstorms per year in the United States. An average of 41 people per year died, and an average of 262 people were injured from lightning strikes in the United States from 2000 to 2009. Most lightning deaths and injuries occur outdoors, with 45% of lightning casualties occurring in open fields and ballparks, 23% under trees, and 14% involving water activities.

The historic record of lightning strikes both in Connecticut and near Bridgewater is presented in Section 5.3.

Downbursts

A downburst is a severe localized wind blasting down from a thunderstorm. They are more common than tornadoes in Connecticut. Depending on the size and location of downburst events, the destruction to property may be significant.

Downburst activity is, on occasion, mistaken for tornado activity. Both storms have very damaging winds (downburst wind speeds can exceed 165 miles per hour) and are very loud. These "straight line" winds are distinguishable from tornadic activity by the pattern of destruction and debris such that the best way to determine the damage source is to fly over the area.

Downbursts fall into two categories:

- ***Microbursts*** *affect an area less than 2.5 miles in diameter, last five to 15 minutes, and can cause damaging winds up to 168 mph.*
- ***Macrobursts*** *affect an area at least 2.5 miles in diameter, last five to 30 minutes, and can cause damaging winds up to 134 mph.*

It is difficult to find statistical data regarding frequency of downburst activity. NOAA reports that there are 10 downburst reports for every tornado report in the United States. This implies that there are approximately 10,000 downbursts reported in the United States each year and further implies that downbursts occur in approximately 10% of all thunderstorms in the United States annually. This value suggests that downbursts are a relatively uncommon yet persistent hazard.

Hail

Hailstones are chunks of ice that grow as updrafts in thunderstorms keep them in the atmosphere. Most hailstones are smaller in diameter than a dime, but stones weighing more than 1.5 pounds have been recorded. NOAA has estimates of the velocity of falling hail ranging from nine meters per second (m/s) (20 mph) for a one centimeter (cm) diameter hailstone, to 48 m/s (107 mph) for an eight cm, 0.7 kilogram stone. While crops are the major victims of hail, larger hail is also a hazard to people, vehicles, and property.

According to NOAA's National Weather Service, hail caused four deaths and an average of 47 injuries per year in the United States from 2000 to 2009. Hailstorms typically occur in at least one part of Connecticut each year during a severe thunderstorm.

5.3 Historic Record

According to NOAA, the highest number of occurrences of tornadoes in Connecticut is in Litchfield (22 events between 1950 and 2009) and Hartford counties, followed by New Haven and Fairfield counties, and then Tolland, Middlesex, Windham, and finally New London County.

An extensively researched list of tornado activity in Connecticut is available on Wikipedia. This list extends back to 1648 although it is noted that the historical data prior to 1950 is incomplete due to lack of official records and gaps in populated areas. Based on available information through July 2013, Litchfield County has experienced a total of 24 tornado events. Table 5-3 summarizes the tornado events near Bridgewater through July 2013 based on the Wikipedia list.

Table 5-3
Tornado Events Near Bridgewater From 1648 to July 2013

Date	Location	Fujita Tornado Scale	Property Damage	Injuries / Deaths
August 17, 1784	Roxbury (east of Bridgewater)	-	Ten houses, five barns and three mills were badly damaged or destroyed	5 injured
June 19, 1794	New Milford (north of Bridgewater)	-	Destroyed several structures	4 injured
August 28, 1911	New Milford	-	Uprooted trees and damaged roofs	NR
August 9, 1972	Southern Litchfield County	F1	NR	NR
July 3, 1974	Southern Litchfield County	F1	NR	NR
July 20, 1975	New Milford	F1	NR	NR
July 1, 2001	New Milford to Roxbury	F0	NR	NR
May 31, 2002	Brookfield (southwest of Bridgewater)	F1	NR	NR
June 9, 2011	Litchfield County	F1	NR	NR

NR = None Reported

Thunderstorms occur on 18 to 35 days each year in Connecticut. The NOAA Technical Memorandum NWS SR-193 documents lightning fatalities, injuries, and damage reports in the United States from 1959 through 1994. This memorandum notes that there were 13 fatalities, 75 injuries, and 269 damage reports due to lightning between 1959 and 1994. According to the National Lightning Safety Institute, only two lightning-related fatalities occurred in Connecticut between 1990 and 2003. The National Weather Service publication *Storm Data* recorded one death in Connecticut from lightning strikes between 1998 and 2008 (on June 8, 2008, lightning struck a pavilion at Hammonasset Beach in Madison, Connecticut, injuring four and killing one).

Hail is often a part of such thunderstorms as seen in the historic record for Bridgewater (below). A limited selection of summer storm damage in and around Bridgewater, taken from the NCDC Storm Events database, is listed below:

- July 9, 1997 – Severe thunderstorms and torrential rain caused flash flooding along the Aspetuck River. Flooding occurred in several homes and along secondary roads in New Milford, just south of Bridgewater.

- June 30, 1998 – A cold front triggered several severe thunderstorms across Litchfield County. The thunderstorms blew down trees in several places across the county. Torrential rains produced flash flooding in Woodbury and Roxbury, just east of Bridgewater.

- May 31, 2002 – a strong cold front clashed with a very unstable air mass across northwestern Connecticut. In addition, there were strong divergent winds aloft. All of these parameters set the stage for severe weather in Litchfield County. The storms knocked out power to about 37,000 Connecticut Light and Power customers, 3,300 of those in the town of Litchfield.

- June 16, 2002 – Scattered severe storms moved into Litchfield County. This same storm hit a large farm in Roxbury, just east of Bridgewater, with hailstones estimated to be dime size. The hail produced an estimated 30,000 dollars of loss to various crops on that farm. Nickel size hail was also reported at New Milford.

- August 5, 2002 – A weak upper air disturbance produced widely scattered thunderstorms across Litchfield County. One of the storms became briefly severe as it deposited dime size hail in the town of New Milford.

- July 18, 2005 – A weak surface low pressure and a minor upper level short wave trough set off thunderstorms in the warm humid air mass over southwestern New England. A thunderstorm over New Milford contained damaging wind gusts which blew down several trees.

- July 28, 2006 – Several severe thunderstorms occurred in western Connecticut. Wind gusts of 60 or greater miles an hour blew down trees in several locations. A trained spotter reported that trees were blown down in Bridgewater.

- May 24, 2009 – A cold front triggered scattered afternoon and early evening severe thunderstorms across southern Connecticut. In addition to the afternoon storms, three people were struck by lightning while camping in early morning convection.

- June 6, 2010 – A strong cold frontal passage produced numerous thunderstorms across western Connecticut. Numerous trees and power lines were downed throughout Newtown, south of Bridgewater. Over 11,000 customers lost power in the region. Over 25 roads were closed due to the damage.

- June 29, 2011 – A pre-frontal trough and an approaching cold front caused a bout of widespread severe weather across most of Southern Connecticut. Around 100 trees were reported down throughout Brookfield, southwest of Bridgewater.

The year 2012 was a memorable year for wind damage in Bridgewater. Town officials indicated that in the spring of 2012 and specifically on June 9, 2012 intense winds accompanied with thunderstorms battered the town. During the June 2012 event there were power outages throughout town and many downed white and red pine trees.

This year is also shaping up to be a memorable year for wind damage. On May 27, 2014, a severe storm thunderstorm passed through western and southern Connecticut. Winds up to 100 mph were recorded by various weather centers. The storm caused down trees and flooded roads. Specifically, trees were knocked down across New Milford, Bridgewater, Southbury, Newtown, and Roxbury. Power was knocked out to large portion of the aforementioned towns with widespread tree and power line damage. According to a wtnh.com article "*Storms roll through Connecticut*", approximately 98% of CL&P customers in Bridgewater were without power.

5.4 Existing Capabilities

Warning is the primary method of existing mitigation for tornadoes and thunderstorm-related hazards. The NOAA National Weather Service issues watches and warnings when severe weather is likely to develop or has developed, respectively. Tables 5-4 and 5-5 list the NOAA

Watches and Warnings, respectively, as pertaining to actions to be taken by emergency management personnel in connection with summer storms and tornadoes.

Table 5-4
NOAA Weather Watches

Weather Condition	Meaning	Actions
Severe Thunderstorm	Severe thunderstorms are possible in your area.	Notify personnel and watch for severe weather.
Tornado	Tornadoes are possible in your area.	Notify personnel and be prepared to move quickly if a warning is issued.
Flash Flood	It is possible that rains will cause flash flooding in your area.	Notify personnel to watch for street or river flooding.

Table 5-5
NOAA Weather Warnings

Weather Condition	Meaning	Actions
Severe Thunderstorm	Severe thunderstorms are occurring or are imminent in your area.	Notify personnel and watch for severe conditions or damage (i.e., downed power lines and trees). Take appropriate actions listed in municipal emergency plans.
Tornado	Tornadoes are occurring or are imminent in your area.	Notify personnel, watch for severe weather, and ensure personnel are protected. Take appropriate actions listed in emergency plans.
Flash Flood	Flash flooding is occurring or imminent in your area.	Watch local rivers and streams. Be prepared to evacuate low-lying areas. Take appropriate actions listed in emergency plans.

> ***A severe thunderstorm watch is issued by the National Weather Service when the weather conditions are such that a severe thunderstorm (winds greater than 58 miles per hour, or hail three-fourths of an inch or greater, or can produce a tornado) is likely to develop.***
>
> ***A severe thunderstorm warning is issued when a severe thunderstorm has been sighted or indicated by weather radar.***

Aside from warnings, several other methods of mitigation for wind damage are employed in Bridgewater as explained in Section 4.0. In addition, the Connecticut State Building Code includes guidelines for the proper grounding of buildings and electrical boxes.

Municipal responsibilities relative to summer storm and tornado mitigation and preparedness include:

- ❑ Developing and disseminating emergency public information and instructions concerning tornado, thunderstorm wind, lightning, and hail safety, especially guidance regarding in-home protection and evacuation procedures and locations of public shelters;
- ❑ Designating appropriate shelter space in the community that could potentially withstand lightning and tornado impact;
- ❑ Periodically testing and exercising tornado response plans; and

- Putting emergency personnel on standby at tornado "watch" stage.

5.5 Vulnerabilities and Risk Assessment

Description – According to the 2014 *Natural Hazard Mitigation Plan Update*, Litchfield County has a high risk of tornado activity based on historical occurrences. Therefore, by virtue of its location in Litchfield County, the Town of Bridgewater has moderate to high potential to experience tornado damage. In addition, NOAA states that climate change has the potential to increase the frequency and intensity of tornadoes, so it is possible that the pattern of occurrence in Connecticut could change in the future.

Although tornadoes pose a threat to all areas of the state, their occurrence is not considered frequent enough to justify the construction of tornado shelters. Instead, the state has provided NOAA weather radios to all public schools as well as many local governments for use in public buildings. The general public continues to rely on mass media for knowledge of weather warnings. Warning time for tornadoes is very short due to the nature of these types of events, so predisaster response time can be limited. However, the NOAA weather radios provide immediate notification of all types of weather warnings in addition to tornadoes, making them very popular with communities.

The central and southern portions of the United States are at higher risk for lightning and thunderstorms than is the northeast. However, FEMA reports that more deaths from lightning occur on the East Coast than elsewhere. Lightning-related fatalities have declined in recent years due to increased education and awareness.

In general, thunderstorms and hailstorms in Connecticut are more frequent in the western and northern parts of the state and less frequent in the southern and eastern parts. Thunderstorms are expected to impact Bridgewater 20 to 30 days each year. The majority of these events do not cause any measurable damage. Although lightning is usually associated with thunderstorms, it can occur on almost any day. The likelihood of lightning strikes in the Bridgewater area is very high during any given thunderstorm although no one area of the town is at higher risk of lightning strikes. The risk of at least one hailstorm occurring in Bridgewater is considered moderate in any given year.

Most thunderstorm damage is caused by straight-line winds exceeding 100 mph. Straight-line winds occur as the first gust of a thunderstorm or from a downburst from a thunderstorm and have no associated rotation. The risk of downbursts occurring during such storms and damaging the Town of Bridgewater is believed to be low for any given year. All areas of the town are susceptible to damage from high winds although more building damage is expected in the town center while more tree damage is expected in the less densely populated areas.

Secondary damage from falling branches and trees is more common than direct wind damage to structures. Heavy winds can take down trees near power lines, leading to the start and spread of fires. CL&P trims trees along powers lines. The town tree warden can remove dead and diseased trees in rights-of-way or Town land, working through the Public Works Department. Town-owned equipment is used except for complex situations, which would call for the use of a contractor.

Town personnel note that strong thunderstorms will cause power lines to fall all over the town. Most downed power lines in Bridgewater are detected quickly, and any associated fires are quickly extinguished. Such fires can be extremely dangerous during the summer months during dry and drought conditions. It is important to have adequate water supply for fire protection to ensure the necessary level of safety is maintained.

Similar to the discussion for hurricanes in Section 4.5, no critical facility is believed to be more susceptible to summer storm damage than any other.

Loss Estimates – The 2014 Connecticut Natural Hazard Mitigation Plan provides annual estimated losses on a countywide basis for several hazards. Based on the population of Bridgewater relative to Litchfield County, the annual estimated loss is $529 for thunderstorms and $14,078 for tornadoes. The figure for tornadoes is influenced by their infrequent occurrence.

Summary – The entire Town of Bridgewater is at relatively equal risk for experiencing damage from summer storms and tornadoes. However, more frequent storm damages are relatively site specific and occur to private property (and therefore are paid for by private insurance). For municipal property, the Town budget is generally adequate to handle summer storm damage.

5.6 Potential Mitigation Strategies and Actions

More information is available at:

FEMA – http://www.fema.gov/library/
NOAA – http://www.nssl.noaa.gov/NWSTornado/

Most of the mitigation activities for summer storm and tornado wind damage are similar to those discussed in Section 4.6 and are not reprinted here. Public education is the best way to mitigate damage from hail, lightning, and tornadoes. In addition to other educational documents, the Building Official should make literature available regarding appropriate design standards for grounding of structures.

Both the FEMA and the NOAA websites contain valuable information regarding preparing for and protecting oneself during a tornado as well as information on a number of other natural hazards. Available information from FEMA includes:

- Design and construction guidance for creating and identifying community shelters
- Recommendations to better protect your business, community, and home from tornado damage, including construction and design guidelines for structures
- Ways to better protect property from wind damage
- Ways to protect property from flooding damage
- Construction of safe rooms within homes

NOAA information includes a discussion of family preparedness procedures and the best physical locations during a storm event. Although tornadoes pose a legitimate threat to public safety, as stated in Section 3.5 their occurrence is considered too infrequent in Connecticut to justify the construction of tornado shelters and safe rooms. Residents should instead be encouraged to purchase a NOAA weather radio containing an alarm feature.

The Town utilizes an emergency notification system known as CT Alert to send geographically specific telephone warnings into areas at risk for hazard damage. This is extremely useful for hazard mitigation as a community warning system that relies on radios and television is less effective at warning residents during the night when the majority of the community is asleep. This fact was evidenced recently by a severe storm that struck Lake County, Florida on February 2, 2007. This powerful storm, which included several tornadoes, stuck at about 3:15 a.m. According to National Public Radio, local broadcast stations had difficulty warning residents due to the lack of listeners and viewers and encouraged those awake to telephone warnings into the affected area.

5.7 Summary of Specific Strategies and Actions

While many potential mitigation activities for addressing wind risks were addressed in Section 4.7, they also apply to thunderstorm winds, tornadoes, hail, and lightning and are listed below:

- ❑ Develop a plan to address dead trees throughout the town in an effort to minimize damage from falling trees.
- ❑ Work with CL&P to determine the feasibility of placing non-conducting steel cables above the power lines to protect them from falling branches and trees.
- ❑ Encourage the use of structural techniques related to mitigation of wind damage in new residential and commercial structures to protect new buildings to a standard greater than the minimum building code requirements. Require such improvements for new municipal critical facilities, for example if the new EOC is constructed.

In addition, important recommendations that apply to all hazards are listed in Section 10.1.

6.0 WINTER STORMS

6.1 Setting

Similar to summer storms and tornadoes, winter storms have the potential to affect any area of the Town of Bridgewater. However, unlike summer storms, winter events and the hazards that result (wind, snow, and ice) have more widespread geographic extent. The entire Town of Bridgewater is susceptible to winter storms and, due to its variable elevation, can have higher amounts of snow in the outskirts of the town than in the town center. In general, winter storms are considered highly likely to occur each year (although major storms are less frequent), and the hazards that result (nor'easter winds, snow, and blizzard conditions) can potentially have a significant effect over a large area of the town.

6.2 Hazard Assessment

This section focuses on those effects commonly associated with winter weather, including blizzards, freezing rain, ice storms, nor'easters, sleet, snow, winter storms and, to a secondary extent, extreme cold.

- **Blizzards** include winter storm conditions of sustained winds or frequent gusts of 35 mph or greater that cause major blowing and drifting of snow, reducing visibility to less than one-quarter mile for three or more hours. Extremely cold temperatures and/or wind chills are often associated with dangerous blizzard conditions.

- **Freezing Rain** consists of rain that freezes on objects, such as trees, cars, or roads and forms a coating or glaze of ice. Temperatures in the mid to upper atmosphere are warm enough for rain to form, but surface temperatures are below the freezing point, causing the rain to freeze on impact.

- **Ice Storms** are forecasted when freezing rain is expected to create ice build-ups of one-quarter inch or more that can cause severe damage.

- **Nor'easters** are the classic winter storm in New England, caused by a warm, moist, low pressure system moving up from the south colliding with a cold, dry high pressure system moving down from the north. The nor'easter derives its name from the northeast winds typically accompanying such storms, and such storms tend to produce a large amount of rain or snow. They usually occur between November 1 and April 1 of any given year, with such storms occurring outside of this period typically bringing rain instead of snow.

- **Sleet** occurs when rain drops freeze into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and does not stick to objects. It can accumulate like snow and cause a hazard to motorists.

- **Snow** is frozen precipitation composed of ice particles that forms in cold clouds by the direct transfer of water vapor to ice.

- **Winter Storms** are defined as heavy snow events that have a snow accumulation of more than six inches in 12 hours or more than 12 inches in a 24-hour period.

According to the National Weather Service, approximately 70% of winter deaths related to snow and ice occur in automobiles, and approximately 25% of deaths occur from people being caught in the cold. In relation to deaths from exposure to cold, 50% are people over 60 years old, 75% are male, and 20% occur in the home.

Impacts from severe winter weather can become dangerous and a threat to people and property. Most winter weather events occur between December and March although in 2011 Connecticut experienced a significant October snowstorm that left much of the state without power for a week. Winter weather may include snow, sleet, freezing rain, and cold temperatures. According to NOAA, winter storms were responsible for the death of 33 people per year from 2000 to 2009. Most deaths from winter storms are indirectly related to the storm, such as from traffic accidents on icy roads and hypothermia from prolonged exposure to cold. Damage to trees and tree limbs and the resultant downing of utility cables are a common effect of these types of events. Secondary effects include loss of power and heat, and flooding as a result of snowmelt.

Until recently, the Northeast Snowfall Impact Scale (NESIS) was used by NOAA to characterize and rank high-impact northeast snowstorms. This ranking system has evolved into the currently used Regional Snowfall Index (RSI). The RSI ranks snowstorms that impact the eastern two thirds of the United States, placing them in one of five categories: Extreme, Crippling, Major, Significant, and Notable. The RSI is based on the spatial extent of the storm, the amount of snowfall, and the juxtaposition of these elements with population. RSI differs from NESIS in that it uses a more refined geographic area to define the population impact. NESIS had used the population of the entire two-thirds of the United States in evaluating impacts for all storms whereas RSI has refined population data into six regions. The result is a more region-specific analysis of a storm's impact. The use of population in evaluating impacts provides a measure of societal impact from the event. Table 6-1 presents the RSI categories, their corresponding RSI values, and a descriptive adjective.

Table 6-1
RSI Categories

Category	RSI Value	Description
1	1-3	Notable
2	3-6	Significant
3	6-10	Major
4	10-18	Crippling
5	18.0+	Extreme

RSI values are calculated within a GIS. The aerial distribution of snowfall and population information are combined in an equation that calculates the RSI score, which varies from around one for smaller storms to over 18 for extreme storms. The raw score is then converted into one of the five RSI categories. The largest RSI values result from storms producing heavy snowfall over large areas that include major metropolitan centers. Approximately 170 of the most notable historic winter storms to impact the Northeast have been analyzed and categorized by RSI through January 2011.

6.3 Historic Record

A total of 16 extreme, crippling, and major winter storms have occurred in Connecticut during the past 30 years. One is listed for each of the years 1983, 1987, 1993, 1994, 1996, 2003, 2005, 2006, and 2007. More alarmingly, four are listed in the calendar year 2010, two in 2011 and one in 2013.

Considering nor'easters only, 11 major winter nor'easters have occurred in Connecticut during the past 30 years (in 1983, 1988, 1992, 1996, 2003, 2006, 2009, 2010, two in 2011, and 2013).

According to the NCDC, there have been approximately 134 snow and ice events in the state of Connecticut between 1993 and April 2010, causing over $18 million in damages. Notably, heavy snow in December 1996 caused $6 million in property damage. Snow removal and power restoration for a winter storm event spanning March 31 and April 1, 1997 cost $1 million. On March 5, 2001, heavy snow caused $5 million in damages, followed by another heavy snow event four days later that caused an additional $2 million in damages.

Catastrophic ice storms are less frequent in Connecticut than the rest of New England due to the close proximity of the warmer waters of the Atlantic Ocean and Long Island Sound. However, winter storm Alfred from October 29-30, 2011 had an ice precipitation component to it. Although wet snow was the major problem, ice mixed in along and just to the north of the shoreline which slickened roadways and led to additional weight build-up on trees and utility lines and other infrastructure.

The most severe ice storm in Connecticut on record was Ice Storm Felix on December 18, 1973. This storm resulted in two deaths and widespread power outages throughout the state. An ice storm in November 2002 that hit Litchfield and western Hartford Counties resulted in $2.5 million in public sector damages.

However, the most damaging winter storms are not always nor'easters. Additional examples of recent winter weather events to affect the Bridgewater area, taken from the NCDC database, include:

- March 13-14, 1993 – A massive, powerful storm dubbed the "Storm of the Century" caused "whiteout" blizzard conditions stretching from Jacksonville, Florida into eastern Canada and affected 26 states, producing 24 inches of snow in Hartford and up to 21 inches of snow in New Haven County. A total of 40,000 power outages and $550,000 in property damage was reported throughout Connecticut, and the state received a federal emergency declaration. The storm had a RSI rating of "Category 5 –Extreme" and is the second highest ranking storm recorded by RSI.

- January 15-16, 1994 – A Siberian air mass brought record to near-record low temperatures across Connecticut. Strong northwest winds accompanied the cold and drove wind chill values to 30 to 50 degrees below zero.

- December 23, 1994 – An unusual snowless late December storm caused gale force winds across the state. The high winds caused widespread power outages affecting up to 130,000 customers statewide. Numerous trees and limbs were blown down, damaging property, vehicles, and power lines to a total of $5 million in damages. Peak wind gusts of up to 64 mph were reported.

- January 7-8, 1996 – Winter Storm Ginger caused heavy snow and shut down the state of Connecticut for an entire day. The state received a federal major disaster declaration. The storm had a RSI rating of "Category 5 – Extreme" and is the third-highest ranked storm by RSI.

- March 31 – April 1, 1997 – A late season storm produced rain and wet snow. This storm caused over one million dollars in property damage and cost an additional one million dollars for snow removal and power restoration. This storm is ranked 36th on the RSI scale and is regarded as a "Category 2 – Significant" storm by RSI.

- November 13, 14, 1997 - A winter storm tracked from the southeast coast north to the coast of southern New England and then out to sea. In Litchfield county, heavy accumulations of sleet and freezing rain occurred after several inches of snow. The freezing rain produced scattered power outages.

- January 21, 2001 **-** A wave of low pressure developed along a stationary frontal boundary, across interior North Carolina, on Saturday January 20. This storm then deepened as it tracked northeastward by early Sunday morning, reaching a point about 100 miles east of Cape Cod by Sunday morning. This storm brought a significant snowstorm to Litchfield County during the predawn hours on Sunday January 21. A general 7-inch swath of snowfall was reported throughout the county. There were no unusual problems reported to the National Weather Service with this storm.

- February 17, 2003 – A heavy snowstorm caused near blizzard conditions and produced 24 inches of snow in areas of the state. The storm had a RSI rating of "Category 4 – Crippling" and is the 6th ranked winter storm by RSI. The State of Connecticut received a federal emergency declaration.

- February 12-13, 2006 – This nor'easter is ranked 30th overall and as a "Category 2 – Significant" storm on the RSI scale. The storm produced 18 to 24 inches of snow across Connecticut. Five Connecticut counties received a federal emergency declaration.

- The winter storms of December 24-28, 2010 and January 9-13, 2011 were rated preliminarily as "Category 2 – Significant" storms on RSI. The successive winter storms in late January to early February 2011 reportedly caused 70 inches of snowfall and collapsed nearly 80 roofs throughout the state. Critical facilities experiencing roof collapses in Connecticut included the Barkhamsted Highway Department Salt Shed and the Public Works Garage in the Terryville section of Plymouth. The Nye Street Fire Station in Vernon was also closed due to concerns related to the possible collapse of the roof due to heavy snow. The January storm resulted in Presidential Snowfall Disaster Declaration FEMA-1958-DR being declared for the state. Bridgewater's public assistance reimbursement for this storm was $21,279.

- January 18, 2011 – A winter storm brought two to three inches of snow and sleet across northern Connecticut with a quarter to one-half inch of ice accumulation on top of that.

- February 1, 2011 – "The Groundhog Day Blizzard of 2011," an ice storm brought a mixture of snow, sleet, and freezing rain with a second heavier round of freezing rain and sleet. The later episode caused numerous road closures and roof collapses across Connecticut.

- February 7, 2011 – Excessive weight from snow and ice caused numerous roof collapses across southern Connecticut during the second week in February.

- October 29, 2011 –Winter Storm Alfred (October 29-30, 2011) produced up to 32" of snow and caused over 600,000 electrical customers in Connecticut to lose power for a significant amount of time. The entire state dealt with wet snow and ice and statewide power outages affecting Connecticut for a week or longer. The storm was unique in that much of the foliage had yet to fall from trees, which provided more surface area for snow to land and stick, therefore making the trees significantly heavier than if the storm was to occur when trees had lost their foliage. The storm resulted in the death of eight people in Connecticut, four from carbon monoxide poisoning. In all, approximately 90 shelters and 110 warming centers were opened state-wide. The overall storm impacts and damages resulted in another Presidential Disaster Declaration for Connecticut.

In Bridgewater, Winter Storm Alfred caused power outages that lasted approximately seven days. Tree damage and damage to power lines were the biggest impacts during this storm.

- A fierce nor'easter (dubbed "Nemo" by the Weather Channel) in February 2013 brought blizzard conditions to most of the Northeast, producing snowfall rates of five to six inches per hour in parts of Connecticut. Many areas of Connecticut experienced more than 40 inches of snowfall, and the storm caused more than 700,000 power outages. All roads in Connecticut were closed for two days. This storm was ranked as a "Major" storm by NESIS. The overall storm impacts and damages resulted in yet one more Presidential Disaster Declaration for Connecticut. Bridgewater's public assistance reimbursement for Nemo was $10,468.

The winter storms of January and February 2011 are listed as the 18th and 19th storms in the NESIS ranking. These storms produced snow, sleet, freezing rain, strong gusty winds, severely low temperatures, and coastal flooding. Snowfall totals for winter 2010-2011 in Connecticut averaged around 70 inches.

The snowfall, sleet, freezing rain, and rain that affected Connecticut during the 2010-2011 winter season proved to be catastrophic for a number of buildings. With severely low temperatures coupled with the absence of the removal of snow and ice buildup from roofs of buildings in Connecticut, numerous roofs collapsed during the winter season.

Using media reports, a list of roof/building collapses and damage due to buildup of frozen precipitation was compiled. The list (Table 6-2) includes 76 locations that span over a month of time from January 12, 2011 to February 17, 2011. No properties are listed in Bridgewater.

TABLE 6-2
Reported Roof Collapse Damage, 2011

Address	Municipality	Date	Description
205 Wakelee Avenue	Ansonia	2/2/2011	Catholic Charities
Route 44	Barkhamsted	2/4/2011	Barkhamsted Highway Department Salt Shed
8 Railroad Avenue	Beacon Falls	2/2/2011	Manufacturing Corporation
20 Sargent Drive	Bethany	2/2/2011	Fairfield County Millworks
50 Hunters Trail	Bethany	2/2/2011	Sun Gold Stables
74 Griffin Road South	Bloomfield	2/14/2011	Home Depot Distribution Center
25 Blue Hill Road	Bozrah	1/27/2011	Kofkoff Egg Farm
135 Albany Turnpike	Canton	2/3/2011	Ethan Allen Design Center
520 South Main Street	Cheshire	1/12/2011	Cheshire Community Pool (Prior to recent ice storm)
1701 Highland Avenue	Cheshire	1/23/2011	Cox Communications
174 East Johnson Avenue	Cheshire	2/2/2011	First Calvary Life Family Worship Center
166 South Main Street	Cheshire	2/3/2011	George Keeler Stove Shop (Historic Building)
1755 Highland Avenue	Cheshire	2/7/2011	Nutmeg Utility Products
45 Shunpike Road (Route 372)	Cromwell	2/2/2011	K Mart (cracks inside and outside - no official collapse)
Cromwell Hills Drive	Cromwell	2/4/2011	Cromwell Gardens
98 West Street	Danbury	1/28/2011	Garage
142 N. Road (Route 140)	East Windsor	2/3/2011	Dawn Marie's Restaurant - Bassdale Plaza Shopping Center
3 Craftsman Road	East Windsor	2/4/2011	Info Shred
140 Mountain Road	Ellington	1/27/2011	Garage Collapse
100 Phoenix Avenue	Enfield	2/1/2011	Brooks Brothers
South Road	Enfield	2/2/2011	Bosco's Auto Garage
175 Warde Terrace	Fairfield	2/3/2011	Parish Court Senior Housing (Ceiling damage - 10 apartments)
19 Elm Tree Road	Glastonbury	2/6/2011	Residence
Unknown	Hampton	1/28/2011	Wood Hill Farm barn collapse - animals died
Gillette Street	Hartford	1/19/2011	Garage
West Street	Hebron	2/2/2011	Residential
Connecticut Route 101	Killingly	2/8/2011	Historic church converted to an office building
759 Boston Post Road	Madison	2/3/2011	Silver Moon, The Brandon Gallery, Madison Coffee Shop and Madison Cinemas (awning began to collapse)
478 Center Street	Manchester	1/28/2011	Lou's Auto Sales and Upholstery
1388 East Main Street	Meriden	1/28/2011	Jacoby's
260 Sherman Avenue	Meriden	2/6/2011	Engine 4 Fire Station
275 Research Parkway	Meriden	2/17/2011	Four Points by Sheraton Carport
1310 South Main Street	Middletown	1/30/2011	Passport Inn Building & Suites
505 Main Street	Middletown	2/2/2011	Accounting firm, converted, mixed use (3 story)
70 Robin Court	Middletown	2/3/2011	Madison at Northwoods Apartment
80 North Main Street	Middletown	2/7/2011	Abandoned warehouse

Address	Municipality	Date	Description
Pepe's Farm Road	Milford	1/30/2011	Vacant manufacturing building
282 Woodmont Road	Milford	2/2/2011	Kip's Tractor Barn
150 Main St # 1	Monroe	2/2/2011	Monroe Paint & Hardware (Slumping roof, weld broke loose from structural beam)
Route 63	Naugatuck	1/21/2011	Former Plumbing Supply House
410 Rubber Avenue	Naugatuck	2/2/2011	Thurston Oil Company
1210 New Haven Road	Naugatuck	2/4/2011	Rainbowland Nursery School (structural damage)
1100 New Haven Road	Naugatuck	2/17/2011	Walmart (structural damage)
290 Goffe Street	New Haven	2/7/2011	New Haven Armory
201 South Main Street	Newtown	2/9/2011	Bluelinx Corp.
80 Comstock Hill Avenue	Norwalk	1/27/2011	Silvermine Stable
5 Town Line Road	Plainville	1/27/2011	Classic Auto Body
130 West Main Street	Plainville	2/2/2011	Congregational Church of Plainville
Terryville Section	Plymouth	1/12/2011	Public Works Garage (Terryville section) - taking plow trucks out
286 Airline Avenue	Portland	1/27/2011	Midstate Recovery Systems, LLC (waste transfer station)
680 Portland-Cobalt Road (Route 66)	Portland	1/27/2011	Vacant commercial property (next to Prehistoric Mini Golf - former True Value Hardware building)
Tryon Street	Portland	1/27/2011	Residential home (sunroof)
Main Street	Portland	1/28/2011	Middlesex Marina
93 Elm Street	Rocky Hill	2/6/2011	Residential garage
99 Bridgeport Avenue	Shelton	2/3/2011	Shell Gas Station
100 Maple Street	Somers	1/27/2011	Lindy Farms (barn)
68 Green Tree Lane	Somers	2/2/2011	Residential
95 John Fitch Boulevard	South Windsor	2/3/2011	South Windsor 10 Pin Bowling Alley
595 Nutmeg Road North	South Windsor	2/8/2011	Waldo Brothers Company
45 Newell Street	Southington	2/2/2011	Yarde Metals
Furnace Avenue	Stafford Springs	2/2/2011	Abandoned mill building
370 South Main Street	Terryville	2/8/2011	Former American Modular
46 Hartford Turnpike	Tolland	2/3/2011	Colonial Gardens
364 High Street	Tolland	2/9/2011	Horse barn
61 Monroe Turnpike	Trumbull	2/1/2011	Trumbull Tennis Center
5065 Main St # L1207	Trumbull	Unknown	Taco Bell
Route 83	Vernon	1/31/2011	Former Clyde Chevrolet
136 Dudley Avenue	Wallingford	1/27/2011	Tri State Tires
1074 South Colony Road	Wallingford	1/29/2011	Zandri's Stillwood Inn
121 N. Main Street	Waterbury	2/2/2011	Former bowling alley (Sena's Lanes)
456 New Park Avenue	West Hartford	2/8/2011	Shell gas station
Island Lane	West Haven	1/27/2011	Commercial building
Unknown	Wethersfield	2/2/2011	Automotive center roof collapse; 10 cars damaged
50 Sage Park Road	Windsor	2/2/2011	Windsor High School (auditorium roof collapse)
1001 Day Hill Road	Windsor	2/7/2011	Mototown USA
27 Lawnacre Road	Windsor Locks	2/7/2011	Long View RV

The overall storm impacts and damages of the winter 2010-2011 storms resulted in Presidential Disaster Declaration DR-1958 for Connecticut. During this snow load disaster, a significant amount of snow removal was done throughout Bridgewater. No municipal buildings suffered damage; however two private barns collapsed.

6.4 Existing Capabilities

Existing programs applicable to flooding and wind are the same as those discussed in Sections 3.0 and 4.0. Programs that are specific to winter storms are generally those related to preparing plows and sand and salt trucks, tree trimming to protect power lines, and other associated snow removal and response preparations.

The amended Connecticut Building Code specifies that a pressure of 40 pounds per square foot (psf) be used as the base "ground snow load" for computing snow loading for different types of roofs. The International Building code specifies the same pressure for habitable attics and sleeping areas, and specifies a minimum pressure of 35 psf for all other areas. As a result of the winter of 2010-2011, it is anticipated that many communities will develop and utilize programs for roof snow removal.

As it is almost guaranteed that winter storms will occur annually in Connecticut, it is important for municipalities to budget fiscal resources toward snow management. In extreme years, such as the winter of 2010-2011, this budget can be quickly eclipsed and must be supplemented from other budget sources.

The town owns five trucks for plowing and is responsible for 36 miles of town roads. The standard salt mixture is used for deicing. Priority is given to plowing egresses to critical facilities. Homeowners, private associations, and businesses are responsible for plowing their own driveways and roads.

Prior to a winter weather event, the Town ensures that all warning/notification and communications systems are ready and ensures that appropriate equipment and supplies, especially snow removal equipment, are in place and in good working order. In some known problem areas, prestorm treatment is applied to roadways to reduce the accumulation of snow. The Town also prepares for the possible evacuation and sheltering of some populations that could be impacted by the upcoming storm (especially the elderly and special needs persons).

6.5 Vulnerabilities and Risk Assessment

Description – Based on the historic record in Section 6.3, Connecticut experiences at least one major nor'easter every four years although a variety of minor and moderate snow and ice storms occur nearly every winter. According to the 2014 *Connecticut Natural Hazard Mitigation Plan Update*, Connecticut residents can expect at least two or more severe winter weather events per season, including heavy snowstorms, potential blizzards, nor'easters, and potential ice storms. Fortunately, catastrophic ice storms are relatively less frequent in Connecticut than the rest of New England due to the close proximity of the warmer waters of the Atlantic Ocean and Long Island Sound.

According to the 2014 *Connecticut Natural Hazard Mitigation Plan Update*, recent climate change studies predict a shorter winter season for Connecticut (as much as two weeks) and less snow-covered days with a decreased overall snowpack. These models also predict that fewer, more intense precipitation events will occur with more precipitation falling as rain rather than snow. This trend suggests that future snowfalls will consist of heavier (denser) snow, and the potential for ice storms will increase. Such changes will have a large impact on how the state and its communities manage future winter storms and will affect the impact such storms have on the residents, roads, and utilities in the state.

After a storm, snow piled on the sides of roadways can inhibit sight lines and reflect a blinding amount of sunlight. When coupled with slippery road conditions, poor sightlines and heavy glare create dangerous driving conditions. Stranded motorists, especially senior and/or handicapped citizens, are at particularly high risk of injury or death from exposure during a blizzard. The elderly population in Bridgewater, in particular, is susceptible to the impacts created by winter storms due to resource needs (heat, electricity loss, safe access to food, etc.).

The structures and utilities in the Town of Bridgewater are vulnerable to a variety of winter storm damage. Tree limbs and some building structures may not be suited to withstand high wind and snow loads. Ice can damage or collapse power lines, render steep gradients impassable for motorists, undermine foundations, and cause "flood" damage from freezing water pipes in basements.

Town officials have indicated that the most vulnerable areas to snow drift are located along Town Line Road, Keeler Road, Curtis Road, Second Hill Road, Northrup Street, Rocky Hill Road and Hut Hill Road. In other areas, the effects are generally mitigated through municipal plowing efforts. Drifting snow is often a problem after a lot is cleared for a new home or new landscaping.

Icing causes difficult driving conditions on Route 133 since there is not a lot of sun exposure. The Town's standard of presalting has been helpful in controlling ice in these problem areas. During the public meeting for this plan development, it was noted that icing is also a concern on Second Hill Road as water seeps from the road bank and freezes as it crosses the road. This could potentially be addressed by installing new drainage along 200 feet of the roadway.

Similar to the discussion for hurricanes and summer storms in the previous two sections, no critical facilities are believed to be more susceptible to winter storm damage than any other.

Loss Estimates – The 2014 Connecticut Natural Hazard Mitigation Plan provides annual estimated losses on a countywide basis for several hazards. Based on the population of Bridgewater relative to Litchfield County, the annual estimated loss is $883 for severe winter storms. The low figure is likely influenced by the difficulty in separating typical winter storm costs from those associated with extreme events. Nevertheless, the Town’s public assistance reimbursements for the last three winter storm disasters were significant relative to its rural setting. For example, Bridgewater’s public assistance reimbursement for Storm Nemo in 2013 was $10,468, and the public assistance reimbursement for DR-1958 was $21,279.

Recall that two barns collapsed in Bridgewater in January and February 2014. The losses were likely significant, although the figures are not available because the properties are privately owned.

Summary – The entire Town of Bridgewater is at relatively equal risk for experiencing damage from winter storms although some areas (such as icing trouble spots and neighborhoods with a high concentration of flat roofs) are more susceptible. Based on the historic record, it is difficult to determine if any winter storms have resulted in costly damages to the Town as damage estimates for severe storms are generally spread over an entire county. Many damages are relatively site specific and occur to private property (and therefore are paid for by private insurance) while repairs for power outages are often widespread and difficult to quantify to any one municipality.

For municipal property, the Town budget is generally adequate to handle winter storm damage although the plowing budget is often depleted. In particular, the heavy snowfalls associated with the winter of 2010-2011 drained the Town's plowing budget and raised a high level of awareness of the danger that heavy snow poses to roofs.

6.6 Potential Mitigation Strategies and Actions

Potential mitigation measures for flooding caused by winter storms include those appropriate for flooding. These were presented in Section 3.6. Winter storm mitigation measures must also address blizzard, snow, and ice hazards. These are emphasized on the following page.

6.6.1 Prevention

Cold air, wind, snow, and ice cannot be prevented from impacting any particular region. Thus, mitigation is typically focused on property protection and emergency services (discussed below) and prevention of damage related to wind and flooding hazards.

Previous recommendations for tree limb inspections and maintenance in Sections 4.0 and 5.0 are thus applicable to winter storm hazards as well. As mentioned previously, utilities in Bridgewater should continue to be placed underground where possible. This can occur in connection with new development and also in connection with redevelopment or roadway reconstruction work. Underground utilities cannot be directly damaged by heavy snow, ice, and winter winds.

6.6.2 Property Protection

Property can be protected during winter storms through the use of structural measures such as shutters, storm doors, and storm windows. Pipes should be adequately insulated to protect against freezing and bursting. Compliance with the amended Connecticut Building Code for wind speeds is necessary. Finally, as recommended in previous sections, dead or dangerous tree limbs overhanging homes should be trimmed. All of these recommendations should apply to new construction although they may also be applied to existing buildings during renovations.

Where flat roofs are used on structures, snow removal is important as the heavy load from collecting snow may exceed the bearing capacity of the structure. This can occur in both older buildings as well as newer buildings constructed in compliance with the most recent building codes. The Town should develop plans to prioritize the removal of snow from critical facilities and other municipal buildings and have funding available for this purpose. Heating coils may also be used to melt or evaporate snow from publicly and privately owned flat roofs.

6.6.3 Emergency Services

Emergency services personnel should continue to identify areas that may be difficult to access during winter storm events and devise contingency plans to continue servicing those areas when regular access is not feasible. The creation of through streets within new developments increases the amount of egress for residents and emergency personnel into neighborhoods.

The Town by default has standardized plowing routes that prioritize access to and from most critical facilities as these facilities are primarily located along state and primary local roads. Residents should be made aware of the plow routes in order to plan how to best access critical facilities, perhaps via posting of the general routes on the Town website. Such routes should also be posted in other municipal buildings such as the library and the post office. It is recognized that plowing critical facilities may not be a priority to all residents as people typically expect their own roads to be cleared as soon as possible.

Available shelters should continue to be advertised and their locations known to the public prior to a storm event. In addition, existing mutual aid agreements with surrounding municipalities should be reviewed and updated as necessary to ensure help will be available when needed.

6.6.4 Public Education and Awareness

The public is typically more aware of the hazardous effects of snow, ice, and cold weather than they are with regard to other hazards discussed in this Plan. Nevertheless, each winter in Connecticut, people are still stranded in automobiles, get caught outside their homes in adverse weather conditions, and suffer heart failure while shoveling. Public education should therefore focus on safety tips and reminders to individuals about how to prepare themselves and their homes for cold and icy weather, including stocking homes, preparing vehicles, and taking care of themselves during winter storms.

Traffic congestion and safe travel of people to and from work can be mitigated by the use of staggered timed releases from work, prestorm closing of schools, and later start times for companies. Many employers and school districts employ such practices. The Town should consider the use of such staggered openings and closings to mitigate congestion during and after severe weather events if traffic conditions warrant.

6.6.5 Structural Projects

While structural projects to completely eliminate winter storm damage are not possible, structural projects related to the mitigation of wind (Section 4.6) or flooding damage (Section 3.6) to structures can be effective in the mitigation of winter storm damage. Additional types of structural projects can be designed to mitigate icing due to poor drainage and other factors as well as performing retrofits for flat-roofed buildings such as heating coils or insulating pipes.

6.7 Summary of Mitigation Strategies and Actions

Most of the recommendations in Section 4.6 for mitigating wind damage are suitable for reducing certain types of damage caused by winter storms. These are not repeated in this subsection. While many potential mitigation activities for the remaining winter storm hazards were addressed in Section 6.6, the recommended mitigation strategies for mitigating wind, snow, and ice in the Town of Bridgewater are listed below.

- ❑ Develop a plan to prioritize snow removal from the roof of critical facilities and other municipal buildings each winter. Ensure adequate funding is available in the Town budget for this purpose.
- ❑ Work in rights of way to provide wind breaks and reduce drifting along town roads.
- ❑ When permits are issued for clearing of properties, require mitigation by land owners to prevent snow drifts from affecting adjacent roads. Snow fencing and certain vegetation buffers may be effective to reduce drifts.
- ❑ Install drainage improvements along Second Hill Road to reduce the potential for icing.

In addition, important recommendations that apply to all hazards are listed in Section 10.1.

7.0 EARTHQUAKES

7.1 Setting

The entire Town of Bridgewater is susceptible to earthquake damage. However, even though earthquake damage has the potential to occur anywhere both in the town and in the northeastern United States, the effects may be felt differently in some areas based on the type of geology. In general, earthquakes are considered a hazard that may possibly occur but that may cause significant effects to a large area of the town.

7.2 Hazard Assessment

An earthquake is a sudden rapid shaking of the earth caused by the breaking and shifting of rock beneath the earth's surface. Earthquakes can cause buildings and bridges to collapse; disrupt gas, electric and telephone lines; and often cause landslides, flash floods, fires, avalanches, and tsunamis. Earthquakes can occur at any time without warning.

The underground point of origin of an earthquake is called its focus; the point on the surface directly above the focus is the epicenter. The magnitude and intensity of an earthquake are determined by the use of the Richter scale and the Mercalli scale, respectively. The Richter scale defines the magnitude of an earthquake. Magnitude is related to the amount of seismic energy released at the hypocenter of the earthquake. It is based on the amplitude of earthquake waves recorded on instruments that have a common calibration. The magnitude of an earthquake is thus represented by a single instrumentally determined value recorded by a seismograph, which records the varying amplitude of ground oscillations.

The magnitude of an earthquake is determined from the logarithm of the amplitude of recorded waves. Being logarithmic, each whole number increase in magnitude represents a tenfold increase in measured strength. Earthquakes with a magnitude of about 2.0 or less are usually called microearthquakes and are generally only recorded locally. Earthquakes with magnitudes of 4.5 or greater are strong enough to be recorded by seismographs all over the world.

The effect of an earthquake on the earth's surface is called the intensity. The Modified Mercalli Intensity Scale consists of a series of key responses such as people awakening, movement of furniture, damage to chimneys, and total destruction. This scale, composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, is designated by Roman numerals. It is an arbitrary ranking based on observed effects. A comparison of Richter magnitude to typical Modified Mercalli intensity is presented in Table 7-1.

Table 7-1
Comparison of Earthquake Magnitude and Intensity

Richter Magnitude	Typical Max. Modified Mercalli Intensity
1.0 to 3.0	I
3.0 to 3.9	II - III
4.0 to 4.9	IV - V
5.0 to 5.9	VI - VII
6.0 to 6.9	VII - IX
7.0 and above	VIII - XII

Unlike seismic activity in California, earthquakes in Connecticut are not associated with specific known faults. Instead, earthquakes with epicenters in Connecticut are referred to as intraplate activity. Bedrock in Connecticut and New England in general is highly capable of transmitting seismic energy; thus, the area impacted by an earthquake in Connecticut can be four to 40 times greater than that of California. For example, the relatively strong earthquake that occurred in Virginia in 2011 was felt in Connecticut because the energy was transmitted over a great distance through hard bedrock.

In addition, population density is up to 3.5 times greater in Connecticut than in California, potentially putting a greater number of people at risk.

The built environment in Connecticut includes old nonreinforced masonry that is not seismically designed. Those who live or work in nonreinforced masonry buildings, especially those built on filled land or unstable soils, are at the highest risk for injury due to the occurrence of an earthquake.

7.3 Historic Record

According to the Northeast States Emergency Consortium and the Weston Observatory at Boston College, there were 139 recorded earthquakes in Connecticut between 1668 and 2011. The vast majority of these earthquakes had a magnitude of less than 3.0. The most severe earthquake in Connecticut's history occurred at East Haddam on May 16, 1791. Stone walls and chimneys were toppled during this quake.

The following is a description of the 12 levels of Modified Mercalli intensity from the USGS:

I. Not felt except by a very few under especially favorable conditions.
II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration similar to the passing of a truck. Duration estimated.
IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V. Felt by nearly everyone; many awakened. Some dishes and windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
XII. Damage total. Lines of sight and level are distorted. Objects thrown in the air.

Additional instances of seismic activity occurring in and around Connecticut are provided below, based on information provided in USGS documents, the Weston Observatory, the 2014 *Connecticut Natural Hazard Mitigation Plan Update*, other municipal hazard mitigation plans, and newspaper articles.

- A devastating earthquake near Three Rivers, Quebec on February 5, 1663 caused moderate damage in parts of Connecticut.
- Strong earthquakes in Massachusetts in November 1727 and November 1755 were felt strongly in Connecticut.
- In April 1837, a moderate tremor occurred at Hartford, causing alarm but little damage.
- In August 1840, another moderate tremor with its epicenter 10 to 20 miles north of New Haven shook Hartford buildings but caused little damage.
- In October 1845, an Intensity V earthquake occurred in Bridgeport. An Intensity V earthquake would be approximately 4.3 on the Richter scale.
- On June 30, 1858, New Haven and Derby were shaken by a moderate tremor.
- On July 28, 1875, an early morning tremor caused Intensity V damage throughout Connecticut and Massachusetts.
- The second strongest earthquake to impact Connecticut occurred near Hebron on November 14, 1925. No significant damage was reported.
- The Timiskarning, Ontario earthquake of November 1935 caused minor damage as far south as Cornwall, Connecticut. This earthquake affected one million square miles of Canada and the United States.
- An earthquake near Massena, New York in September 1944 produced mild effects in Hartford, Marion, and New Haven, Connecticut.
- An Intensity V earthquake was reported in Stamford in March 1953, causing shaking but no damage.
- On November 3, 1968, another Intensity V earthquake in southern Connecticut caused minor damage in Madison and Chester.
- Recent earthquake activity has been recorded near New Haven in 1988, 1989, and 1990 (2.0, 2.8, and 2.8 in magnitude, respectively), in Greenwich in 1991 (3.0 magnitude), and on Long Island in East Hampton, New York in 1992.
- A 2.0 magnitude with its epicenter three miles northwest of the center of Chester occurred on March 11, 2008.
- A magnitude 5.0 earthquake struck at the Ontario-Quebec border region of Canada on June 23, 2010. This earthquake did not cause damage in Connecticut but was felt by residents in Hartford and New Haven Counties.
- A magnitude 3.9 earthquake occurred 117 miles southeast of Bridgeport, Connecticut on the morning of November 30, 2010. The quake did not cause damage in Connecticut but was felt by residents along Long Island Sound.
- An earthquake with a magnitude 2.1 was recorded near southeastern Connecticut on November 29, 2013. The earthquake did not cause damage but was felt by residents from Montville to Mystic.
- A magnitude 2.7 quake occurred beneath the Town of Deep River on August 14, 2014.

An earthquake of special consideration was the magnitude 5.8 earthquake which occurred 38 miles from Richmond, Virginia on August 23, 2011. The quake was felt from Georgia to Maine and reportedly as far west as Chicago. Many residents of Connecticut experienced the swaying and shaking of buildings and furniture during the earthquake although widespread damage was constrained to an area from central Virginia to southern Maryland. According to Cornell

University, the August 23 quake was the largest event to occur in the east central United States since instrumental recordings have been available to seismologists.

7.4 Existing Capabilities

The Connecticut Building Codes include design criteria for buildings specific to each municipality as adopted by the Building Officials and Code Administrators (BOCA). These include the seismic coefficients for building design in the Town of Bridgewater. The Town has adopted these codes for new construction, and they are enforced by the Building Official. Due to the infrequent nature of damaging earthquakes, land use policies in the Town do not directly address earthquake hazards. However, various documents do indirectly discuss areas susceptible to earthquake damage and regulations that help to minimize potential earthquake damage.

- ***Zoning Regulations***: Section 5.06 outlines soil erosion and sediment control regulations. Section 7.02.03 outlines application requirements and states that applicants shall provide the location of natural features including but not limited to, rock outcroppings, slopes in excess of 15%, soil types, and forested areas on the lot.

- ***Subdivision Regulations***. Section 2.2.9 requires that soil erosion and sediment control plans be developed for proposed projects.

- ***Plan of Conservation and Development.*** The 2012 plan recommends reviewing the definition of steep slopes and limiting residential development on steep slopes.

7.5 Vulnerabilities and Risk Assessment

According to Cornell University, the earth's crust is far more efficient at propagating seismic waves in the eastern United States than in the west, so even a moderate earthquake can be felt at great distances and over a larger region. The cause of intraplate earthquakes remains a fundamental mystery and this, coupled with the large areas affected, resulted in the August 2011 earthquake in Virginia to be of particular interest to seismologists.

> ***Liquefaction** is a phenomenon in which the strength and stiffness of a soil are reduced by earthquake shaking or other rapid loading. It occurs in soils at or near saturation and especially in finer textured soils.*

Surficial earth materials behave differently in response to seismic activity. Unconsolidated materials such as sand and artificial fill can amplify the shaking associated with an earthquake. In addition, artificial fill material has the potential for liquefaction. When liquefaction occurs, the strength of the soil decreases, and the ability of soil to support building foundations and bridges is reduced. Increased shaking and liquefaction can cause greater damage to buildings and structures and a greater loss of life.

As explained in Section 2.3, some areas in Bridgewater are underlain by sand and gravel. Figure 2-4 depicts surficial materials in the town. Structures in these areas are at increased risk from earthquakes due to amplification of seismic energy and/or collapse. The best mitigation for future development in areas of sandy material may be application of the most stringent building codes or possibly the prohibition of new construction. However, many of these areas occur in floodplains associated with the various streams and rivers in Bridgewater, so they are already regulated. The areas that are not at increased risk during an earthquake due to unstable soils are the areas in Figure 2-4 underlain by glacial till, which includes most of the town.

Areas of steep slopes can collapse during an earthquake, creating landslides. Seismic activity can also break utility lines such as water mains, electric and telephone lines, and stormwater management systems. Damage to utility lines can lead to fires, especially in electric and gas mains. Dam failure can also pose a significant threat to developed areas during an earthquake. For this Plan, dam failure has been addressed separately in Section 9.0.

The AEL is the expected losses due to earthquakes each year. Note that this number represents a long-term average; thus, actual earthquake losses may be much greater or nonexistent for a particular year.

In the FEMA *HAZUS-MH Estimated Annualized Earthquake Losses for the United States* (2008) document, FEMA used probabilistic curves developed by the USGS for the National Earthquakes Hazards Reduction Program to calculate Annualized Earthquake Losses (AEL) for the United States. Based on the results of this study, FEMA calculated the AEL for Connecticut to be $11,622,000. This value placed Connecticut 30th out of the 50 states in terms of AEL. The magnitude of this value stems from the fact that Connecticut has a large building inventory that would be damaged in a severe earthquake and takes into account the lack of damaging earthquakes in the historical record.

According to the 2014 *Connecticut Natural Hazard Mitigation Plan Update,* Connecticut is at a low to moderate risk for experiencing an earthquake of a magnitude greater than 3.5 and at a moderate risk of experiencing an earthquake of a magnitude less than 3.0 in the future. No earthquake with a magnitude greater than 3.5 has occurred in Connecticut within the last 30 years, and the USGS currently ranks Connecticut 43rd out of the 50 states for overall earthquake activity.

A series of earthquake probability maps was generated using the 2009 interactive web-based mapping tools hosted by the USGS. These maps were used to determine the probability of an earthquake of greater than magnitude 5.0 or greater than magnitude 6.0 damaging the Town of Bridgewater. Results are presented in Table 7-2 below.

Table 7-2
Probability of a Damaging Earthquake in the Vicinity of Bridgewater

Time Frame (Years)	Probability of the Occurrence of an Earthquake Event > Magnitude 5.0	Probability of the Occurrence of an Earthquake Event > Magnitude 6.0
50	2% to 3%	< 1%
100	4% to 6%	1% to 2%
250	10% to 12%	2% to 3%
350	12% to 15%	3% to 4%

Based on the historic record and the probability maps generated from the USGS database, the state of Connecticut possesses areas of seismic activity. It is likely that Connecticut will continue to experience minor earthquakes (magnitude less than 3.0) in the future. While the risk of an earthquake affecting Bridgewater is relatively low over the short term, long-term probabilities suggest that a damaging earthquake (magnitude greater than 5.0) could occur within the vicinity of Bridgewater.

HAZUS-MH Simulations and Loss Estimates

The 2014 *Connecticut Natural Hazard Mitigation Plan Update* utilizes four "maximum plausible" earthquake scenarios (three historical, one potential) within HAZUS-MH to generate potential earthquake risk to the State of Connecticut. These same four scenarios were simulated within HAZUS-MH (using the default year 2000 building inventories and census data) to generate potential damages in Bridgewater. The four events are as follows:

- Magnitude 5.7, epicenter in Portland, CT, based on historic event
- Magnitude 5.7, epicenter in Haddam, CT, based on historic event
- Magnitude 6.4, epicenter in East Haddam, CT, based on historic event
- Magnitude 5.7, epicenter in Stamford, CT, magnitude based on USGS probability mapping

The results for each HAZUS-MH earthquake simulation are presented in Appendix C and presented below. These results are believed conservative and considered appropriate for planning purposes in Bridgewater. Note that potentially greater impacts could also occur.

Table 7-3 presents the number of residential buildings (homes) damaged by the various earthquake scenarios, while Table 7-4 presents the total number of buildings damaged by each earthquake scenario. A significant percentage of building damage is to residential buildings, while other building types include agriculture, commercial, education, government, industrial, and religious buildings. The exact definition of each damage state varies based on building construction. See Chapter 5 of the *HAZUS-MH Earthquake Model Technical Manual*, available on the FEMA website, for the definitions of each building damage state based on building construction.

Table 7-3
HAZUS-MH Earthquake Scenarios – Number of Residential Buildings Damaged

Epicenter Location and Magnitude	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage	Total
Haddam – 5.7	23	4	None	None	27
Portland – 5.7	29	5	None	None	34
Stamford – 5.7	64	13	1	None	78
East Haddam – 6.4	74	16	1	None	91

Table 7-4
HAZUS-MH Earthquake Scenarios – Total Number of Buildings Damaged

Epicenter Location and Magnitude	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage	Total
Haddam – 5.7	27	5	None	None	32
Portland – 5.7	35	7	1	None	43
Stamford – 5.7	57	11	1	None	69
East Haddam – 6.4	86	22	2	None	110

The HAZUS simulations consider a subset of critical facilities termed "essential facilities" which are important during emergency situations. As shown in Table 7-5, minor damage to essential facilities is expected for each earthquake scenario.

Table 7-5
HAZUS-MH Earthquake Scenarios – Essential Facility Damage

Epicenter Location and Magnitude	Fire Stations (1)	Police Stations (1)	Schools (1)
Haddam – 5.7	Minor damage (86% functionality)	Minor damage (86% functionality)	Minor damage (86% functionality)
Portland – 5.7	Minor damage (83% functionality)	Minor damage (83% functionality)	Minor damage (83% functionality)
Stamford – 5.7	Minor damage (74% functionality)	Minor damage (74% functionality)	Minor damage (74% functionality)
East Haddam – 6.4	Minor damage (71% functionality)	Minor damage (71% functionality)	Minor damage (71% functionality)

Table 7-6 presents potential damage to utilities and infrastructure based on the various earthquake scenarios. The HAZUS-MH software assumes that the Bridgewater transportation network and utility network includes the following:

- Highway: 2 major bridges and 1 major segments;
- A potable water system consisting of 108 total kilometers of pipelines;
- A waste water system consisting of 65 total kilometers of pipelines and;
- A total of 43 kilometers of natural gas lines

The HAZUS-MH software is based on a national database that assumes each town has infrastructure such as water and wastewater facilities and gas pipelines. It is understood that Bridgewater does not have this type of infrastructure.

As shown in Table 7-6, sewer, and gas lines are expected to have leaks and breaks, no loss of potable water or electrical service is expected. No displacement of people due to fire is expected.

For all earthquake scenarios there is no estimated debris generation for Bridgewater and there are no predicted sheltering requirements or casualty estimates for all earthquake scenarios simulated by HAZUS-MH. However, it is possible that an earthquake could also produce a dam failure (flooding) or be a contingent factor in another hazard event that could increase the overall sheltering need in the community. All earthquake scenarios cause only minor injuries or no injury at all.

Casualties are broken down into four severity levels that describe the extent of injuries. The levels are as follows:

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed;
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening;
- Severity Level 3: Injuries will require hospitalization and can become life-threatening if not promptly treated; and
- Severity Level 4: Victims are killed by the earthquake.

All earthquake scenarios cause no injury.

Table 7-6
HAZUS-MH Earthquake Scenarios – Utility, Infrastructure, and Fire Damage

Epicenter Location and Magnitude	Transportation Network	Utilities	Fire Damage
Haddam – 5.7	No Damage	1 leak in potable water system ($0.01 million). No loss of service expected. Total damage: Approximately $0.01 million.	Fire damage will displace no people.
Portland – 5.7	No Damage	1 leak in potable water system ($0.01 million). No loss of service expected. Total damage: Approximately $0.01 million.	Fire damage will displace no people.
Stamford – 5.7	No Damage	2 leaks and 1 major break in potable water system ($0.01million), and 1 leak in waste water system (<$0.01 million). No loss of service expected. Total damage: Approximately $0.02 million.	Fire damage will displace no people.
East Haddam – 6.4	No Damage	4 leaks and 1 major break in potable water system ($0.02 million), 2 leaks and 1 major break in waste water system ($0.01 million) and 1 leak in natural gas system (<$0.01 million). No loss of service expected. Total damage: Approximately $0.03 million.	Fire damage will displace no people.

Table 7-7 presents the total estimated losses and direct economic impact that may result from the four earthquake scenarios created for Bridgewater as estimated by the HAZUS-MH software. Capital damage loss estimates include the subcategories of building, contents, and inventory damages. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building or its contents. Business interruption loss estimates include the subcategories of lost income, relocation expenses, and lost wages. The business interruption losses are associated with the inability to operate a business due to the damage sustained during an earthquake, and also include temporary living expenses for those people displaced from their home because of the storm. Note that these damages do not include transportation, utility, or fire damage in Table 7-6.

Table 7-7
HAZUS-MH Estimated Direct Losses from Earthquake Scenarios

Epicenter Location and Magnitude	Estimated Total Capital Losses	Estimated Total Income Losses	Estimated Total Losses
Haddam – 5.7	$310,000	$60,000	$370,000
Portland – 5.7	$450,000	$80,000	$54,000
Stamford – 5.7	$1,340,000	$230,000	$1,570,000
East Haddam – 6.4	$1,470,000	$280,000	$1,750,000

The maximum simulated damage considering direct losses and infrastructure losses is approximately $1.75 million for the Stamford scenario. Note that the losses are presented in 2006 dollars, which implies that they will be greater in the future due to inflation. It is also believed that the next plan update will be able to utilize 2010 census data within HAZUS-MH, providing a more recent dataset for analysis.

Despite the low probability of occurrence of damaging earthquakes, this analysis demonstrates that earthquake damage presents a potential hazard to Bridgewater. Additional infrastructure not modeled by HAZUS-MH, such as water treatment plants, sewer pumping stations, and water storage tanks, could be affected by an earthquake.

7.6 Potential Mitigation Strategies and Actions

As earthquakes are relatively infrequent, difficult to predict, and can affect the entire Town of Bridgewater, potential mitigation can only include adherence to building codes, education of residents, and adequate planning.

Requiring adherence to current State building codes for new development and redevelopment is necessary to minimize the potential risk of earthquake damage. Communities may consider preventing new residential development in areas that are most at risk to collapse or liquefaction. Many Connecticut communities already have regulations restricting development on steep slopes. Additional regulations could be enacted to buffer development a certain distance from the bottom of steep slopes, or to prohibit development on fill materials and areas of fine sand and clay. The State Geologist indicates that such deposits have the highest risk for seismic wave amplification. Other regulations could specify a minimum level of compaction for filled areas before it is approvable for development.

Departments providing emergency services should have backup plans and adequate backup facilities such as portable generators in place in case earthquake damage occurs to critical facilities, particularly public water and the waste water treatment facilities. The Highway Department should also have adequate backup plans and facilities to ensure that roads can be opened as soon as possible after a major earthquake.

The fact that damaging earthquakes are rare occurrences in Connecticut heightens the need to educate the public about this potential hazard. An annual pamphlet outlining steps each family can take to be prepared for disaster is recommended. Also, because earthquakes generally provide little or no warning time, municipal personal and students should be instructed on what to do during an earthquake in a manner similar to fire drills.

Critical facilities may be retrofitted to reduce potential damage from seismic events. Potential mitigation activities may include bracing of critical equipment such as generators, identifying and hardening critical lifeline systems, utilizing flexible piping where possible, and installing shutoff valves and emergency connector hoses where utilities cross fault lines. Potential seismic mitigation measures for all buildings include strengthening and retrofitting non-reinforced masonry buildings and non-ductile concrete facilities that are particularly vulnerable to ground shaking, retrofitting building veneers to prevent failure, installing window films to prevent injuries from shattered glass, anchoring rooftop-mounted equipment, and reinforcing masonry chimneys with steel bracing.

If the event that a damaging earthquake occurs, Bridgewater will activate its Emergency Operations Plan and initiate emergency response procedures as necessary.

7.7 Summary of Mitigation Strategies and Actions

The following potential mitigation measures have been identified:

- Consider preventing new residential development in areas prone to collapse. In particular the 2012 POCD recommends reviewing the definition of steep slopes and limiting residential development on steep slopes.
- The town may consider bracing systems and assets inside critical facilities. This could help protect IT systems, important records and files.

In addition, important recommendations that apply to all hazards are listed in Section 10.1.

8.0 DAM FAILURE

8.1 Setting

Dam failures can be triggered suddenly, with little or no warning, and often from other natural disasters such as floods and earthquakes. Dam failures often occur during flooding when the dam breaks under the additional force of floodwaters. In addition, a dam failure can cause a chain reaction where the sudden release of floodwaters causes the next dam downstream to fail. DEEP inventory documents 18 dams within Town limits. Additionally, high hazard dams located in surrounding municipalities have the potential to affect the Town of Bridgewater in a failure event. While flooding from a dam failure generally has a moderate geographic extent, the effects are potentially catastrophic. Fortunately, a major dam failure is considered only a possible hazard event in any given year.

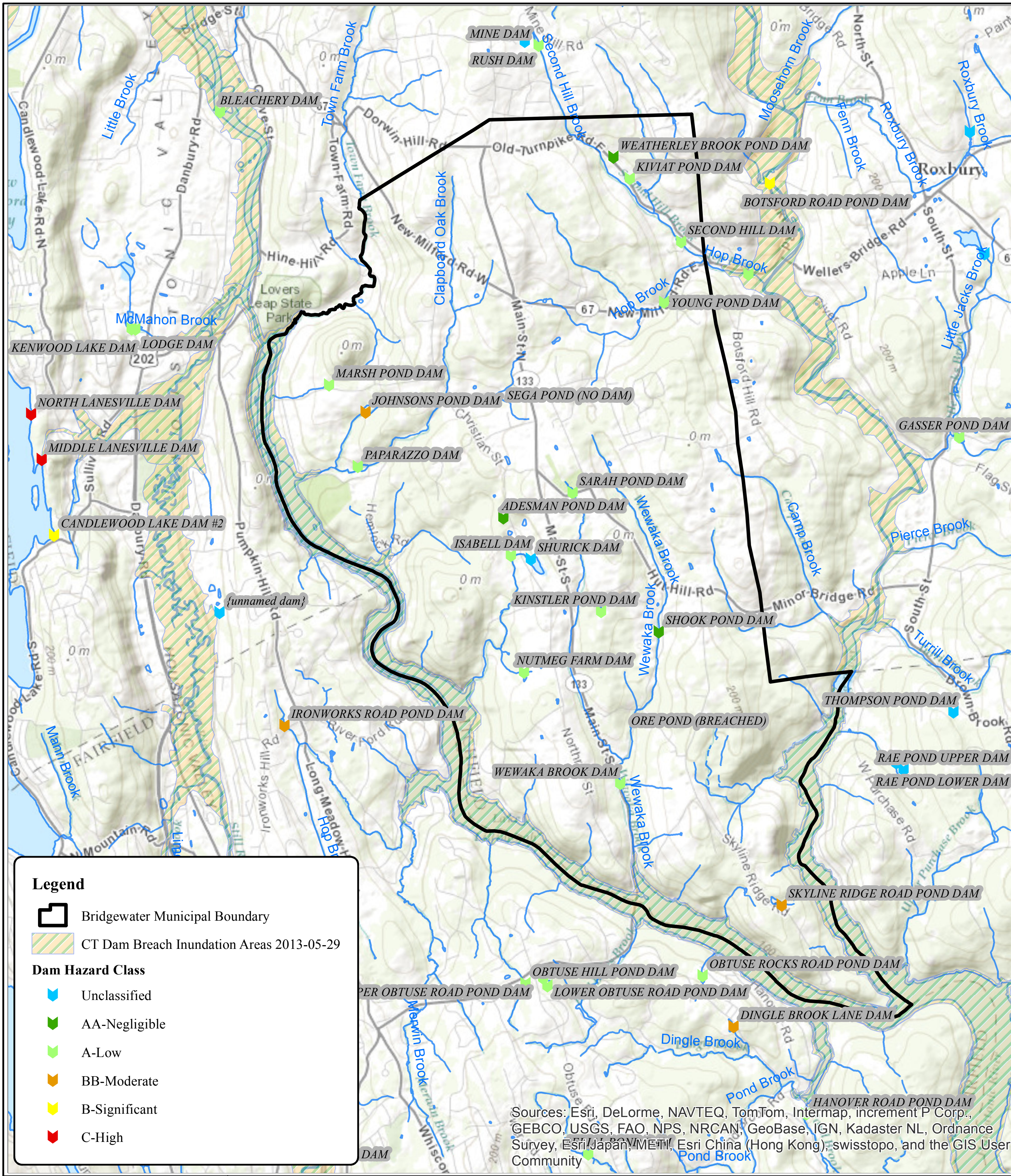
8.2 Hazard Assessment

The Connecticut DEEP administers the statewide Dam Safety Program and designates a classification to each state-inventoried dam based on its potential hazard.

- ❑ *Class AA* dams are negligible hazard potential dams that upon failure would result in no measurable damage to roadways and structures, and negligible economic loss.
- ❑ *Class A* dams are low hazard potential dams that upon failure would result in damage to agricultural land and unimproved roadways, with minimal economic loss.
- ❑ *Class BB* dams are moderate hazard potential dams that upon failure would result in damage to normally unoccupied storage structures, damage to low volume roadways, and moderate economic loss.
- ❑ *Class B* dams are significant hazard potential dams that upon failure would result in possible loss of life; minor damage to habitable structures, residences, hospitals, convalescent homes, schools, and the like; damage or interruption of service of utilities; damage to primary roadways; and significant economic loss.
- ❑ *Class C* dams are high potential hazard dams that upon failure would result in loss of life and major damage to habitable structures, residences, hospitals, convalescent homes, schools, and main highways with great economic loss.

As of 2013, there were 18 DEEP-inventoried dams within the Town of Bridgewater. These dams are shown in Figure 8-1. The primary dam failure concern relates to upstream dams located in adjacent municipalities. Failure of these structures would have an impact on Bridgewater.

This section primarily discusses the possible effects of failure of high hazard (Class B and C) dams. Failure of a Class C dam has a high potential for loss of life and extensive property and infrastructure damage.



SOURCE(S):

2013 CT DEEP Dam Inventory

Figure 8-1: Dam Locations and Hazard Classifications

LOCATION:

Bridgewater, CT

N

Town of Bridgewater
Hazard Mitigation Plan

MXD: P:\3101-14\Design\GIS\Fairfield County\Bridgewater\Maps\Bridgewater Dam Locations and Hazard Classification.mxd

Map By: CPS
MMI#: 3101-14
Original: 01/14/2014
Revision: 1/14/2014
Scale: 1 inch = 0.95 miles

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8.3 Historic Record

Approximately 200 notable dam and reservoir failures occurred worldwide in the 20th century. More than 8,000 people died in these disasters. The following is a listing of some of the more catastrophic dam failures in Connecticut's recent history:

- 1938 and 1955: Exact numbers of dam failures caused by these floods are unavailable, but the Connecticut DEEP believes that more dams were damaged in these events than in the 1982 event listed below or the 2005 dam failure events listed below.
- 1961: Crystal Lake Dam in Middletown failed, injuring three and severely damaging 11 homes.
- 1963: Failure of the Spaulding Pond Dam in Norwich caused six deaths and $6 million in damage.
- June 5-6, 1982: Connecticut experienced a severe flood that caused 17 dams to fail and seriously damaged 31 others. Failure of the Bushy Hill Pond Dam in Deep River caused $50 million in damages, and the remaining dam failures caused nearly $20 million in damages.

The Connecticut DEEP reported that the sustained heavy rainfall from October 7 to 15, 2005 caused 14 complete or partial dam failures and damage to 30 other dams throughout the state. A sample of damaged dams is summarized in Table 8-2.

Table 8-1
Dams Damaged Due to Flooding From October 2005 Storms

Number	Name	Location	Class	Damage Type	Ownership
-----	Somerville Pond Dam	Somers	--	Partial Breach	DEEP
4701	Windsorville Dam	East Windsor	BB	Minor Damage	Private
10503	Mile Creek Dam	Old Lyme	B	Full Breach	Private
-----	Staffordville Reservoir #3	Union	--	Partial Breach	CT Water Co.
8003	Hanover Pond Dam	Meriden	C	Partial Breach	Town of Meriden
-----	ABB Pond Dam	Bloomfield	--	Minor Damage	Private
4905	Springborn Dam	Enfield	BB	Minor Damage	DEEP
13904	Cains Pond Dam	Suffield	A	Full Breach	Private
13906	Schwartz Pond Dam	Suffield	BB	Partial Breach	Private
14519	Sessions Meadow Dam	Union	BB	Minor Damage	DEEP

The Association of State Dam Safety Officials states that no one knows precisely how many dam failures have occurred, but they have been documented in every state. From January 1, 2005 through January 1, 2009, state dam safety programs reported 132 dam failures and 434 incidents requiring intervention to prevent failure.

8.4 Existing Capabilities

The Dam Safety Section of the Connecticut DEEP Inland Water Resources Division is charged with the responsibility for administration and enforcement of Connecticut's dam safety laws. The existing statutes require that permits be obtained to construct, repair, or alter dams and that existing dams be inventoried and periodically inspected to assure that their continued operation does not constitute a hazard to life, health, or property.

The dam safety requirements are codified in Sections 22a-401 through 22a-411 inclusive of the Connecticut General Statutes. Sections 22a-409-1 and 22a-409-2 of the Regulations of Connecticut State Agencies have been enacted and set requirements for the registration, classification, and inspection of dams. Dams must be inventoried by the owner with the Connecticut DEEP according to Connecticut Public Act 83-38.

Dams regulated by the Connecticut DEEP must be designed to pass the 1% annual chance rainfall event with one foot of freeboard, a factor of safety against overtopping.

Significant and high hazard dams are required to meet a design standard greater than the 1% annual chance rainfall event.

Dam inspection regulations require that nearly 700 dams in Connecticut be inspected annually. The Connecticut DEEP currently prioritizes inspections of those dams that pose the greatest potential threat to downstream persons and properties, and also performs inspections as complaints are registered.

Dams found to be unsafe under the inspection program must be repaired by the owner. Depending on the severity of the identified deficiency, an owner is allowed reasonable time to make the required repairs or remove the dam. If a dam owner fails to make necessary repairs to the subject structure, the Connecticut DEEP may issue an administrative order requiring the owner to restore the structure to a safe condition and may refer noncompliance with such an order to the Attorney General's office for enforcement. As a means of last resort, the Connecticut DEEP Commissioner is empowered by statute to remove or correct, at the expense of the owner, any unsafe structures that present a clear and present danger to public safety.

Owners of Class C dams have traditionally been required to maintain Emergency Operation Plans (EOPs). Guidelines for dam EOPs were published by DEEP in 2012, creating a uniform approach for development of EOPs. As dam owners develop EOPs using the new guidance, DEEP anticipates that the quality of EOPs will improve, which will ultimately help reduce vulnerabilities to dam failures.

Important dam safety program changes are underway in Connecticut. Public Act No. 13-197, *An Act Concerning the Dam Safety Program and Mosquito Control*, passed in June 2013 and describes new requirements for dams related to registration, maintenance, and EOPs, which will be called emergency action plans (EAPs) moving forward. This Act requires owners of certain unregistered dams or similar structures to register them by October 1, 2015. The Act generally shifts regularly scheduled inspection and reporting requirements from the DEEP to the owners of dams. The Act also makes owners generally responsible for supervising and inspecting construction work and establishes new reporting requirements for owners when the work is completed.

Effective October 1, 2013, the owner of any high or significant hazard dam (Class B and C) must develop and implement an EAP after the Commissioner of DEEP adopts regulations. The EAP shall be updated every two years, and copies shall be filed with DEEP and the chief executive officer of any municipality that would potentially be affected in the event of an emergency. New regulations shall establish the requirements for such EAPs, including but not limited to (1) criteria and standards for inundation studies and inundation zone mapping; (2) procedures for monitoring the dam or structure during periods of heavy rainfall and runoff, including personnel assignments and features of the dam to be inspected at given intervals during such periods; and (3) a formal notification system to alert appropriate local officials who are responsible for the warning and evacuation of residents in the inundation zone in the event of an emergency.

The CT DEEP also administers the Flood and Erosion Control Board program, which can provide noncompetitive state funding for repair of municipality-owned dams. Funding is limited by the State Bond Commission. State statute Section 25-84 allows municipalities to form Flood and Erosion Control Boards, but municipalities must take action to create the board within the context of the local government such as by revising the municipal charter. The Town's Planning and Zoning Commission is responsible for reviewing all development activities that occur within flood hazard or flood-prone areas.

The Town uses the CT Alert system for emergency notification. The dam failure inundation mapping discussed in the next section can be used to help streamline the geographic contact areas if the failure of a major dam is imminent.

8.5 Vulnerabilities and Risk Assessment

The following section primarily discusses known vulnerable areas located downstream of Class B and C dams.

Class B and C Dams – The western and southwest borders of Bridgewater are formed by watercourses. The Housatonic River forms the boundary between New Milford and Brookfield, and the Shepaug River forms the border with Southbury. Both of these watercourses have been modified by the construction of high hazard dams, and as such, failure of upstream structures has the potential to affect portions of Bridgewater.

The Rocky River Development consists of a series of dams used to impound water for hydroelectric power generation. It is a seasonal pumped storage facility located along the Housatonic River in New Milford. The powerhouse is located seven miles downstream of the Bulls Bridge Dam in New Milford. The structures are owned by First Light Power.

The main dam (Candlewood Lake Dam #9602) crosses the Rocky River approximately one mile upstream of its confluence with the Housatonic River and impounds Candlewood Lake. This is the upper reservoir of the development and has a surface area of 5,610 acres at normal maximum water levels with a contributing watershed of 40.4 square miles. Candlewood Lake has a maximum storage volume of 577,000 acre-feet. It is an earth-filled structure with a 952 foot long core wall and a maximum height of 107 feet. The Canal Dike is an earthen embankment about 2500 feet in length, and 72 feet height, forming the north bank of the power canal to the intake structure. Three Lanesville Dikes were constructed at low points along the middle of the eastern shoreline of Candlewood Lake:

An EAP for the Candlewood Lake Dam was prepared in 2004 by Northeast Utilities Service Company for First Light Power. The plan addresses the requirements of FERC Project No. 2576 and includes Candlewood Lake Dam, Lake Candlewood Dike #2, North Lanesville Dike and Middle Lanesville Dike on Candlewood Lake. The EAP contains a Dam Breach Analysis for the main dam and dikes, and Inundation Maps for a "sunny day" failure and failure under 100-year flood conditions.

The EAP describes the thorough maintenance and monitoring schedule for all structures. This includes continuous staffing at the Rocky River Station; weekly inspections of the dikes; monthly weir and piezometer readings; and annual inspections by FERC representatives. Water levels in Candlewood Lake are monitored continuously by a signal transmitted via an underground cable. Tailrace levels in the Housatonic River are also monitored continuously via a mounted staff gage. Monitors have also been installed at weirs downstream of the Danbury Dike, Middle Lanesville Dike, the Main Dam, and the Canal Dike.

Inundation mapping developed in conjunction with the dam breach analysis indicates the limits of dam failure impacts extending downstream through Bridgewater along its entire western boundary. The flooding impacts also extend upstream along the Shepaug River on the town's southeast border with Southbury. Inundation areas include the length of Lake Lillinoah (Housatonic River), Lillinoah Lake Road North, the western end of Tappen Road, the State Route 133 crossing of the Housatonic River, and approximately 1,800 feet of Main Street north of the Housatonic River. The EAP specifies that representatives of the Rocky River Project are responsible for notifying Bridgewater government officials in the event of an emergency.

<u>Loss Estimates</u> – *HAZUS-MH* was utilized to determine the effect of dam failure for the main dam which crosses the Rocky River approximately one mile upstream from its confluence with the Housatonic River. The Emergency Action Plan for the main dam was obtained for this analysis. Cross-sectional data and flooding areas from the dam failure analyses for a Sunny Day breach were imported into the *HAZUS-MH* flood module. The following paragraphs discuss the results of the *HAZUS-MH* analysis.

The *HAZUS-MH* simulation estimates that no buildings will be at least moderately damaged in Bridgewater. The school, fire station, and police station are not expected to experience damage. The *HAZUS-MH* simulation estimated the following tons of debris would be generated by flood damage from the dam failure scenario. The simulation also estimates the number of truckloads (at approximately 25 tons per truck) that will be required to remove the debris. The breakdown of debris generation is as follows:

Table 8-3
***HAZUS-MH* Flood Scenario – Debris Generation (Tons)**

Stream	Finishes	Structural	Foundations	Total	Truckloads
Failure of Main Dam	11	18	12	41	2

HAZUS-MH calculated the potential sheltering requirement for the dam failure scenario. Displacement includes households evacuated from within or very near to the inundated areas.

Table 8-4
***HAZUS-MH* Flood Scenario – Sheltering Requirements**

Stream	Displaced Households	Population Using Public Shelters
Failure of Main Dam	1	0

HAZUS-MH also calculated the predicted economic losses due to the dam failure scenario. Economic losses are categorized between building-related losses (Table 8-5) and business interruption losses (which are zero or negligible). The low economic losses for Bridgewater are related to the lack of development along the Housatonic River.

Table 8-5
***HAZUS-MH* Flood Scenario – Building Loss Estimates**

Stream	Residential	Commercial	Industrial	Others	Total
Failure of Main Dam	$230,000	$0	$0	$0	$230,000

The total loss for a worst-case scenario dam failure event is estimated by *HAZUS-MH* to be approximately $230,000.

<u>*Other Dams*</u>

- The Paparazzo dam, a low hazard dam located on Clapboard Oak Brook, had repairs reportedly accomplished about three years ago yet is still considered a concern of maintenance and observation because any failure could have significant results.
- The Johnsons Pond Dam, located on a northern branch of the Clapboard Oak Brook, is one of only two dams considered to have moderate hazard.

<u>*Beaver Dams*</u>

Finally, the Town of Bridgewater has expressed concern with the potential failure of beaver dams. Specifically, the 300-acre, Three Rivers Farm (where the Housatonic, Shepaug, and Pook rivers converge) called Promisek, in the southern tip of Bridgewater has a few beaver dams that could present minor problems should the dam breach.

This is a typical concern in many Connecticut communities. Recent beaver dam failures have been known to cause damage in the state. A beaver dam in Colchester failed in spring 2013 and released approximately seven million gallons of water which washed out portions of Old Hartford Road as shown in the photo below.

The town may consider utilizing beaver deterrent devices such as beaver stops or beaver bafflers. A technical memo prepared by the United States Army Corps of Engineers, Wetland Regulatory Assistance Program entitled "Control of Beaver Flooding at Restoration Projects is included in Appendix D and provides various methods of controlling beaver dams.

Photo courtesy of NBC Connecticut.com

8.6 Potential Mitigation Strategies and Actions

Preventive measures associated with dam failure include semi-annual or annual inspections of each dam. Dam inspections in the State of Connecticut are required to be conducted by a licensed professional engineer. In addition, local communities should maintain a dialogue with Connecticut DEEP regarding the development of EAPs and Dam Failure Analysis for dams not owned by the municipality, and encourage Connecticut DEEP to approach dam owners of Class B and Class C dams to develop or update such plans as needed. Some of this will be forthcoming with the recent legislation.

Communities containing or located downstream from high and significant hazard dams should maximize their emergency preparedness for a potential dam failure. This can be done by having copies of the EOP/EAP for each dam on file with the local emergency manager and the local engineering department as well as by including potential inundation areas in an emergency notification database. It is important to maintain up to date dam failure inundation mapping in order to properly direct notifications into potentially affected areas. Dam failure inundation areas should be mapped for all community-owned significant and high hazard dams. For dams without a mapped failure inundation area, the 100-year and 500-year floodplains described in Section 3 could be utilized to provide approximate failure inundation areas for the notification database.

Public education and awareness should be directed at dam owners in the community in order to keep them up to date on maintenance resources, repair resources, funding sources, and regulatory changes. Public education for residents will be similar to those for flooding, but should also be directed to residents in potential inundation areas. Such residents should be given information regarding preparing evacuation kits and potential evacuation procedures.

Structural projects for preventing dam failure are typically focused on maintaining and repairing subject dams to be in good condition, resizing spillways to pass a larger flood event without causing damage, and maintaining upstream dams such that sequential failures do not occur.

8.7 Summary of Specific Strategies and Actions

The following strategies are applicable to mitigation related to dam failures:

- ❑ Include dam failure inundation areas in the CT Alert emergency contact database.
- ❑ Work with the owners of the Paparazzo dam on Clapboard Oak Brook to develop an EAP for this dam despite its relatively low hazard classification, as the town is concerned with its condition and potential for failure.
- ❑ File EOPs/EAPs with town departments and emergency personnel.
- ❑ Consider the use of beaver deterrent devices such as beaver stops or beaver bafflers.

In addition, there are several suggested potential mitigation strategies that are applicable to all hazards in this plan. These are outlined in the Section 10.1.

9.0 WILDFIRES

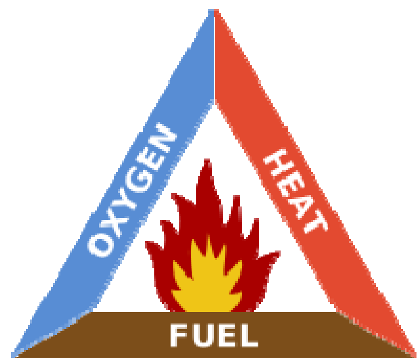
9.1 Setting

The ensuing discussion about wildfires is generally focused on the undeveloped wooded and shrubby areas of Bridgewater, along with low-density suburban type development found at the margins of these areas known as the wildland interface.

The Town of Bridgewater is generally considered a moderate risk area for small wildfires but a low risk area for large wildfires. Wildfires are of particular concern in outlying areas with poor access for fire-fighting equipment. Hazards associated with wildfires include property damage and loss of habitat. Wildfires of any type are considered a likely event each year but, when one occurs, it is generally contained to a small range with limited damage to non-forested areas.

9.2 Hazard Assessment

Wildfires are any non-structure fire, other than a prescribed burn, that occurs in undeveloped areas. They are considered to be highly destructive, uncontrollable fires. Although the term brings to mind images of tall trees engulfed in flames, wildfires can occur as brush and shrub fires, especially under dry conditions. Wildfires are also known as "wildland fires." According to the U.S. Bureau of Land Management, each of three elements (known as the fire triangle) must be present in order to have any type of fire:



The Fire Triangle. Public Domain Image Hosted by Wikimedia Commons.

- Fuel – Without fuel, a fire will stop. Fuel can be removed naturally (when the fire has consumed all burnable fuel) or manually by mechanically or chemically removing fuel from the fire. In structure fires, removal of fuel is not typically a viable method of fire suppression. Fuel separation is important in wildfire suppression and is the basis for controlling prescribed burns and suppressing other wildfires. The type of fuel present in an area can help determine overall susceptibility to wildfires. According to the Forest Encyclopedia Network, four types of fuel are present in wildfires:
    - Ground Fuels, consisting of organic soils, forest floor duff, stumps, dead roots, and buried fuels
    - Surface Fuels, consisting of the litter layer, downed woody materials, and dead and live plants to two meters in height
    - Ladder Fuels, consisting of vine and draped foliage fuels
    - Canopy Fuels, consisting of tree crowns

- Heat – Without sufficient heat, a fire cannot begin or continue. Heat can be removed through the application of a substance, such as water, powder, or certain gases, that reduces the amount of heat available to the fire. Scraping embers from a burning structure also removes the heat source.

- ❑ Oxygen – Without oxygen, a fire cannot begin or continue. In most wildland fires, this is commonly the most abundant element of the fire triangle and is therefore not a major factor in suppressing wildfires.

Nationwide, humans have caused approximately 90% of all wildfires in the last decade. Accidental and negligent acts include unattended campfires, sparks, burning debris, and irresponsibly discarded cigarettes. The remaining 10% of fires are caused primarily by lightning. According to the USGS, wildfires can increase the potential for flooding, debris flows, or landslides; increase pollutants in the air; temporarily destroy timber, foliage, habitats, scenic vistas, and watershed areas; and have long-term impacts such as reduced access to recreational areas, destruction of community infrastructure, and reduction of cultural and economic resources.

Nevertheless, wildfires are also a natural process, and their suppression is now recognized to have created a larger fire hazard as live and dead vegetation accumulates in areas where fire has been prevented. In addition, the absence of fire has altered or disrupted the cycle of natural plant succession and wildlife habitat in many areas. Consequently federal, state, and local agencies are committed to finding ways such as prescribed burning to reintroduce fire into natural ecosystems while recognizing that fire fighting and suppression are still important.

Connecticut has a particular vulnerability to fire hazards where development and wildland areas are in close proximity. The "wildland/urban interface" is where many such fires are fought. Wildland areas are subject to fires because of weather conditions and fuel supply. An isolated wildland fire may not be a threat, but the combined effect of having residences, businesses, and lifelines near a wildland area causes increased risk to life and property. Thus, a fire that might have been allowed to burn itself out with a minimum of fire fighting or containment in the past is now fought to prevent fire damage to surrounding homes and commercial areas as well as smoke threats to health and safety in these areas.

9.3 Historic Record

According to the Connecticut DEEP Forestry Division, much of Connecticut was deforested by settlers and turned into farmland during the colonial period. A variety of factors in the 19^{th} century caused the decline of farming in the state, and forests reclaimed abandoned farm fields. In the early 20^{th} century, deforestation again occurred in Connecticut, this time for raw materials needed to ship goods throughout the world. Following this deforestation, shipping industries in Connecticut began to look to other states for raw materials, and the deciduous forests of today began to grow in the State.

During the early 20^{th} century, wildfires regularly burned throughout Connecticut. Many of these fires began accidentally by sparks from railroads and industry while others were deliberately set to clear underbrush in the forest and provide pasture for livestock. A total of 15,000 to 100,000 acres of land was burned annually during this period. This destruction of resources led to the creation of the position of the State Forest Fire Warden and led to a variety of improved coordination measures described in Section 9.4.

According to the USDA Forest Service Annual Wildfire Summary Report for 1994 through 2003, an average of 600 acres per year in Connecticut was burned by wildfires. The National Interagency Fire Center (NIFC) reports that a total of 3,686 acres of land burned in Connecticut from 2002 through 2013 due to 2,410 non-prescribed wildfires, an average of 1.5 acres per fire and 307 acres per year (Table 9-1).

Table 9-1
Wildland Fire Statistics for Connecticut

Year	Number of Wildland Fires	Acres Burned	Number of Prescribed Burns	Acres Burned	Total Acres Burned
2013	76	238	4	37	275
2012	180	417	4	42	459
2011	196	244	7	42	286
2010	93	262	6	52	314
2009	264	246	6	76	322
2008	330	893	6	68	961
2007	361	288	7	60	348
2006	322	419	6	56	475
2005	316	263	10	130	393
2004	74	94	12	185	279
2003	97	138	8	96	234
2002	101	184	13	106	290
Total	**2,410**	**3,686**	**89**	**950**	**4,636**

Source: National Interagency Fire Center

The 2014 *Connecticut Natural Hazard Mitigation Plan Update* states that in seven of the eight counties in Connecticut, the primary cause of wildland fires is unknown. The secondary cause is identified as incendiary (arson) and debris burning.

Traditionally, the highest forest fire danger in Connecticut occurs in the spring from mid-March to mid-May. The worst wildfire year for Connecticut in the recent past occurred during the extremely hot and dry summer of 1999. Over 1,733 acres of Connecticut burned in 345 separate wildfires, an average of about five acres per fire. Only one wildfire occurred between 1994 and 2003 that burned over 300 acres, and a wildfire in 1986 in the Mattatuck State Forest in the town of Watertown, Connecticut burned 300 acres.

Minor brush fires have occurred in Bridgewater but nothing significant has occurred in several years.

9.4 Existing Capabilities

Connecticut enacted its first statewide forest fire control system in 1905, when the state was largely rural with very little secondary growth forest. By 1927, the state had most of the statutory foundations for today's forest fire control programs and policies in place such as the State Forest Fire Warden system, a network of fire lookout towers and patrols, and regulations regarding open burning. The severe fire weather in the 1940s prompted the state legislature to join the Northeastern Interstate Forest Fire Protection Compact with its neighbors in 1949.

The technology used to combat wildfires has significantly improved since the early 20th century. An improved transportation network, coupled with advances in firefighting equipment, communication technology, and training, has improved the ability of firefighters to minimize damage due to wildfires in the state. For example, radio and cellular technologies have greatly improved firefighting command capabilities. Existing mitigation for wildland fire control is typically focused on Fire Department training and maintaining an adequate supply of equipment. Firefighters are typically focused on training for either structural fires or wildland fires and maintain a secondary focus on the opposite category.

The Connecticut DEEP Division of Forestry monitors the weather each day during non-winter months as it relates to fire danger. The Division utilizes precipitation and soil moisture data to compile and broadcast daily forest fire probability forecasts. Forest fire danger levels are classified as low, moderate, high, very high, or extreme. In addition, the National Weather Service issues a Red Flag warning when winds will be sustained or there will be frequent gusts above a certain threshold (usually 25 mph), the relative humidity is below 30%, and precipitation for the previous five days has been less than one-quarter inch. Such conditions can cause wildfires to quickly spread from their source area.

The Connecticut DEEP has recently changed its Open Burning Program. It now requires individuals to be nominated and designated by the Chief Executive Officer in each municipality that allows open burning to take an online training course and exam to become certified as an “Open Burning Official.” Permit template forms were also revised that provides permit requirements so that the applicant/permittee is made aware of the requirements prior to, during and post burn activity. The regulated activity is then overseen by the town.

According to town officials there are a few dry hydrants and a few ponds in town that are utilized for fire suppression. The town has one all-terrain brush truck for fighting off-road fires and utilizes mutual aid agreements with all of its neighbors. Unlike the west coast of the United States where the fires are allowed to burn toward development and then stopped, the Bridgewater Fire Department goes to the fires whenever possible. This proactive approach is believed to be effective for controlling wildfires. Finally, the DEEP Forestry Division uses rainfall data from a variety of sources to compile forest fire probability forecasts. This allows the DEEP and the Town to monitor the drier areas of the state to be prepared for forest fire conditions.

Regulations regarding fire protection are outlined in the Subdivision Regulations. Specifically, Section 5.5 states that “the Commission may, in its sole discretion, require, for fire protection, the construction of ponds, including dry hydrants, in any subdivision.” However, local regulations do not require fire protection in buildings. This is a concern if an affordable housing proposal is again presented to the town’s land use commissions. The town is interested in adding fire protection requirements to the Zoning Regulations.

9.5 Vulnerabilities and Risk Assessment

Today, most of Connecticut's forested areas are secondary growth forests. According to the Connecticut DEEP, forest has reclaimed over 500,000 acres of land that was used for agriculture in 1914. However, that new forest has been fragmented in the past few decades by residential development. The urban/wildland interface is increasing each year as sprawl extends further out from Connecticut's cities. It is at this interface that the most damage to buildings and infrastructure occurs.

The most common causes of wildfires are arson, lightning strikes, and fires started from downed trees hitting electrical lines. Thus, wildfires have the potential to occur anywhere and at any time in both undeveloped and lightly developed areas. The extensive forests and fields covering the state are prime locations for a wildfire. In many areas, structures and subdivisions are built abutting forest borders, creating areas of particular vulnerability.

Wildfires are more common in rural areas than in developed areas as most fires in populated areas are quickly noticed and contained. The likelihood of a severe wildfire developing is lessened by the vast network of water features in the state, which create natural breaks likely to stop the spread of a fire. During long periods of drought, these natural features may dry up, increasing the vulnerability of the state to wildfires.

According to the Connecticut DEEP, the overall forest fire risk in Connecticut is low due to several factors. First, the overall incidence of forest fires is very low (an average of 215 fires per year occurred in Connecticut from 2002 to 2010, which is a rate slightly higher than one per municipality per year). Secondly, as the wildfire/forest fire prone areas become fragmented due to development, the local fire departments have increased access to those neighborhoods for firefighting equipment. Third, the problematic interface areas such as driveways too narrow to permit emergency vehicles are site specific. Finally, trained firefighters at the local and state level are readily available to fight fires in the state, and inter-municipal cooperation on such instances is common.

However, local risk is not necessarily the same as the overall statewide risk. Bridgewater town officials believe that the fuels are present in the forested parts of the town, and thus believe that the risk is present.

As suggested by the historic record presented in Section 9.3, most wildfires in Connecticut are relatively small. In the drought year of 1999, the average wildfire burned five acres in comparison to the two most extreme wildfires recorded since 1986 that burned 300 acres each. Given the availability of firefighting water in the town, including the use of nearby water bodies, it is believed that this average value for a drought year and the extreme value are applicable to the town as well.

Town officials have noted that the Zoning Regulations do not include fire protection elements or any specifications that require underground tanks or on-site standards for water storage. The town has also indicated that there are a number of “dry fuel” areas throughout town that are considered vulnerable to wildfires.

Loss Estimates – The 2014 Connecticut Natural Hazard Mitigation Plan provides annual estimated losses on a countywide basis for several hazards. Based on the population of Bridgewater relative to Litchfield County, the annual estimated loss is $510 for wildfires. This figure is low compared to those provided by the Town, and it may not represent the true risks in Bridgewater.

9.6 Potential Mitigation Strategies and Actions

Potential mitigation measures for wildfires include a mixture of prevention, education, and emergency planning. Although educational materials are available through the Fire Department, they should be made available at other municipal offices as well. Education of homeowners on methods of protecting their homes is far more effective than trying to steer growth away from potential wildfire areas, especially given that the available land that is environmentally appropriate for development may be forested.

9.7 Summary of Mitigation Strategies and Actions

The following recommendations could be implemented to mitigate fire risk:

- ❑ The town should consider modifying the Zoning Regulations to require the installation of fire protection sources in new developments.
- ❑ The town should develop a list of "at risk" wildfire areas and consider a combination of all available methods of risk reduction, and then increase the availability of water sources in the town's high risk areas.
- ❑ Revise and enhance the town's website concerning the local regulatory requirements concerning Open Burning.

In addition, specific recommendations that apply to all hazards are listed in Section 10.1.

10.0 HAZARD MITIGATION STRATEGIES AND ACTIONS

Strategies and actions that are applicable to two, three, or four hazards were discussed in the applicable subsections of Sections 3.0 through 9.0 although not necessarily repeated in each subsection. For example, protecting overhead utilities is a prudent strategy for hurricane, summer storm, winter storm, and wildfire mitigation. Public education and awareness is a type of mitigation applicable to all hazards because it includes recommendations for improving public safety and planning for emergency response. Instead of repeating these recommendations in section after section of this Plan, these are described below.

10.1 Additional Strategies and Actions

As noted in Section 2.9, several municipal buildings and private properties are considered critical facilities. The Senior Center is the primary shelter for the town. The Town Hall is considered the backup shelter and the Village Store is used as a temporary warming shelter. Each of these facilities has backup generators. Provision of standby power to assist other facilities such as Burnham Elementary School and the local Mobil gas station is a priority strategy of this plan.

Although the town has an EOC and backup EOC, the town administration desires construction of a new Police Station that can house the EOC. This would allow Bridgewater to have an EOC with the level of technology available at the City of Danbury EOC and Town of New Fairfield EOC. The town would also like sufficient dedicated Internet Protocol addresses (IP address) for the EOC.

A community warning system that relies on radios and television is less effective at warning residents during the night when the majority of the community is asleep. The Town should utilize CT Alert to its fullest capabilities. Databases should be set up as best possible for hazards with a specific geographic extent, particularly flooding and dam failure. Residents should also be encouraged to purchase a NOAA weather radio containing an alarm feature. In addition, the Town EOP should continue to be reviewed and updated at least once annually.

10.2 Summary of Proposed Strategies and Actions

Strategies and actions have been presented throughout this document in individual sections as related to each hazard. This section lists specific recommendations of the Plan without any priority ranking. Recommendations that span multiple hazards are only reprinted once in this section under the most appropriate hazard event. Refer to the matrix in Appendix A for recommendations with scores based on the STAPLEE methodology described in Section 1.0.

<u>All Hazards</u>

- ❑ Pursue funding to acquire portable generators and acquire transfer switches to facilitate the use of portable generators when needed.
- ❑ Pursue the steps needed to construct a combined Police Department/EOC with the capabilities of the nearby Danbury and new Fairfield EOCs including internet and communications capabilities.
- ❑ Work with CT DOT to ensure that safety improvements to Route 133 are consistent with the goals of this hazard mitigation plan.
- ❑ Utilize the existing CT Alert emergency notification software to its fullest capabilities.

- ❑ Encourage residents to purchase and use NOAA weather radios with alarm features.
- ❑ Add pages to the Town website (www.Bridgewatertownhall.org) dedicated to citizen education, evacuation routes and preparation for hazard events.

Flooding

Prevention

- ❑ Consider updating the Town Floodplain Ordinance in order to put additional restrictions on floodplain development.
- ❑ Require developers to demonstrate whether detention or retention of stormwater is the best option for reducing peak flows downstream of a project and provide a design for the appropriate alternative.

Property Protection

- ❑ Consider conducting a Wewaka Brook flood mitigation study to identify appropriate methods of reducing flood risk along the stream corridor.
- ❑ Evaluate the small number of floodprone properties along Wewaka Brook to determine potential flood damage reduction methods for these properties.
- ❑ Provide technical assistance regarding floodproofing measures to interested residents. Pursue funding for home elevations should any residents become interested.

Public Education

- ❑ Compile a checklist that cross-references the bylaws, regulations, and codes related to flood damage prevention that may be applicable to a proposed project and make this list available to potential applicants. The information in Section 3.4 provides a starting point for this list.

Natural Resource Protection

- ❑ Develop an open space acquisition program as recommended in the POCD.
- ❑ Pursue the acquisition of additional municipal open space inside SFHAs and set it aside as greenways, parks, and undeveloped land.
- ❑ Develop buffer zone requirements for land adjacent to water as recommended in the POCD.

Structural Projects

- ❑ Identify locations for stormwater detention/retention in the town center area and along Route 133 to reduce peak flows that cause flash flood conditions and streambank erosion along Clapboard Oak Brook.
- ❑ Pursue streambank stabilization improvements along Clapboard Oak Brook.
- ❑ Review culvert conveyances based on existing hydrology and Northeast Regional Climate Center guidance and develop a priority list of culverts for replacement.
- ❑ When replacing or upgrading culverts, work with CT DOT to incorporate findings of the climate change pilot study.

Wind Damage Related to Hurricanes, Summer Storms, and Winter Storms

- Develop a plan to address dead trees throughout the town in an effort to minimize damage from falling trees.
- Work with CL&P to determine the feasibility of placing non-conducting steel cables above the power lines to protect them from falling branches and trees.
- Encourage the use of structural techniques related to mitigation of wind damage in new residential and commercial structures to protect new buildings to a standard greater than the minimum building code requirements. Require such improvements for new municipal critical facilities, for example if the new EOC is constructed.

Winter Storms

- Develop a plan to prioritize snow removal from the roof of critical facilities and other municipal buildings each winter. Ensure adequate funding is available in the Town budget for this purpose.
- Work in rights of way to provide wind breaks and reduce drifting along town roads.
- When permits are issued for clearing of properties, require mitigation by land owners to prevent snow drifts from affecting adjacent roads. Snow fencing and certain vegetation buffers may be effective to reduce drifts.
- Install drainage improvements along Second Hill Road to reduce the potential for icing.

Earthquakes

- Consider preventing new residential development in areas prone to collapse. In particular the 2012 POCD recommends reviewing the definition of steep slopes and limiting residential development on steep slopes.
- The town may consider bracing systems and assets inside critical facilities. This could help protect IT systems, important records and files.

Dam Failure

- Include dam failure inundation areas in the CT Alert emergency contact database.
- Work with the owners of the Paparazzo dam on Clapboard Oak Brook to develop an EAP for this dam despite its relatively low hazard classification, as the town is concerned with its condition and potential for failure.
- File EOPs/EAPs with town departments and emergency personnel.
- Consider the use of beaver deterrent devices such as beaver stops or beaver bafflers.

Wildfires

- The town should consider modifying the Zoning Regulations to require the installation of fire protection sources in new developments.
- The town should develop a list of “at risk” wildfire areas and consider a combination of all available methods of risk reduction, and then increase the availability of water sources in the town’s high risk areas.
- Revise and enhance the town’s website concerning the local regulatory requirements concerning Open Burning.

10.3 Priority Projects and Procedures

As discussed in Section 1.4, the STAPLEE method was used to score mitigation activities. The STAPLEE matrix in Appendix A ranks the mitigation activities proposed in Section 10.1 and 10.2 and also lists possible funding sources. The town's top nine priority strategies and actions are the following:

- Pursue funding to acquire portable generators and acquire transfer switches to facilitate the use of portable generators when needed.
- Pursue streambank stabilization improvements along Clapboard Oak Brook.
- Develop a plan to prioritize snow removal from the roof of critical facilities and other municipal buildings each winter. Ensure adequate funding is available in the Town budget for this purpose.
- Work with CT DOT to ensure that safety improvements to Route 133 are consistent with the goals of this hazard mitigation plan.
- Review culvert conveyances based on existing hydrology and Northeast Regional Climate Center guidance and develop a priority list of culverts for replacement.
- Pursue the acquisition of additional municipal open space inside SFHAs and set it aside as greenways, parks, and undeveloped land.
- Develop buffer zone requirements for land adjacent to water as recommended in the POCD.
- Work in rights of way to provide wind breaks and reduce drifting along town roads.
- The town may consider bracing systems and assets inside critical facilities. This could help protect IT systems, important records and files.

The strategies and actions were separated into two categories:

- The first category includes those strategies and actions that are meant to be implemented within the timeframe of this hazard mitigation plan update (2015-2020).

- The second category includes those strategies and actions that cannot be implemented within the timeframe of this hazard mitigation plan update, but that should be incorporated into capital improvement plans and the next POCD. It is important to maintain this list of longer term strategies and actions because their absence from this HMP may contribute to them not appearing in future updates to this HMP, future capital improvement plans, and the next POCD (to be updated in 2021-2022). For example, "Pursue the acquisition of additional municipal open space inside SFHAs and set it aside as greenways, parks, and undeveloped land" may not be completed by 2019, but it is an important project for Bridgewater to pursue when sources of funding can be secured. Even if a decade is required for setting aside formal greenways, it is an important action.

10.4 Sources of Funding and Technical Assistance

The following sources of funding and technical assistance may be available for the priority projects listed above. This information comes from the FEMA website (http://www.fema.gov/government/grant/index.shtm). Funding requirements and contact information is given in Section 12.4.

Community Disaster Loan Program
http://www.fema.gov/government/grant/fs_cdl.shtm

This program provides funds to any eligible jurisdiction in a designated disaster area that has suffered a substantial loss of tax and other revenue. The assistance is in the form of loans not to exceed twenty-five percent of the local government's annual operating budget for the fiscal year in which the major disaster occurs, up to a maximum of five million dollars.

Continuing Training Grants (CTG)
http://www.grants.gov/web/grants/search-grants.html

This program provides funds to develop and deliver innovative training programs that are national in scope and meet emerging training needs in local communities.

Emergency Food and Shelter Program
http://www.fema.gov/government/grant/efs.shtm

This program was created in 1983 to supplement the work of local social service organizations, both private and governmental, to help people in need of emergency assistance.

Emergency Management Institute
http://training.fema.gov/

Provides training and education to the floodplain managers, fire service, emergency management officials, its allied professions, and the general public.

Emergency Management Performance Grants
http://www.fema.gov/emergency/empg/empg.shtm

The Emergency Management Performance Grant (EMPG) is designed to assist local and state governments in maintaining and strengthening the existing all-hazards, natural and man-made, emergency management capabilities. Allocations if this fund is authorized by the 9/11 Commission Act of 2007, and grant amount is determined demographically at the state and local level.

Flood Mitigation Assistance (FMA) Program
http://www.fema.gov/government/grant/fma/index.shtm

The FMA was created as part of the National Flood Insurance Reform Act of 1994 with the goal of reducing or eliminating claims under the NFIP. FEMA provides funds in the form of planning grants for Flood Mitigation Plans and project grants to implement measures to reduce flood losses, including elevation, acquisition, or relocation of NFIP-insured structures. Repetitive loss properties are prioritized under this program. This grant program is administered through DEMHS.

Hazard Mitigation Grant Program (HMGP)
http://www.fema.gov/government/grant/hmgp/index.shtm

The HMGP provides grants to States and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. This grant program is administered through DEMHS.

Homeland Security Grant Program (HSGP)
http://www.fema.gov/government/grant/hsgp/index.shtm

The objective of the HSGP is to enhance the response, preparedness, and recovery of local, State, and tribal governments in the event of a disaster or terrorist attack. Eligible applicants include all 50 states, the District of Columbia, Puerto Rico, American Samoa, Guam, Northern Mariana Islands, and the Virgin Islands. Risk and effectiveness, along with a peer review, determine the amount allocated to each applicant.

Intercity Passenger Rail (IPR) Program
http://www.fema.gov/fy-2013-intercity-passenger-rail-ipr-amtrak-0

This program provides funding to the National Passenger Railroad Corporation (Amtrak) to protect critical surface transportation infrastructure and the traveling public from acts of terrorism, and to increase the resilience of the Amtrak rail system.

National Flood Insurance Program (NFIP)
http://www.fema.gov/library/viewRecord.do?id=3005

This program enables property owners in participating communities to purchase insurance as a protection against flood losses in exchange for State and community floodplain management regulations that reduce future flood damages. Municipalities that join the associated Community Rating System can gain discounts of flood insurance for their residents.

Nonprofit Security Grant Program (NSGP)
http://www.fema.gov/fy-2014-urban-areas-security-initiative-uasi-nonprofit-security-grant-program-nsgp

This program provides funding support for hardening and other physical security enhancements to nonprofit organizations that are at high risk of terrorist attack and located within one of the specific Urban Areas Security Initiative (UASI)-eligible Urban Areas. The program seeks to integrate the preparedness activities of nonprofit organizations that are at high risk of terrorist attack with broader state and local preparedness efforts, and serve to promote coordination and collaboration in emergency preparedness activities among public and private community representatives and state and local government agencies.

Pre-Disaster Mitigation (PDM) Grant Program
http://www.fema.gov/government/grant/pdm/index.shtm

The purpose of the PDM program is to fund communities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. PDM grants are provided to states, territories, Indian tribal governments, communities, and universities, which, in turn, provide sub-grants to local governments. PDM grants are awarded on a competitive basis. This grant program is administered through DEMHS.

Public Assistance Grant Program
http://www.fema.gov/government/grant/pa/index.shtm

The Public Assistance Grant Program (PA) is designed to assist State, Tribal and local governments, and certain types of private non-profit organizations in recovering from major disasters or emergencies. Along with helping to recover, this grant also encourages prevention against potential future disasters by strengthening hazard mitigation during the recovery process. The first grantee to apply and receive the PA would usually be the State, and the State could then allocate the granted funds to the sub-grantees in need of assistance.

Small Town Economic Assistance Program
http://www.ct.gov/opm/cwp/view.asp?Q=382970&opmNav
|

The Small Town Economic Assistance Program (STEAP) funds economic development, community conservation and quality of life projects for localities that are ineligible to receive Urban Action bonds. This program is administered by the Connecticut Office of Policy and Management (OPM). Connecticut municipalities may receive up to $500,000 per year if (1) they are not designated as a distressed municipality or a public investment community, and (2) the State Plan of Conservation and Development does not show them as having a regional center. Public Act 05-194 allows an Urban Act Town that is not designated as a regional center under the State Plan of Conservation and Development to opt out of the Urban Action program and become a STEAP town for a period of four years.

Transit Security Grant Program (TSGP)
http://www.fema.gov/government/grant/tsgp/index.shtm

The purpose of TSGP is to bolster security and safety for public transit infrastructure within Urban Areas throughout the United States. Applicable grantees include only the state Governor and the designated State Administrative Agency (SAA) appointed to obligate program funds to the appropriate transit agencies.

U.S. Fire Administration

Assistance to Firefighters Grant Program (AFGP)
http://www.firegrantsupport.com/afg/
http://www.usfa.dhs.gov/fireservice/grants/

The primary goal of the Assistance to Firefighters Grants (AFG) is to meet the firefighting and emergency response needs of fire departments and nonaffiliated emergency medical services organizations. Since 2001, AFG has helped firefighters and other first responders to obtain critically needed equipment, protective gear, emergency vehicles, training, and other resources needed to protect the public and emergency personnel from fire and related hazards. The Grant Programs Directorate of the Federal Emergency Management Agency administers the grants in cooperation with the U.S. Fire Administration.

Fire Prevention & Safety Grants (FP&S)
http://www.firegrantsupport.com/fps/

The Fire Prevention and Safety Grants (FP&S) are part of the Assistance to Firefighters Grants (AFG) and are under the purview of the Grant Programs Directorate in the Federal Emergency Management Agency. FP&S grants support projects that enhance the safety of the public and firefighters from fire and related hazards. The primary goal is to target high-risk populations and mitigate high incidences of death and injury. Examples of the types of projects supported by FP&S include fire prevention and public safety education campaigns, juvenile firesetter interventions, media campaigns, and arson prevention and awareness programs.

National Fire Academy Education and Training
http://www.usfa.dhs.gov/nfa/

Provides training to increase the professional level of the fire service and others responsible for fire prevention and control.

Reimbursement for Firefighting on Federal Property
http://www.usfa.dhs.gov/fireservice/grants/rfff/

Reimbursement may be made to fire departments for fighting fires on property owned by the federal government for firefighting costs over and above normal operating costs. Claims are submitted directed to the U.S. Fire Administration.

Staffing for Adequate Fire & Emergency Response (SAFER)
http://www.firegrantsupport.com/safer/

The goal of SAFER is to enhance the local fire departments' abilities to comply with staffing, response and operational standards established by NFPA and OSHA (NFPA 1710 and/or NFPA 1720 and OSHA 1910.134 - see http://www.nfpa.org/SAFERActGrant for more details). Specifically, SAFER funds should assist local fire departments to increase their staffing and deployment capabilities in order to respond to emergencies whenever they may occur. As a result of the enhanced staffing, response times should be sufficiently reduced with an appropriate number of personnel assembled at the incident scene. Also, the enhanced staffing should provide that all front-line/first-due apparatus of SAFER grantees have a minimum of four trained personnel to meet the OSHA standards referenced above. Ultimately, a faster, safer and more efficient incident scene will be established and communities will have more adequate protection from fire and fire-related hazards.

<u>Other Grant Programs</u>

<u>Flood Mitigation</u>

- U.S. Army Corps of Engineers – *50/50 match funding for floodproofing and flood preparedness projects.*
- U.S. Department of Agriculture – *financial assistance to reduce flood damage in small watersheds and to improve water quality.*
- CT Department of Energy and Environmental Protection – *assistance to municipalities to solve flooding and dam repair problems through the Flood and Erosion Control Board Program.*

<u>Erosion Control and Wetland Protection</u>

- U.S. Department of Agriculture – *technical assistance for erosion control.*
- North American Wetlands Conservation Act Grants Program – *funding for projects that support long term wetlands acquisition, restoration, and/or enhancement. Requires a 1-to-1 funds match.*

11.0 PLAN IMPLEMENTATION

11.1 Implementation Strategy and Schedule

The Town of Bridgewater is authorized to update this hazard mitigation plan as described below and guide it through the FEMA approval process.

As individual recommendations of the hazard mitigation plan are implemented, they must be implemented by the municipal departments that oversee these activities. The Office of the First Selectman will primarily be responsible for developing and implementing selected projects. A "local coordinator" will be selected as the primary individual in charge. ***This will be the First Selectman.*** Appendix A incorporates an implementation strategy and schedule, detailing the responsible department and anticipated time frame for the specific recommendations listed throughout this document.

Upon adoption, the Plan will be made available to all Town departments and agencies as a planning tool to be used in conjunction with existing documents. It is expected that revisions to other Town plans and regulations, such as the Plan of Conservation and Development, department annual budgets, and the Zoning and Subdivision Regulations, will reference this plan and its updates. The local coordinator will be responsible for ensuring that the actions identified in this plan are incorporated into ongoing Town planning activities, and that the information and requirements of this plan are incorporated into existing planning documents within five years from the date of adoption or when other plans are updated, whichever is sooner.

The local coordinator will be responsible for assigning appropriate Town officials to update the Plan of Conservation and Development, Zoning Regulations, Subdivision Regulations, Wetlands Regulations, and Emergency Operations Plan to include the provisions in this plan. Should a general revision be too cumbersome or cost prohibitive, simple addendums to these documents will be added that include the provisions of this plan. The Plan of Conservation and Development and the Emergency Operations Plan are the two documents most likely to benefit from the inclusion of the HMP in the Town's library of planning documents.

> ***The POCD was updated and adopted in 2012 and already includes policies that are consistent with this HMP, despite the fact that this HMP was not in existence. These policies are listed in Sections 3.4 and 7.4 of this HMP. When the POCD is updated in approximately 2022, the town will incorporate additional policies and strategies from this HMP or its updates.***

Finally, information and projects in this planning document will be included in the annual budget and capital improvement plans as part of implementing the projects recommended in this Plan. This will primarily include the annual budget and capital improvement projects lists maintained and updated by the Public Works Department.

11.2 Progress Monitoring and Public Participation

The local coordinator will be responsible for monitoring the successful implementation of this HMP update, and will provide the linkage between the multiple departments involved in hazard mitigation at the local level relative to communication and participation. As the plans will be adopted by the local government, coordination is expected to be able to occur without significant barriers.

Site reconnaissance for Specific Suggested Actions – The local coordinator, with the assistance of appropriate department personnel, will annually perform reconnaissance-level inspections of sites that are associated with specific actions. Examples include structural projects. This will ensure that the suggested actions remain viable and appropriate. The worksheet in Appendix C will be filled out for specific project-related actions as appropriate. This worksheet is taken from the *Local Mitigation Planning Handbook.*

Site Reconnaissance to be completed between April 1 and November 1 each year

The local coordinator will be responsible for obtaining a current list of repetitive loss properties (RLPs) in the community each year, although it is understood that currently the towns lacks any RLPs. This list is available from the State NFIP Coordinator. The RLPs shall be subject to a windshield survey at least once every two years to ensure that the list is reasonably accurate relative to addresses and other basic information. Some of the reconnaissance-level inspections could occur incidentally during events such as flooding when response is underway.

Repetitive loss properties to be viewed biennially

Annual Reporting and Meeting – The local coordinator will be responsible for holding an annual meeting to review the plan. Matters to be reviewed on an annual basis include the goals and objectives of the HMP, hazards or disasters that occurred during the preceding year, mitigation activities that have been accomplished to date, a discussion of reasons that implementation may be behind schedule, and suggested actions for new projects and revised activities. Results of site reconnaissance efforts will be reviewed also. A meeting should be conducted in March or April of each year, at least two months before the annual application cycle for grants under the HMA program[3]. This will enable a list of possible projects to be circulated to applicable local departments to review and provide sufficient time to develop a grant application. The local coordinator shall prepare and maintain documentation and minutes of this annual review meeting.

Annual meeting to be conducted in March or April each year

Post-Disaster Reporting and Metering – Subsequent to federally-declared disasters in the State of Connecticut for Litchfield County, a meeting shall be conducted by the local coordinator with representatives of appropriate departments to develop a list of possible projects for developing an HMGP application. The local coordinator shall prepare a report of the recent events and ongoing or recent mitigation activities for discussion and review at the HMGP meeting. Public outreach may be solicited for HMGP applications at a *separate* public meeting.

Meeting to be conducted within two months of each Federal disaster declaration in Connecticut

Continued Public Involvement – Continued public involvement will be sought regarding the monitoring, evaluating, and updating of the HMP. Public input can be solicited through community meetings, presentations on local cable access channels, and input to web-based information gathering tools. Public comment on changes to the HMP may be sought through posting of public notices and notifications posted on the town's web site.

[3] PDM and FMA applications are typically due to the State in summer of any given year.

11.3 Updating the Plan

The town will update the hazard mitigation plan if a consensus to do so is reached by the Town Board of Selectman, or at least once every five years. Updates to this HMP will be coordinated by the local coordinator. The town understands that this HMP will be considered current for a period of five years from the date of approval with the expiration date reported by FEMA via the approval letter. The local coordinator will be responsible for compiling the funding required to update the HMP in a timely manner such that the current plan will not expire while the plan update is being developed; the assistance of the regional planning organization may be solicited from time to time for this purpose.

Table 11-1 presents a schedule to guide the preparation for the plan update and then the actual update of the plan. The schedule is based on the plan adoption date of March 2015 and therefore expiration in March 2020.

Table 11-1
Schedule for Hazard Mitigation Plan Update

Month and Year	Tasks
March 2016	Annual meeting to review plan content and progress
March 2017	Annual meeting to review plan content and progress
March 2018	Annual meeting to review plan content and progress
June 2018	Ensure that funding for the plan update is included in the fiscal year 2018-2019 budget
March 2019	Annual meeting to review plan content and progress
	Secure consultant to begin updating the plan, or begin updating in-house
October 2019	Forward draft updated plan to DEMHS for review
November 2019 – February 2020	Process edits from DEMHS and FEMA and obtain the Approval Pending Adoption (APA)
March 2020	Adopt updated plan

To update the Plan, the local coordinator will coordinate the appropriate group of local officials consisting of representatives of many of the same departments solicited for input to this HMP. In addition, local business leaders, community and neighborhood group leaders, relevant private and non-profit interest groups, and the neighboring municipalities will be solicited for representation, including the following:

- Western Connecticut Council of Governments (WCCOG)
- Town of New Milford
- Town of Brookfield
- Town of Newtown
- Town of Southbury
- Town of Roxbury

The project action worksheets prepared by the local coordinator and annual reports described above will be reviewed. In addition, the following questions will be asked:

- ❑ Do the mitigation goals and objectives still reflect the concerns of local residents, business owners, and officials?
- ❑ Have local conditions changed so that findings of the risk and vulnerability assessments should be updated?
- ❑ Are new sources of information available that will improve the risk assessment?
- ❑ If risks and vulnerabilities have changed, do the mitigation goals and objectives still reflect the risk assessment?
- ❑ What hazards have caused damage locally since the last edition of the HMP was developed? Were these anticipated and evaluated in the HMP or should these hazards be added to the plan?
- ❑ Are current personnel and financial resources at the local level sufficient for implementing mitigation actions?
- ❑ For each mitigation action that has not been completed, what are the obstacles to implementation? What are potential solutions for overcoming these obstacles?
- ❑ For each mitigation action that has been completed, was the action effective in reducing risk?
- ❑ What mitigation actions should be added to the plan and proposed for implementation?
- ❑ If any proposed mitigation actions should be deleted from the plan, what is the rationale?

Future HMP updates may include deleting suggested actions as projects are completed, adding suggested actions as new hazard effects arise, or modifying hazard vulnerabilities as land use changes. For instance, several prior actions were removed from the HMP while preparing this update because they had become institutionalized capabilities, they were successfully completed, or they were subsumed by more specific local or State actions.

11.4 Technical and Financial Resources

This Section is comprised of a list of resources to be considered for technical assistance and potentially financial assistance for completion of the actions outlined in this Plan. This list is not all-inclusive and is intended to be updated as necessary.

Federal Resources

Federal Emergency Management Agency
Region I
99 High Street, 6th floor
Boston, MA 02110
(617) 956-7506
http://www.fema.gov/

Mitigation Division

The Mitigation Division is comprised of three branches that administer all of FEMA's hazard mitigation programs. The **Risk Analysis Branch** applies planning and engineering principles to identify hazards, assess vulnerabilities, and develop strategies to manage the risks associated with natural hazards. The **Risk Reduction Branch** promotes the use of land use controls and building practices to manage and assess risk in both the existing built developments and future development areas in both pre- and post-disaster environments. The **Risk Insurance Branch** mitigates flood losses by providing affordable flood insurance for property owners and by encouraging communities to adopt and enforce floodplain management regulations.

FEMA Programs administered by the Risk Analysis Branch include:

- *Flood Hazard Mapping Program*, which maintains and updates National Flood Insurance Program maps
- *National Dam Safety Program*, which provides state assistance funds, research, and training in dam safety procedures
- *National Hurricane Program*, which conducts and supports projects and activities that help protect communities from hurricane hazards
- *Mitigation Planning*, a process for states and communities to identify policies, activities, and tools that can reduce or eliminate long-term risk to life and property from a hazard event

FEMA Programs administered by the Risk Reduction Branch include:

- *Hazard Mitigation Grant Program (HMGP)*, which provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration
- *Flood Mitigation Assistance Program (FMA)*, which provides funds to assist states and communities to implement measures that reduce or eliminate long-term risk of flood damage to structures insurable under the National Flood Insurance Program
- *Pre-Disaster Mitigation Grant Program (PDM)*, which provides program funds for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event
- *Community Rating System (CRS)*, a voluntary incentive program under the National Flood Insurance Program that recognizes and encourages community floodplain management activities
- *National Earthquake Hazards Reduction Program (NEHRP)*, which in conjunction with state and regional organizations supports state and local programs designed to protect citizens from earthquake hazard

The Risk Insurance Branch oversees the *National Flood Insurance Program (NFIP)*, which enables property owners in participating communities to purchase flood insurance. The NFIP assists communities in complying with the requirements of the program and publishes flood hazard maps and flood insurance studies to determine areas of risk.

FEMA also can provide information on past and current acquisition, relocation, and retrofitting programs, and has expertise in many natural and technological hazards. FEMA also provides funding for training state and local officials at Emergency Management Institute in Emmitsburg, Maryland.

The Mitigation Directorate also has *Technical Assistance Contracts (TAC)* in place that support FEMA, states, territories, and local governments with activities to enhance the effectiveness of natural hazard reduction program efforts. The TACs support FEMA's responsibilities and legislative authorities for implementing the earthquake, hurricane, dam safety, and floodplain management programs. The range of technical assistance services provided through the TACs varies based on the needs of the eligible contract users and the natural hazard programs. Contracts and services include:

- *The Hazard Mitigation Technical Assistance Program (HMTAP) Contract*- supporting post-disaster program needs in cases of large, unusual, or complex projects; situations where resources are not available; or where outside technical assistance is determined to be needed. Services include environmental and biological assessments, benefit/cost analyses, historic preservation assessments, hazard identification, community planning, training, and more.

<u>Response & Recovery Division</u>

As part of the National Response Plan, this division provides information on dollar amounts of past disaster assistance including Public Assistance, Individual Assistance, and Temporary Housing, as well as information on retrofitting and acquisition/ relocation initiatives. The Response & Recovery Division also provides mobile emergency response support to disaster areas, supports the National Disaster Medical System, and provides urban search and rescue teams for disaster victims in confined spaces.

The division also coordinates federal disaster assistance programs. The Public Assistance Grant Program (PA) that provides 75% grants for mitigation projects to protect eligible damaged public and private non-profit facilities from future damage. "Minimization" grants at 100% are available through the Individuals and Family Grant Program. The Hazard Mitigation Grant Program and the Fire Management Assistance Grant Program are also administered by this division.

<u>Computer Sciences Corporation</u>
New England Regional Insurance Manager
Bureau and Statistical Office
(781) 848-1908

Corporate Headquarters
3170 Fairview Park Drive
Falls Church, VA 22042
(703) 876-1000
http://www.csc.com/

A private company contracted by the Federal Insurance Administration as the National Flood Insurance Program Bureau and Statistical Agent, CSC provides information and assistance on flood insurance, including handling policy and claims questions, and providing workshops to leaders, insurance agents, and communities.

Small Business Administration
Region I
10 Causeway Street, Suite 812
Boston, MA 02222-1093
(617) 565-8416
http://www.sba.gov/

SBA has the authority to "declare" disaster areas following disasters that affect a significant number of homes and businesses, but that would not need additional assistance through FEMA. (SBA is triggered by a FEMA declaration, however.) SBA can provide additional low-interest funds (up to 20% above what an eligible applicant would "normally" qualify for) to install mitigation measures. They can also loan the cost of bringing a damaged property up to state or local code requirements. These loans can be used in combination with the new "mitigation insurance" under the NFIP, or in lieu of that coverage.

Environmental Protection Agency
Region I
1 Congress Street, Suite 1100
Boston, MA 02114-2023
(888) 372-7341

Provides grants for restoration and repair, and educational activities, including:

- *Capitalization Grants for Clean Water State Revolving Funds*: Low interest loans to governments to repair, replace, or relocate wastewater treatment plans damaged in floods. Does not apply to drinking water or other utilities.

- *Clean Water Act Section 319 Grants*: Cost-share grants to state agencies that can be used for funding watershed resource restoration activities, including wetlands and other aquatic habitat (riparian zones). Only those activities that control non-point pollution are eligible. Grants are administered through the CT DEEP.

U.S. Department of Housing and Urban Development
20 Church Street, 19th Floor
Hartford, CT 06103-3220
(860) 240-4800
http://www.hud.gov/

The U.S. Department of Housing and Urban Development offers *Community Development Block Grants (CDBG)* to communities with populations greater than 50,000, who may contact HUD directly regarding CDGB. One program objective is to improve housing conditions for low and moderate income families. Projects can include acquiring floodprone homes or protecting them from flood damage. Funding is a 100% grant; can be used as a source of local matching funds for other funding programs such as FEMA's "404" Hazard Mitigation Grant Program. Funds can also be applied toward "blighted" conditions, which is often the post-flood condition. A separate set of funds exists for conditions that create an "imminent threat." The funds have been used in the past to replace (and redesign) bridges where flood damage eliminates police and fire access to the other side of the waterway. Funds are also available for smaller municipalities through the state-administered CDBG program participated in by the State of Connecticut.

U.S. Army Corps of Engineers
Institute for Water Resources
7701 Telegraph Road
Alexandria, VA 22315
(703) 428-8015
http://www.iwr.usace.army.mil/

The Corps provides 100% funding for floodplain management planning and technical assistance to states and local governments under several flood control acts and the Floodplain Management Services Program (FPMS). Specific programs used by the Corps for mitigation are listed below.

- *Section 205 – Small Flood Damage Reduction Projects*: This section of the 1948 Flood Control Act authorizes the Corps to study, design, and construct small flood control projects in partnership with non-Federal government agencies. Feasibility studies are 100 percent federally-funded up to $100,000, with additional costs shared equally. Costs for preparation of plans and construction are funded 65 percent with a 35 percent non-federal match. In certain cases, the non-Federal share for construction could be as high as 50 percent. The maximum federal expenditure for any project is $7 million.

- *Section 14 – Emergency Streambank and Shoreline Protection:* This section of the 1946 Flood Control Act authorizes the Corps to construct emergency shoreline and streambank protection works to protect public facilities such as bridges, roads, public buildings, sewage treatment plants, water wells, and non-profit public facilities such as churches, hospitals, and schools. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $1.5 million.

- *Section 103 – Hurricane and Storm Damage Reduction Projects:* This section of the 1962 River and Harbor Act authorizes the Corps to study, design, and construct small coastal storm damage reduction projects in partnership with non-Federal government agencies. Beach nourishment (structural) and floodproofing (non-structural) are examples of storm damage reduction projects constructed under this authority. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $5 million.

- *Section 208 – Clearing and Snagging Projects:* This section of the 1954 Flood Control Act authorizes the Corps to perform channel clearing and excavation with limited embankment construction to reduce nuisance flood damages caused by debris and minor shoaling of rivers. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $500,000.

- *Section 206 – Floodplain Management Services:* This section of the 1960 Flood Control Act, as amended, authorizes the Corps to provide a full range of technical services and planning guidance necessary to support effective floodplain management. General technical assistance efforts include determining the following: site-specific data on obstructions to flood flows, flood formation, and timing; flood depths, stages, or floodwater velocities; the extent, duration, and frequency of flooding; information on natural and cultural floodplain resources; and flood loss potentials before and after the use of floodplain management measures. Types of studies conducted under FPMS include floodplain delineation, dam failure, hurricane evacuation, flood warning, floodway, flood damage reduction, stormwater management, floodproofing, and inventories of floodprone structures. When funding is available, this work is 100 percent federally funded.

In addition, the Corps also provides emergency flood assistance (under Public Law 84-99) after local and state funding has been used. This assistance can be used for both flood response and post-flood response. Corps assistance is limited to the preservation of life and improved property; direct assistance to individual homeowners or businesses is not permitted. In addition, the Corps can loan or issue supplies and equipment once local sources are exhausted during emergencies.

U.S. Department of Commerce
National Weather Service
Northeast River Forecast Center
445 Myles Standish Blvd.
Taunton, MA 02780
(508) 824-5116
http://www.nws.noaa.gov/

The National Weather Service prepares and issues flood, severe weather, and coastal storm warnings. Staff hydrologists can work with communities on flood warning issues and can give technical assistance in preparing flood warning plans.

U.S. Department of the Interior
National Park Service
Steve Golden, Program Leader
Rivers, Trails, & Conservation Assistance
15 State Street
Boston, MA 02109
(617) 223-5123
http://www.nps.gov/rtca/

The National Park Service provides technical assistance to community groups and local, state, and federal government agencies to conserve rivers, preserve open space, and develop trails and greenways as well as identify nonstructural options for floodplain development.

U.S. Fish and Wildlife Service
New England Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5087
(603) 223-2541
http://www.fws.gov/

The U.S. Fish and Wildlife Service provides technical and financial assistance to restore wetlands and riparian habitats through the North American Wetland Conservation Fund and Partners for Wildlife programs. It also administers the *North American Wetlands Conservation Act Grants Program*, which provides matching grants to organizations and individuals who have developed partnerships to carry out wetlands projects in the United States, Canada, and Mexico. Funds are available for projects focusing on protecting, restoring, and/or enhancing critical habitat.

U.S. Department of Agriculture
Natural Resources Conservation Service
Connecticut Office
344 Merrow Road, Suite A
Tolland, CT 06084-3917
(860) 871-4011

The Natural Resources Conservation Service provides technical assistance to individual landowners, groups of landowners, communities, and soil and water conservation districts on land use and conservation planning, resource development, stormwater management, flood prevention, erosion control and sediment reduction, detailed soil surveys, watershed/river basin planning and recreation, and fish and wildlife management. Financial assistance is available to reduce flood damage in small watersheds and to improve water quality. Financial assistance is available under the Emergency Watershed Protection Program, the Cooperative River Basin Program, and the Small Watershed Protection Program.

Regional Resources

Northeast States Emergency Consortium
1 West Water Street, Suite 205
Wakefield, MA 01880
(781) 224-9876
http://www.serve.com/NESEC/

The Northeast States Emergency Consortium (NESEC) develops, promotes, and coordinates "all-hazards" emergency management activities throughout the northeast. NESEC works in partnership with public and private organizations to reduce losses of life and property. They provide support in areas including interstate coordination and public awareness and education, along with reinforcing interactions between all levels of government, academia, nonprofit organizations, and the private sector.

State Resources

Connecticut Department of Administrative Services, Division of Construction Services
165 Capitol Avenue
Hartford, CT 06106
(860) 713-5850
http://www.ct.gov/dcs/site/default.asp

Office of the State Building Inspector - The Office of the State Building Inspector is responsible for administering and enforcing the Connecticut State Building Code and is also responsible for the municipal Building Inspector Training Program.

<u>Connecticut Department of Economic and Community Development</u>
505 Hudson Street
Hartford, CT 06106-7106
(860) 270-8000
http://www.ct.gov/ecd/

The Connecticut Department of Economic and Community Development administers HUD's State CDBG Program, awarding smaller communities and rural areas grants for use in revitalizing neighborhoods, expanding affordable housing and economic opportunities, and improving community facilities and services.

<u>Connecticut Department of Energy and Environmental Protection</u>
79 Elm Street
Hartford, CT 06106-5127
(860) 424-3000
http://www.dep.state.ct.us/

The Department includes several divisions with various functions related to hazard mitigation:

Bureau of Water Management, Inland Water Resources Division - This division is generally responsible for flood hazard mitigation in Connecticut, including administration of the National Flood Insurance Program. Other programs within the division include:

- *National Flood Insurance Program State Coordinator*: Provides flood insurance and floodplain management technical assistance, floodplain management ordinance review, substantial damage/improvement requirements, community assistance visits, and other general flood hazard mitigation planning including the delineation of floodways.

- *Flood & Erosion Control Board Program*: Provides assistance to municipalities to solve flooding, beach erosion, and dam repair problems. Have the power to construct and repair flood and erosion management systems. Certain nonstructural measures that mitigate flood damages are also eligible. Funding is provided to communities that apply for assistance through a Flood & Erosion Control Board on a noncompetitive basis.

- *Inland Wetlands and Watercourses Management Program*: Provides training, technical, and planning assistance to local Inland Wetlands Commissions, reviews and approves municipal regulations for localities. Also controls flood management and natural disaster mitigations.

- *Dam Safety Program*: Charged with the responsibility for administration and enforcement of Connecticut's dam safety laws. Regulates the operation and maintenance of dams in the state. Permits the construction, repair or alteration of dams, dikes or similar structures and maintains a registration database of all known dams statewide. This program also operates a statewide inspection program.

Planning and Standards Division - Administers the Clean Water Fund and many other programs directly and indirectly related to hazard mitigation including the Section 319 nonpoint source pollution reduction grants and municipal facilities program which deals with mitigating pollution from wastewater treatment plants.

Office of Long Island Sound Programs (OLISP) - Administers the Coastal Area Management Act (CAM) program and Long Island Sound License Plate Program.

Connecticut Department of Emergency Services and Public Protection
1111 Country Club Road
Middletown, CT 06457
(860) 685-8190
http://www.ct.gov/dps/

Connecticut Division of Emergency Management and Homeland Security
25 Sigourney Street, 6th Floor
Hartford, CT 06106-5042
(860) 256-0800
http://www.ct.gov/demhs/

DEMHS is the lead division responsible for emergency management. Specifically, responsibilities include emergency preparedness, response and recovery, mitigation, and an extensive training program. DEMHS is the state point of contact for most FEMA grant and assistance programs and oversees hazard mitigation planning and policy; administration of the Hazard Mitigation Grant Program, Flood Mitigation Assistance Program, and Pre-Disaster Mitigation Program; and the responsibility for making certain that the State Natural Hazard Mitigation Plan is updated every five years. DEMHS administers the Earthquake and Hurricane programs described above under the FEMA resource section. Additionally, DEMHS operates a mitigation program to coordinate mitigation throughout the state with other government agencies. Additionally, the agency is available to provide technical assistance to sub-applicants during the planning process.

DEMHS operates and maintains the CT "Alert" emergency notification system powered by Everbridge. This system uses the state's Enhanced 911 database for location-based notifications to the public for life-threatening emergencies. The database includes traditional wire-line telephone numbers and residents have the option to register other numbers on-line in addition to the land line.

DEMHS employs the *State Hazard Mitigation Officer*, who is in charge of hazard mitigation planning and policy; oversight of administration of the Hazard Mitigation Grant Program,
Flood Mitigation Assistance Program, and Pre-Disaster Mitigation Program, and has the responsibility of making certain that the State Natural Hazard Mitigation Plan is updated every five years.

Connecticut Department of Transportation
2800 Berlin Turnpike
Newington, CT 06131-7546
(860) 594-2000
http://www.ct.gov/dot/

The Department of Transportation administers the federal Intermodal Surface Transportation Efficiency Act (ISTEA) that includes grants for projects that promote alternative or improved methods of transportation. Funding through grants can often be used for projects with mitigation benefits such as preservation of open space in the form of bicycling and walking trails. CT DOT is also involved in traffic improvements and bridge repairs that could be mitigation related.

<u>Connecticut Office of Policy and Management</u>
450 Capitol Avenue
Hartford, CT 06106
(860) 418-6200
http://www.ct.gov.opm

Small Town Economic Assistance Program

The Small Town Economic Assistance Program (STEAP) funds economic development, community conservation and quality of life projects for localities that are ineligible to receive Urban Action bonds. This program is administered by the Connecticut Office of Policy and Management (OPM). Connecticut municipalities may receive up to $500,000 per year if (1) they are not designated as a distressed municipality or a public investment community, and (2) the State Plan of Conservation and Development does not show them as having a regional center. Public Act 05-194 allows an Urban Act Town that is not designated as a regional center under the State Plan of Conservation and Development to opt out of the Urban Action program and become a STEAP town for a period of four years. Projects eligible for STEAP funds include:

1) economic development projects such as (a) constructing or rehabilitating commercial, industrial, or mixed-use structures and (b) constructing, reconstructing, or repairing roads, access ways, and other site improvements;
2) recreation and solid waste disposal projects;
3) social service-related projects, including day care centers, elderly centers, domestic violence and emergency homeless shelters, multi-purpose human resource centers, and food distribution facilities;
4) housing projects;
5) pilot historic preservation and redevelopment programs that leverage private funds; and
6) other kinds of development projects involving economic and community development, transportation, environmental protection, public safety, children and families and social service programs.

In recent years, STEAP grants have been used to help fund many types of projects that are consistent with the goals of hazard mitigation. Projects funded in 2013 and 2014 include streambank stabilization, dam removal, construction of several emergency operations centers (EOCs) in the state, conversion of a building to a shelter, public works garage construction and renovations, design and construct a public safety communication system, culvert replacements, drainage improvements, bridge replacements, generators, and open space acquisition.

Private and Other Resources

Association of State Dam Safety Officials (ASDSO)
450 Old Vine Street
Lexington, KY 40507
(859) 257-5140
http://www.damsafety.org

ASDSO is a non-profit organization of state and federal dam safety regulators, dam owners/operators, dam designers, manufacturers/suppliers, academia, contractors and others interested in dam safety. The mission is to advance and improve the safety of dams by supporting the dam safety community and state dam safety programs, raising awareness, facilitating cooperation, providing a forum for the exchange of information, representing dam safety interests before governments, providing outreach programs, and creating an unified community of dam safety advocates.

The Association of State Floodplain Managers (ASFPM)
2809 Fish Hatchery Road, Suite 204
Madison, WI 53713
(608) 274-0123
http://www.floods.org/

ASFPM is a professional association of state employees that assist communities with the NFIP with a membership of over 1,000. ASFMP has developed a series of technical and topical research papers and a series of Proceedings from their annual conferences. Many "mitigation success stories" have been documented through these resources and provide a good starting point for planning.

Connecticut Association of Flood Managers (CAFM)
P.O. Box 960
Cheshire, CT 06410
ContactCAFM@gmail.com

CAFM is a professional association of private consultants and local floodplain managers that provides training and outreach regarding flood management techniques. CAFM is the local state chapter of ASFPM.

Institute for Business & Home Safety
4775 East Fowler Avenue
Tampa, FL 33617
(813) 286-3400
http://www.ibhs.org/

A nonprofit organization put together by the insurance industry to research ways of reducing the social and economic impacts of natural hazards. The Institute advocates the development and implementation of building codes and standards nationwide and may be a good source of model code language.

<u>Multidisciplinary Center for Earthquake Engineering and Research (MCEER)</u>
University at Buffalo
State University of New York
Red Jacket Quadrangle
Buffalo, New York 14261
(716) 645-3391
http://mceer.buffalo.edu/

A source for earthquake statistics, research, and for engineering and planning advice.

<u>The National Association of Flood & Stormwater Management Agencies (NAFSMA)</u>
1301 K Street, NW, Suite 800 East
Washington, DC 20005
(202) 218-4122
http://www.nafsma.org

NAFSMA is an organization of public agencies who strive to protect lives, property, and economic activity from the adverse impacts of stormwater by advocating public policy, encouraging technology, and conducting educational programs. NAFSMA is a voice in national politics on water resources management issues concerning stormwater management, disaster assistance, flood insurance, and federal flood management policy.

<u>National Emergency Management Association (NEMA)</u>
P.O. Box 11910
Lexington, KY 40578
(859)-244-8000
http://www.nemaweb.org/

A national association of state emergency management directors and other emergency management officials, the NEMA Mitigation Committee is a strong voice to FEMA in shaping all-hazard mitigation policy in the nation. NEMA is also an excellent source of technical assistance.

<u>Natural Hazards Center</u>
University of Colorado at Boulder
482 UCB
Boulder, CO 80309-0482
(303) 492-6818
http://www.colorado.edu/hazards/

The Natural Hazards Center includes the Floodplain Management Resource Center, a free library and referral service of the ASFPM for floodplain management publications. The Natural Hazards Center is located at the University of Colorado in Boulder. Staff can use keywords to identify useful publications from the more than 900 documents in the library.

Volunteer Organizations **-** Volunteer organizations including the American Red Cross, the Salvation Army, Habitat for Humanity, and the Mennonite Disaster Service are often available to help after disasters. Service Organizations such as the Lions Club, Elks Club, and the Veterans of Foreign Wars are also available. Habitat for Humanity and the Mennonite Disaster

Service provide skilled labor to help rebuild damaged buildings while incorporating mitigation or floodproofing concepts. The office of individual organizations can be contacted directly or the FEMA Regional Office may be able to assist.

Flood Relief Funds **-** After a disaster, local businesses, residents, and out-of-town groups often donate money to local relief funds. They may be managed by the local government, one or more local churches, or an ad hoc committee. No government disaster declaration is needed. Local officials should recommend that the funds be held until an applicant exhausts all sources of public disaster assistance, allowing the funds to be used for mitigation and other projects that cannot be funded elsewhere.

Americorps **-** Americorps is the National Community Service Organization. It is a network of local, state, and national service programs that connects volunteers with nonprofits, public agencies, and faith-based and community organizations to help meet our country's critical needs in education, public safety, health, and the environment. Through their service and the volunteers they mobilize, AmeriCorps members address critical needs in communities throughout America, including helping communities respond to disasters. Some states have trained Americorps members to help during flood-fight situations such as by filling and placing sandbags.

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APPENDIX A
STAPLEE MATRIX

Strategies and Actions for the Town of Bridgewater

#	Strategies and Actions for the Town of Bridgewater	Report Sections: Flooding	Hurricanes and Tropical Storms	Summer Storms and Tornadoes	Winter Storms	Earthquakes	Dam Failure	Wildfires	Categories[1]	Responsible Department[2]	Timeframe	Cost[3]	Potential Funding Sources[4]	Weighted STAPLEE Criteria[5] – Benefits: Social	Technical (x2)	Administrative	Political	Legal	Economic (x2)	Environmental	STAPLEE Subtotal	Costs: Social	Technical (x2)	Administrative	Political	Legal	Economic (x2)	Environmental	STAPLEE Subtotal	Total STAPLEE Score
	Strategies and Actions for Implementation During the Timeframe of this Hazard Mitigation Plan (2015-2020)																													
	ALL HAZARDS																													
1	Pursue funding to acquire portable generators and acquire transfer switches to facilitate the use of portable generators when needed	x	x	x	x	x	x	x	6	EMD	7/2015-6/2016	Moderate	HMA, STEAP, Municipal	1	1	1	1	0	1	0	**7.0**	0	0	0	0	0	-0.5	0	**-1.0**	**6.0**
2	Pursue the steps needed to construct a combined Police Department/EOC with the capabilities of the nearby Danbury and new Fairfield EOCs including internet and communications capabilities.	x	x	x	x	x	x	x	6	EMD	1/2016-12/2016	High	EOC, STEAP, Municipal	1	1	1	0.5	0	1	0	**6.5**	0	0	0	0	0	-1	0	**-2.0**	**4.5**
3	Work with CT DOT to ensure that safety improvements to Route 133 are consistent with the goals of this hazard mitigation plan.	x	x	x	x	x	x	x	6	EMD	1/2015-12/2015	Low	Municipal, CT DOT	1	1	1	0.5	0	0.5	0	**5.5**	0	0	0	0	0	0	0	**0.0**	**5.5**
4	Utilize the CT Alert emergency notification system to its fullest capabilities	x	x	x	x	x	x	x	5,6	EMD	7/2015-6/2016	Low	Municipal	1	0.5	0	0	0	0	0	**2.0**	0	0	0	0	0	0	0	**0.0**	**2.0**
5	Encourage residents to purchase and use NOAA weather radios with alarm features	x	x	x	x	x	x	x	6	EMD	1/2017-12/2017	Low	Municipal	1	0.5	0	0	0	0	0	**2.0**	0	0	0	0	0	0	0	**0.0**	**2.0**
6	Add pages to the town website dedicated to citizen education, evacuation routes and preparation for hazard events.	x	x	x	x	x	x	x	5,6	EMD	1/2017-12/2017	Low	Municipal	1	0.5	0	0	0	0	0	**2.0**	0	0	0	0	0	0	0	**0.0**	**2.0**
	FLOODING - Prevention																													
7	Consider updating the Town floodplain ordinances in order to put additional restrictions on floodplain development.	x	x	x			x		1,2	P&Z	1/2017-12/2017	Low	Municipal	1	0.5	1	0	0.5	0	0.5	**4.0**	0	0	-0.5	0	0	0	0	**-0.5**	**3.5**
8	Require developers to demonstrate whether detention or retention of stormwater is the best option for reducing peak flows downstream of a project and provide a design for the appropriate alternative.	x	x	x			x		2	P&Z	1/2018-12/2018	Low	Municipal	1	0.5	0	0	0	0	0.5	**2.5**	0	0	0	0	0	0	0	**0.0**	**2.5**
	FLOODING - Property Protection																													
9	Consider conducting a Wewaka Brook flood mitigation study to identify appropriate methods of reducing flood risk along the stream corridor	x	x	x					2	PW	1/2018-12/2018	High	Municipal, STEAP	1	1	1	0	0	0.5	0.5	**5.5**	0	0	0	0	0	-0.5	0	**-1.0**	**4.5**
10	Evaluate the small number of floodprone properties along Wewaka Brook to determine potential flood damage reduction methods for these properties	x	x	x					2	PW	1/2019-12/2019	High	Municipal	1	1	1	0	0	0.5	0.5	**5.5**	0	0	0	0	0	-0.5	0	**-1.0**	**4.5**
11	Provide technical assistance regarding floodproofing measures to interested residents. Pursue funding for home elevations should any residents become interested	x	x	x			x		2,5	BD	1/2019-6/2020	Low	Municipal, HMA	1	0.5	0	0	0	0	0	**2.0**	0	0	0	0	0	0	0	**0.0**	**2.0**
	FLOODING - Public Education																													
12	Compile a checklist that cross-references the bylaws, regulations, and codes related to flood damage prevention that may be applicable to a proposed project and make this list available to potential applicants.	x	x	x			x		2,5	P&Z	1/2017-12/2017	Low	Municipal	1	0	0	0	0	0	0	**1.0**	0	0	-0.5	0	0	0	0	**-0.5**	**0.5**
	FLOODING - Natural Resource Protection																													
13	Develop an open space acquisition program as recommended in the POCD.	x	x	x			x		2,3	FS	1/2016-12/2016	Low	Municipal	1	1	0.5	0	0	0	0	**3.5**	0	0	0	0	0	-1	0	**-2.0**	**1.5**
14	Develop buffer zone requirements for land adjacent to water as recommended in the POCD.	x	x	x			x		2,5	P&Z	1/2016-12/2016	Minimal	Municipal	0.5	1	1	0	0	0.5	1	**5.5**	-0.5	0	0	0	0	0	0	**-0.5**	**5.0**
	FLOODING - Structural Projects																													
15	Identify locations for stormwater detention/retention in the town center area and along Route 133 to reduce peak flows that cause flashy conditions and streambank erosion along Clapboard Oak Brook.	x	x	x					6	PW	7/2015-12/2016	Low	Municipal	1	1	0.5	0.5	0	0.5	0	**5.0**	-0.5	0	0	0	0	0	0	**0.0**	**5.0**
16	Pursue streambank stabilization improvements along Clapboard Oak Brook.	x	x	x			x		3	PW	1/2018-12/2018	High	Municipal, HMA	1	1	1	0	0	1	1	**7.0**	0	0	0	0	0	-0.5	0	**-1.0**	**6.0**
17	Review culvert conveyances based on existing hydrology and Northeast Regional Climate Center guidance and develop a priority list of culverts for replacement	x	x	x			x		1,2	PW	1/2017-12/2017	Moderate	Municipal	1	1	0.5	1	0.5	0.5	0.5	**6.5**	0	0	0	0	0	-0.5	0	**-1.0**	**5.5**
	WIND DAMAGE RELATED TO HURRICANES, SUMMER STORMS, AND WINTER STORMS																													
18	Develop a plan to address dead trees throughout the town in an effort to minimize damage from falling trees.		x	x	x				2	PW	1/2017-12/2017	Low	Municipal	1	1	0	1	0	0.5	0	**5.0**	0	-0.5	0	0	0	0	0	**-1.0**	**4.0**
19	Work with CL&P to determine the feasibility of placing non-conducting steel cable above the power lines		x	x	x				2	PW	1/2018-12/2018	High	Municipal, CL&P	1	1	1	0.5	0	0.5	0	**5.5**	0	-0.5	0	0	0	0	0	**-1.0**	**4.5**
20	Encourage the use of structural techniques related to mitigation of wind damage in new residential and commercial structures to protect new buildings to a standard greater than the minimum building code requirements. Require such improvements for new municipal critical facilities		x	x	x				2	BD, EMD	1/2019-6/2020	Low	Municipal	1	1	0	1	0	0	0	**4.0**	0	0	0	0	0	0	0	**0.0**	**4.0**
	WINTER STORMS																													
21	Develop a plan to prioritize snow removal from the roof of critical facilities and other municipal buildings each winter. Ensure adequate funding is available in the Town budget for this purpose.				x				6	EMD	1/2016-12/2016	Low	Municipal	1	1	1	0.5	0	1	0	**6.5**	0	0	-0.5	0	0	0	0	**-0.5**	**6.0**
22	Work in rights of way to provide wind breaks and reduce drifting along town roads				x				1	PW	1/2016-12/2016	Moderate	Municipal	1	1	1	0	0	0.5	0	**5.0**	0	0	0	0	0	0	0	**0.0**	**5.0**
23	When permits are issued for clearing of properties, require mitigation by land owners to prevent snow drifts from affecting adjacent roads. Snow fencing and certain vegetation buffers may be effective to reduce drifts.				x				1	P&Z	1/2016-12/2019	Minimal	Municipal	0.5	1	1	0	0	0	0.5	**4.0**	0	0	0	0	0	0	0	**0.0**	**4.0**
24	Install drainage improvements along Second Hill Road to reduce the potential for icing.				x				6	PW	7/2017-6/2018	High	Municipal, STEAP, HMA	0.5	1	0.5	0	0	0	0	**3.0**	-0.5	0	0	0	0	-1	0	**-2.5**	**0.5**
	DAM FAILURE																													
25	Work with the owners of the Paparazzo dam on Clapboard Oak Brook to develop an EAP for this dam despite its relatively low hazard classification, as the town is concerned with its condition and potential for failure.						x		3	FS	1/2016-12/2016	Low	Municipal, Private	0.5	1	0.5	0	0	0	0	**3.0**	-1	0	0	0	0	0	0	**-1.0**	**2.0**
26	File EOP's/EAP's with town departments and emergency personnel						x		5,6	EMD	1/2017-12/2017	Low	Municipal	1	0	1	0	0	0	0	**2.0**	0	0	0	0	0	0	0	**0.0**	**2.0**
	WILDFIRES																													
27	Consider updating the Zoning Regulations to require the installation of fire protection sources in new developments.							x	2,3	P&Z	1/2015-12/2015	Low	Municipal	1	1	1	0.5	0	0	0.5	**5.0**	0	0	-0.5	0	0	0	0	**-0.5**	**4.5**
28	Revise and enhance the town's website concerning the local regulatory requirements concerning Open Burning							x	5,6	FD	1/2015-12/2015	Low	Municipal	1	0.5	1	0	0	0	0	**3.0**	0	0	0	0	0	0	0	**0.0**	**3.0**

#	Strategies and Actions for the Town of Bridgewater	Report Sections							Categories[1]	Responsible Department[2]	Timeframe	Cost[3]	Potential Funding Sources[4]	Weighted STAPLEE Criteria[5]																Total STAPLEE Score
														Benefits								*Costs*								
		Flooding	Hurricanes and Tropical Storms	Summer Storms and Tornadoes	Winter Storms	Earthquakes	Dam Failure	Wildfires						Social	Technical (x2)	Administrative	Political	Legal	Economic (x2)	Environmental	**STAPLEE Subtotal**	Social	Technical (x2)	Administrative	Political	Legal	Economic (x2)	Environmental	**STAPLEE Subtotal**	
	Strategies and Actions for Implementation After the Timeframe of this Hazard Mitigation Plan Update (2015-2020) but to be incorporated into CIPs, the POCD, and other plans																													
	FLOODING																													
29	Pursue acquisition of additional municipal open space in SHFAs and set it aside for greenways, parks, etc.	x	x	x			x		2,3	FS	2020-2025	High	Municipal, Private	1	1	1	1	0	1	1	**8.0**	0	0	-0.5	0	0	-1	0	**-2.5**	**5.5**
30	When replacing or upgrading culverts, work with CT DOT to incorporate findings of the climate change pilot study and work with HVA to incorporate findings of the stream crossing assessment training.	x	x	x			x		2	PW	2020-2025	Moderate	CT DOT	1	0	0	0	0	0	0	**1.0**	0	0	0	0	0	0	0	**0.0**	**1.0**
	EARTHQUAKES																													
31	Consider preventing new residential development in areas prone to collapse. In particular the 2012 POCD recommends reviewing the definition of steep slopes and limiting residential development on steep slopes.					x			1,2	P&Z	2020-2025	Low	Municipal	1	0.5	1	0	0	0	0	**3.0**	0	0	0	0	0	0	0	**0.0**	**3.0**
32	Consider bracing vulernable systems and assets inside critical facilities. This could help protect IT systems, important records and files					x			2,6	EMD,PW	2025-2030	High	Municipal, EOC, STEAP	1	1	1	0	0	0.5	0	**5.0**	0	0	0	0	0	0	0	**0.0**	**5.0**
	DAM FAILURE																													
33	Include dam failure inundation areas in the CT Alert emergency contact database.						x		2	EMD	2020-2025	Minimal	Municipal	1	0.5	1	0	0	0	0	**3.0**									
34	Consider the use of beaver deterrent devices such as beaver stops or beaver bafflers.						x		2,4	PW	2020-2025	Low	Municipal	0.5	0.5	1	0	0	0	0.5	**3.0**	0	0	0	0	0	0	-0.5	**-0.5**	**2.5**
	WILDFIRES																													
35	The town should develop a list of "at risk" wildfire areas and consider a combination of all available methods of risk reduction, and then increase the availability of water sources in the town's high risk areas.							x	6	FD	2020-2025	Low	Municipal, STEAP	1	0.5	1	0	0	0	0	**3.0**	0	0	-0.5	0	0	0	0	**-0.5**	**2.5**

NOTES

1. Categories: 1: Prevention. 2: Property Protection. 3: Emergency Services. 4: Public Information. 5: Natural Resource Protection. 6: Structural Projects.
2. Responsible Departments: BD = Building Department; EMS = Emergency Management; FD = Fire Department; FS = First Selectman; LC = Local Coordinator; PW = Public Works; P&Z = Planning & Zoning Commission
3. Costs: Minimal = To be completed by staff or volunteers where costs are primarily printing, copying, or meetings; Low = Costs are less than $10,000; Moderate = Costs are less than $100,000; High = Costs are > than $100,000
4. Funding Sources:
   HMA = Hazard Mitigation Assistance
   A * by "HMA" indicates that it has a potential for a benefit-cost ratio above 1.0
   EOC = Emergency Operations Center grant (not currently active)
   STEAP = Small Town Economic Assistance Program (State grant program)
   Private = Bridgewater Land Trust and private individuals
5. A beneficial or favorable rating = 1; an unfavorable rating = -1. Technical and Financial benefits and costs are double-weighted (i.e. their values are counted twice in each subtotal

APPENDIX B
RECORD OF MUNICIPAL ADOPTION

TOWN OF BRIDGEWATER

Town Hall · P.O. Box 216 · Bridgewater, CT 06752

CURTIS S. READ
FIRST SELECTMAN

TEL: 860-354-5250
FAX: 860-350-5944

CERTIFICATE OF ADOPTION
TOWN OF BRIDGEWATER BOARD OF SELECTMEN

A RESOLUTION ADOPTING THE TOWN OF BRIDGEWATER HAZARD MITIGATION PLAN

WHEREAS, the Town of Bridgewater has historically experienced severe damage from natural hazards and it continues to be vulnerable to the effects of those natural hazards profiled in the plan (e.g. *flooding, high wind, thunderstorms, winter storms, earthquakes, dam failure, and wildfires)*, resulting in loss of property and life, economic hardship, and threats to public health and safety; and

WHEREAS, the Town of Bridgewater has developed and received conditional approval from the Federal Emergency Management Agency (FEMA) for its Hazard Mitigation Plan under the requirements of 44 CFR 201.6; and

WHEREAS, committee meetings were held in 2014 and public input was gathered by several methods regarding the development and review of the Hazard Mitigation Plan; and

WHEREAS, the Plan specifically addresses hazard mitigation strategies and Plan maintenance procedure for the Town of Bridgewater; and

WHEREAS, the Plan recommends several hazard mitigation actions/projects that will provide mitigation for specific natural hazards that impact the Town of Bridgewater, with the effect of protecting people and property from loss associated with those hazards; and

WHEREAS, adoption of this Plan will make the Town of Bridgewater eligible for funding to alleviate the impacts of future hazards; now therefore be it

RESOLVED by the Board of Selectmen:

1. The Plan is hereby adopted as an official plan of the Town of Bridgewater;
2. The respective officials identified in the mitigation strategy of the Plan are hereby directed to pursue implementation of the recommended actions assigned to them;
3. Future revisions and Plan maintenance required by 44 CFR 201.6 and FEMA are hereby adopted as a part of this resolution for a period of five (5) years from the date of this resolution.
4. An annual report on the progress of the implementation elements of the Plan shall be presented to the Board of Selectmen.

Adopted this __10__ day of __March__ 2015 by the Board of Selectman of Bridgewater, Connecticut

Curtis S. Read
____
First Selectman

IN WITNESS WHEREOF, the undersigned has affixed his/her signature and the corporate seal of the Town of Bridgewater this __10__ day of __March__ 2015.

John R. DiBella
____
Town Clerk

APPENDIX C
MITIGATION PROJECT STATUS WORKSHEET

Mitigation Action Progress Report Form

Progress Report Period	From Date:	To Date:
Action/Project Title		
Responsible Agency		
Contact Name		
Contact Phone/Email		
Project Status	❑ Project completed ❑ Project canceled ❑ Project on schedule ❑ Anticipated completion date:__________ ❑ Project delayed Explain __________	

Summary of Project Progress for this Report Period

1. What was accomplished for this project during this reporting period?

2. What obstacles, problems, or delays did the project encounter?

3. If uncompleted, is the project still relevant? Should the project be changed or revised?

4. Other comments

Plan Update Evaluation Worksheet

Plan Section	Considerations	Explanation
Planning Process	Should new jurisdictions and/or districts be invited to participate in future plan updates?	
	Have any internal or external agencies been invaluable to the mitigation strategy?	
	Can any procedures (e.g., meeting announcements, plan updates) be done differently or more efficiently?	
	Has the Planning Team undertaken any public outreach activities?	
	How can public participation be improved?	
	Have there been any changes in public support and/or decision- maker priorities related to hazard mitigation?	
Capability Assessment	Have jurisdictions adopted new policies, plans, regulations, or reports that could be incorporated into this plan?	
	Are there different or additional administrative, human, technical, and financial resources available for mitigation planning?	
	Are there different or new education and outreach programs and resources available for mitigation activities?	
	Has NFIP participation changed in the participating jurisdictions?	
Risk Assessment	Has a natural and/or technical or human-caused disaster occurred?	
	Should the list of hazards addressed in the plan be modified?	
	Are there new data sources and/or additional maps and studies available? If so, what are they and what have they revealed? Should the information be incorporated into future plan updates?	
	Do any new critical facilities or infrastructure need to be added to the asset lists?	
	Have any changes in development trends occurred that could create additional risks?	
	Are there repetitive losses and/or severe repetitive losses to document?	

Worksheet 7.2

Plan Update Evaluation Worksheet

Plan Section	Considerations	Explanation
Mitigation Strategy	Is the mitigation strategy being implemented as anticipated? Were the cost and timeline estimates accurate?	
	Should new mitigation actions be added to the Action Plan? Should existing mitigation actions be revised or eliminated from the plan?	
	Are there new obstacles that were not anticipated in the plan that will need to be considered in the next plan update?	
	Are there new funding sources to consider?	
	Have elements of the plan been incorporated into other planning mechanisms?	
Plan Maintenance Procedures	Was the plan monitored and evaluated as anticipated?	
	What are needed improvements to the procedures?	

APPENDIX D
DOCUMENTATION OF PLAN DEVELOPMENT

APPENDIX D
PREFACE

An extensive data collection, evaluation, and outreach program was undertaken to compile information about existing hazards and mitigation in the Town of Bridgewater as well as to identify areas that should be prioritized for hazard mitigation. Documentation of this process is provided within the following sets of meeting minutes and field reports.

Development of Hazard Mitigation Plan for the Town of Bridgewater

Presented by:
David Murphy, P.E., CFM
Craig Southern, CFM
Milone & MacBroom, Inc.
January 15, 2014

MILONE & MACBROOM®

Purpose and Need for a Hazard Mitigation Plan

- **Authority**
  - **Disaster Mitigation Act of 2000 (amendments to Stafford Act of 1988)**
- **Goal of Disaster Mitigation Act**
  - **Encourage disaster preparedness**
  - **Encourage hazard mitigation measures to reduce losses of life and property**
- **Status of Plans in Connecticut**
  - **Most initial plans developed 2005-2010**
  - **A few areas of the State remain**
  - **The State hazard mitigation plan is updated every three years; local plans are updated every five years**

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What is a Natural Hazard?

- An extreme natural event that poses a risk to people, infrastructure, and resources

MILONE & MACBROOM®

What is Hazard Mitigation?

- Actions that reduce or eliminate long-term risk to people, property, and resources from natural hazards and their effects

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Long-Term Goals of Hazard Mitigation

- Reduce loss of life and damage to property and infrastructure
- Reduce the costs to residents and businesses (taxes, insurance, repair costs, etc.)
- Educate residents and policy-makers about natural hazard risk and vulnerability
- Connect hazard mitigation planning to other community planning efforts
- Enhance and preserve natural resource systems in the community

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What a Hazard Mitigation Plan Does Not Address

- Terrorism and Sabotage
- Disaster Response and Recovery
- Human Induced Emergencies (some fires, hazardous spills and contamination, disease, etc.)

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Update on Hazard Mitigation Grant Programs

- Local communities must have a FEMA-approved Hazard Mitigation Plan in place to receive Federal Grant Funds for Hazard Mitigation Projects
  - PDM (Pre-Disaster Mitigation)
  - HMGP (Hazard Mitigation Grant Program)
  - FMA (Flood Mitigation Assistance)
- Connecticut has >$20M to distribute under HMGP

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How Can the Plan be Used?

- Grants can be used for:
  - Building acquisitions or elevations
  - Culvert replacements
  - Drainage projects
  - Riverbank stabilization
  - Landslide stabilization
  - Wind retrofits
  - Seismic retrofits
  - Snow load retrofits
  - **Standby power supplies for critical facilities**

FEMA's new cost effectiveness guidelines will make acquisitions and elevations easier

This home in Trumbull was acquired and demolished using a FEMA grant

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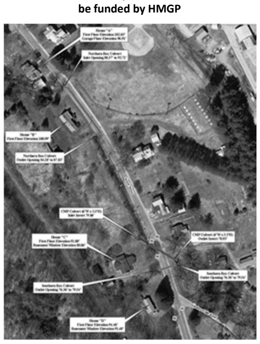
How Can the Plan be Used?

Culvert Replacement to be funded by HMGP



Floyd 1999

Irene 2011

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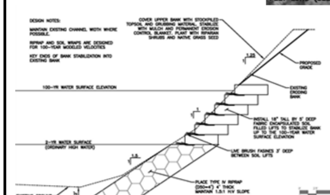
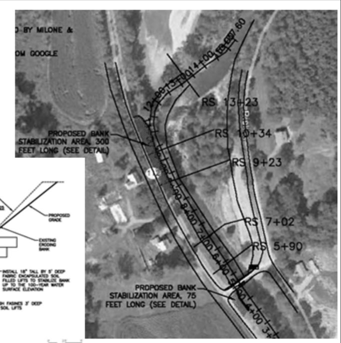
How Can the Plan be Used?

Riverbank Stabilization to be funded by HMGP





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Hazards Proposed to Include in the Plan

- Floods
- Hurricanes and tropical storms
- Summer storms and tornadoes

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Hazards Proposed to Include in the Plan

- Winter storms and nor'easters
- Earthquakes
- Wildfires
- Dam failure
- Landslides (optional)

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Components of Hazard Mitigation Plan Process

- Review natural hazards that could occur in Bridgewater
- Review the vulnerability of structures and populations and identify critical facilities and areas of concern
- Incorporate effects of federally declared disasters that have occurred in the last few years:
  - ✓ March 2010 floods
  - ✓ Winter snow loads/collapsing roofs in January 2011
  - ✓ Tropical Storm Irene in August 2011 (and T.S. Lee afterward)
  - ✓ Winter Storm Alfred in October 2011
  - ✓ Hurricane Sandy in October 2012
  - ✓ Winter Storm Nemo in February 2013

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Components of Hazard Mitigation Plan Process

- Assess adequacy of mitigation measures currently in place such as regulations and drainage projects
- Develop mitigation goals, strategies, and actions
- Outreach to stakeholders and neighboring towns
- HAZUS vulnerability/risk analysis
- Public participation
- Develop plan document
- State and FEMA approvals
- Local adoption

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Scope of Services and Schedule

- Task 1 – Project Initiation and Data Collection: January 2014
- Task 2 – Risk and Vulnerability Assessment: HAZUS already completed; additional analysis February 2014
- Task 3 – Strategy and Plan Development: February-March 2014
- Task 4 – DEMHS and FEMA Review and Plan Adoption: April 2014 and continuing as needed

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Data Collection and Discussion

- What are Bridgewater's critical facilities?
- Shelters and evacuation routes
- Standby power supplies
- Discussion of recent storms (Irene, Alfred, Sandy)
- Development and redevelopment trends
- Utilities above/below ground?
- Areas of flooding
- How are drainage and flooding complaints received and tracked?

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Data Collection and Discussion

- Have any bridges, culverts, or stormwater systems been replaced or upgraded recently?
- Areas prone to wind damage or increased wind damage risk
- Tree maintenance and tree warden budget
- Snow and ice removal routes and capabilities
- Areas prone to icing or drifts in winter
- Dams and effects of dam failure
- Areas without fire protection and use of dry hydrants and cisterns
- Areas prone to wildfires, fire department capabilities, coordination with nearby municipalities

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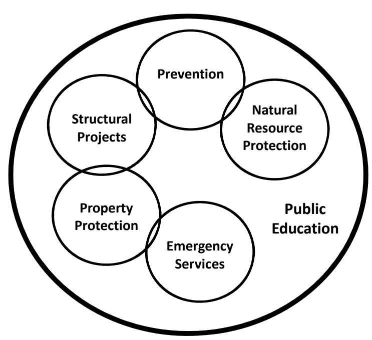
Hazard Mitigation Strategies



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Typical Hazard Mitigation Strategies

- Elevate or remove flood-prone buildings
- Wet and dry floodproofing
- Move critical facilities from flood zones
- Strengthen or reinforce shelters
- Remove and replace undersized and/or failing bridges and culverts
- Replace overhead utilities with underground utilities
- Organize tree maintenance priorities and scheduling
- Enhance fire suppression capabilities
- Public education programs – dissemination of public safety information

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Hazard Mitigation Strategies for Bridgewater

- Goals?
- Strategies and actions?
- What one or two things can be done in Bridgewater with current budgets?
- What one or two things would be done in Bridgewater if money was not a concern?

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Next Steps

- Outreach and public involvement
  - Coordination with other HVCEO municipalities
  - Public information meeting in February 2014
- Materials needed or resulting from this meeting
  - Are POCD, Regulations, and zoning map on town web site?
  - Are any specific ordinances related to hazard mitigation?
  - NFIP regulations: Is flood damage prevention included in the municipal code, zoning, or both?

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Meeting Minutes

HAZARD MITIGATION PLAN
Data Collection Meeting for Bridgewater
January 15, 2014

A. Welcome & Introductions

The following individuals attended the data collection meeting:

- Curtis Rea, First Selectman
- Anne Marie Lindblom, Assistant to First Selectman
- Brian Sullivan, Public Works Foreman
- Ron Rotter, Emergency Management Director
- David Hannon, Housatonic Valley Council of Elected Officials (HVCEO)
- David Murphy, Milone & MacBroom, Inc. (MMI)
- Craig Southern, Milone & MacBroom, Inc. (MMI)

B. Description and Need for Hazard Mitigation Plans / Disaster Mitigation Act of 2000

David briefly described the basis for the natural hazard planning process and possible outcomes, including the role of the subject plan in grant application support for the community. David noted that with several declared disasters in the past few years there are opportunities for grants under HMGP through the State of Connecticut (DEMHS). FEMA grant programs require a local match of 25% of the project cost, and application materials must show that the proposed action will be cost-effective (i.e., provide more long term benefits in preventing damage than the upfront costs).

The plan will address flooding, hurricanes and tropical storms, winter storms and nor'easters, summer storms and tornadoes, earthquakes, dam failure, and wildfires. These hazards were discussed along with critical facilities, development trends and mitigation strategies and actions for the Town of Bridgewater.

C. Critical Facilities

- The following Critical Facilities have backup power and generators:
  - Senior Center
  - Fire Department
  - The Public Works Highway Garage
  - The Village Store
- The Police Department and the local Mobil gas station are also considered critical facilities, they do not have any backup power. Although the town recognizes that this facility is privately-owned, the Mobil gas station is vital for residents to obtain gas in time of severe storm events.

- The Public Works Highway Garage has 500 gallons of reserve gas stored at its location in time of emergencies.
- The Senior Center is the primary shelter for the Town and the current location of the EOC.
- The Town Hall is the secondary shelter for the Town
- The Village Store is considered a temporary warming shelter, that has wi-fi and phone services available while providing a location to purchase food during a storm event.
- Anne Marie Lindblom will email a more detailed comprehensive list of critical facilities
- The Burnham Elementary, this facility needs a generator; once acquired it could be operated as a shelter. The school sends alerts on the Nutmeg Network.
- Road closures are a major concern. Main Street (Route 133) has occasionally been closed due to snow, ice or fallen trees. This Route is considered the evacuation route for the Town. The clearing and opening up of this route is typically dependent upon the Town of Bridgewater rarely does DOT or CL & P clean and clear Route 133 in an expedient manner. Road closures due to fallen trees can result in extended detour times for emergency personnel.
- DOT is proposing to do additional work and safety improvements to Route 133, which would include a long retaining wall. The Town would like to be more involved in the improvement process.
- Acquisition of portable generators would greatly assist the town in providing emergency power when needed.

D. Development Trends

- In the 1980's Bridgewater had a lot of single family homes constructed, around 2007 - 2008 new construction virtually came to a standstill.
- Town personnel indicated that there was a recent affordable housing project proposed with over 200 units but the proposal was denied and rejected by the Town. The Town anticipates that this developer will be return with a new proposal for the same piece of land.
- The Town is planning to construct a new Police Station that will house the EOC.
- There are plans for up to eight residential units to be constructed for seniors around the Senior Center.
- The town is open to considering changes to its floodplain ordinance in order to put additional restrictions on floodplain development.
- The Town encourages development of homes out of the floodplain, although recreational areas of lots may be within the floodplain.
- One of the restaurants in town has been considering renovating their building.

E. Flooding

- Typically there is not a lot of flooding in town.
- The areas that have occurring flooding in the town are from these three sources; Clapboard Oak Brook, Wewaka Brook and Hop Brook.

- The Fire Station typically fields phone calls related to flooding and drainage complaints, though there are reportedly only a few of these complaints.
- The house and mill adjacent to Route 133 on Wewaka Brook has occasional flooding.
- Clapboard Oak Brook has had severe eroding and scouring along its bank. DOT has reportedly contributed to heavy runoff with more impervious area and improvements being installed along Route 133.
- Scouring and wash-outs around undersized culverts have occasionally occurred. Minor repairs and replacements with larger pipe diameters have been done. Bridgewater could encourage the CT DOT to apply for funding to remediate these areas, since State agencies may apply for grants.
- In 2011, storms Irene and T.S. Lee caused many road wash outs. Primarily along Clapboard Oak Brook around Hemlock Road and also along Wewaka Brook and Hop Brook.
- Bridgewater is not a member of the Community Rating System

F. Wind

- Power was lost during Irene and Alfred for about 7 days for each event. Some homes with supply lines down on private property were out longer. Bridgewater made a lot of effort to convince CL&P that shutting off downed live wires and clearing roads for emergency purposes was more important than restoring power. Significant isolation is possible when trees fall across roads in a wide area.
- "Shear wind" (likely downbursts) is the most common type of wind that causes significant tree damage in Bridgewater due to the areas ridges and hills. There are huge exposures of wind in the south and west of Town, these areas are considered to be the most vulnerable.
- In the spring of 2012 and on June 9, 2012 there were intense winds accompanied with thunder storms in Bridgewater. On June 9, 2012 there were power-outages throughout town. Northrup Street had many downed white and red pines.
- The Town Tree Warden is Bud Wright and he has tree trimming budget of $30,000 a year to subcontract trimming.
- The town feels that CL&P is being more proactive recently than in past years.
- Tree damage and damage to power lines were the biggest impact during Irene.

G. Winter Storms

- Bridgewater received heavy snowfall in January 2011 as in many other areas of the Connecticut. There was a lot of roof shoveling in town during this time. Luckily no building in town collapsed only two barns.
- Icing is a problem on Route 133. There is not a lot of sun exposure and reportedly there is alot of salt is usually used to prevent ice or to help melt the ice.
- Five snow-plow trucks are used to cover 36 miles of public roadways. The Town does not plow any private roads in town.
- Anytime someone clears a lot, there is typically a new area for snow drifts. There are several areas in Town that have repetitive snowdrift accumulation; Town Line Road,

Keeler Road, Curtis Road, Second Hill Road, Northrup Street, Rocky Hill Road and Hut Hill Road.

- ❑ Tree damage and damage to power lines were the biggest impact during winter storm Alfred.

H. *Earthquakes*

- ❑ No Earthquakes were discussed that have recently affected Bridgewater.

I. *Dam Failure*

- ❑ The 300-acre, Three Rivers Farm (where the Housatonic, Shepaug, and Pook rivers converge) called Promisek, in the southern tip of Bridgewater has a few beaver dams that could present minor flooding in the area.
- ❑ The Paparazzo dam, a low hazard dam located on Clapboard Oak Brook, had reportedly repairs done to it about three years ago yet is still considered a concern of maintenance and observation because any failure could have significant results.
- ❑ The Johnsons Pond Dam, located on a northern branch of the Clapboard Oak Brook, is one of only two dams considered to have moderate hazard. This dam located at Mia Farrow's property.

J. *Wildfires*

- ❑ There are a handful of dry hydrants and a couple of ponds in town that are utilized for fire suppression.
- ❑ No large fires have occurred in recent times, only a few small fires have occurred.
- ❑ Bridgewater has one all-terrain brush truck for fighting off-road fires.
- ❑ Bridgewater has mutual aid agreements with all of its neighbors.
- ❑ There is a lot of "dry fuel" and Town staff believe that vulnerability is high.
- ❑ Overall fire response in town is believed to be sufficient for the wildfire risk.
- ❑ The Zoning regulations do not have any fire protection elements or any specifications that indicate the need for underground tanks or on-site standards for water storage

K. *Mitigation Strategies and Actions*

- ❑ The Town hopes to have a fully functional EOC with better alert and warning systems.
- ❑ The Town needs a dedicated IP address for the EOC and in general, the EOC should be equipped to communicate and interact with the State EOC and nearby local EOCs.
- ❑ The Town is planning to construct a new Police Station that will house the EOC.
- ❑ More equipment for fighting fires, tree trimming and stormwater pumps are desired.
- ❑ The Town hopes to address the downtown area drainage issues toward adjacent to the brook by adding retention capabilities for stormwater to ease the runoff.

L. *Public Outreach*

- ❑ The proposed Public Outreach meeting is scheduled for March 11, 2014 at 6pm.

PUBLIC INVITED TO PARTICIPATE IN THE DEVELOPMENT OF THE

BRIDGEWATER HAZARD MITIGATION PLAN

Tropical Storm Irene, October snowstorm Alfred, and Superstorm Sandy are recent events that caused severe damage and resulted in Federal disaster declarations. Flooding, heavy snow, wind, and downed power lines cause damage to property, disrupt our daily routines, close our schools and businesses, and jeopardize the health and safety of the citizens of Bridgewater.

What can be done to minimize our vulnerabilities to natural hazards? The Town of Bridgewater is developing a hazard mitigation plan to identify activities that can be undertaken before natural hazards occur in order to minimize property damage, risk of life, and the costs that are shared by all. The plan will discuss the occurrence and consequences of floods, winter storms, tornadoes, hurricanes and tropical storms, wildfires, earthquakes, and dam failure. The plan will outline the steps that Bridgewater can take to mitigate for future natural hazards.

In order to gain input to the hazard mitigation planning process, the Town will be hosting an informational meeting on Tuesday, March 11 at 6 PM in the Town Hall. For residents and business owners who are unable to attend the meeting, comments can be sent to the Housatonic Valley Council of Elected Officials. For more information, please contact the office of the Bridgewater First Selectman at (860) 354-2731.

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- Senior Center

Welcome to Bridgewater Connecticut

This site is provided as a service to our residents and neighbors, and will enhance the Town's ability to provide better information to our community.

Where Do I Go For?

- Post a Community Event
- Housing Rehabilitation Loan Program
- Community Contacts
- Persbacker Family Fund Scholarship
- Make an Online TAX PAYMENT
- Legal Notices
- Bridgewater Scholarship Application
- MORE>>

News & Announcements

- BRIDGEWATER HAZARD MITIGATION PLAN
- CURBSIDE ORGANIC RECYCLING PILOT PROGRAM: KICKOFF ON MARCH 11th
- A message from the First Selectman regarding the wet/dry vote
- Lake Lillinonah Update
- RECYCLING SURVEY

MORE>>

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3/11/2014

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BRIDGEWATER HAZARD MITIGATION PLAN

Printer-Friendly Version

PUBLIC INVITED TO PARTICIPATE IN THE DEVELOPMENT OF THE BRIDGEWATER HAZARD MITIGATION PLAN

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In order to gain input to the hazard mitigation planning process, the Town will be hosting an **INFORMATIONAL MEETING on TUESDAY, MARCH 11 at 6 PM** in the Town Hall. For residents and business owners who are unable to attend the meeting, comments can be sent to the Housatonic Valley Council of Elected Officials.

For more information, please contact the office of the Bridgewater First Selectman at (860) 354-2731.

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10:35 PM 3/11/2014

Public Invited to Participate in Development of Bridgewater Hazard Mitigation Plan

Published:
Friday, March 7, 2014 1:49 PM EST

BRIDGEWATER — Tropical Storm Irene, October snowstorm Alfred and Superstorm Sandy are recent events that caused severe damage and resulted in federal disaster declarations.

Flooding, heavy snow, wind and downed power lines cause damage to property, disrupt daily routines, close schools and businesses and jeopardize the health and safety of the citizens of Bridgewater.

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The plan will discuss the occurrence and consequences of floods, winter storms, tornadoes, hurricanes and tropical storms, wildfires, earthquakes and dam failure.

The plan will outline the steps the town and residents can take to mitigate for future natural hazards.

In order to gain input to the hazard mitigation planning process, the town will host an informational meeting at 6 p.m. Tuesday, March 11, in Town Hall.

Residents and business owners unable to attend the meeting may send comments to the Housatonic Valley Council of Elected Officials.

Those seeking more information may call the office of the first selectman at 860-354-2731.

NEWS BITES

Newtown

A lesser known president

James Garfield is not a name that springs to mind when we think about our Presidents; his short term in office doesn't resonate as Kennedy's Camelot does. Nevertheless, he was our president, and he died 80 days after a would-be assassin fired two bullets in his back less than four months after his inauguration.

Though Garfield did not live long enough to make a name for himself as president, he did have a long career as a congressman and as a Civil War general. To learn more about his life and legacy, the Newtown Historical Society will offer a program at the Meeting House, 31 Main St., on Monday at 7:30 p.m. The program is titled, "The President and the Madman," and will be presented by Gordon Williams.

For more information, contact John Renijilian at 203-426-0864.

Bridgewater

Hazard mitigation forum Tuesday

The town of Bridgewater will host a public information meeting in the Bridgewater Town Hall to discuss the preparation of a Natural Hazard Mitigation Plan for the Town on Tuesday at 6 p.m.

Residents are encouraged to participate in this discussion to help identify potential natural hazard risks. The plan would then identify activities that could prevent injuries and property damage associated with such hazards. Residents and business owners who are unable to attend the meeting can send comments to the first selectman's office. For more information, call the Bridgewater first selectman's office at 860-354-5250.

Carol Kaliff/Staff photographer

A moving experience

From left, Xavier Ross, Johanse Martinez, Luis Amaya-Baylon, Cole Brown and Ryan Wunsch carry boxes of collected items to be loaded into a car and donated to the Dorothy Day Hospitality House on Spring Street in Danbury. For the third year in a row, Shelter Rock School in Danbury has organized "Hearts United Against Hunger," a way to mark the 100th day of school by giving back to the community.

Brookfield

Town committee appointed

The Republican Town Committee has appointed its new leadership team, 25 committee members and 10 alternates.

The new chairman is Matt Grimes, who is also chairman of the Charter Revision Commission and vice chairman of the Zoning Commission. He replaces Selectman Marty Flynn, who remains as a committee member.

Former Selectman George Walker is vice chairman, Board of Education member Steve Harding is secretary, Planning Commission member Linda Taylor is corresponding secretary, and former Board of Finance chairman Jerry Friedrich is the temporary treasurer.

Twenty-five committee members were selected, as well as 10 alternates. For a full listing, visit the Republican Town Committee website, www.tinsley-flynn2013.com.

Danbury

Meeting on new fees

Members of the City Council will hold an ad-hoc meeting at 7 p.m. on Monday to discuss the building department's fee schedule.

Proposals include a new $28 fee that would be charged by the department for certificates of approval to help cover costs associated with providing the certificate.

The committee will meet in the third floor caucus room at City Hall, which is located at 155 Deer Hill Avenue.

Ridgefield

Budget hearing scheduled

The Board of Finance will hold its annual budget hearing on March 26 at 7:30 p.m. at East Ridge Middle School.

The hearing will give town residents a chance to comment on the proposed 2014-15 town budget of $131.5 million. That include a town operating budget of $33.2 million; a school budget of $85.2 million; and town debt of about $12.5 million.

The finance board will begin its budget deliberations on March 31. It will complete its work in April. There will be a town meeting on the budget on May 5 and a budget referendum on May 13.

A-24

Bethel

Dog park concerns

Some residents have told town officials they are worried about the proposed location of a dog park at Meckauer Park.

The Parks and Recreation Commission noted that Mark Rinaldi and Catherine O'Connell of Lexington Meadows have written of their concerns about the park being overcrowded already and want the dog park put somewhere else.

Park department director Eileen Earle told the commission during its meeting last month that she would take all concerns into consideration as she researched the project that the local Girl Scouts initiated.

Bridgewater Field Reconnaissance
March 11, 2014
David Murphy, P.E., CFM

A reconnaissance of the Wewaka Brook corridor was conducted by traveling south on Wewaka Brook Road and then Route 133. The brook runs parallel to the road and crosses beneath it in several bridges and culverts. Photographs were taken as follows:

1. Brook at Hut Hill Road
2. Most upstream crossing on Wewaka Brook Road
3. Most upstream crossing on Wewaka Brook Road
4. Tributary stream
5. Next crossing on Wewaka Brook Road
6. Beach Hill Road intersection
7. Below next crossing on Waweka Brook Road
8. Home at bend in Waweka Brook Road
9. Tributary at bend in Waweka Brook Road
10. Home at bend in Waweka Brook Road
11. Mill house
12. Mill house and view of dam

Sections of Waweka Brook Road and Route 133 are potentially floodprone. At least two houses are believed floodprone – the home at the bend in the road, and the mill house.

Next, Route 133 was traveled northbound. The stream channel along the west side of Route 133 was visibly eroding along a reach located between the Stuart Hill Road and Beach Hill Road alignments.

Finally, Clapboard Oak Brook was viewed in the Hemlock Road area. A section of the channel is eroding, with high banks sliding into the brook, on the north side of Hemlock Road near Christian Street (photograph 13). Sections of the brook downstream and upstream did not appear to be eroding the banks.

Photographs 14-16 were taken of the center store and town hall. Photograph 17 is an image of the DOT graphic for the Route 133 project.

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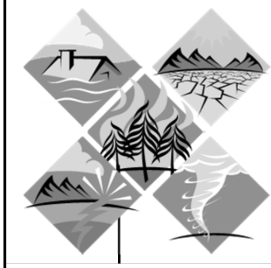
Natural Hazard Mitigation Plan
Town of Bridgewater



Presented by:
David Murphy, P.E., CFM
Milone & MacBroom, Inc.

March 11, 2014

History of Hazard Mitigation Planning

- **Authority and Goals**
  - Disaster Mitigation Act of 2000
  - Encourage disaster preparedness
  - Encourage hazard mitigation measures to reduce losses of life and property
- **Status of Plans in Connecticut**
  - Most initial plans developed 2005-2010
  - A few areas of the State remain
  - The State hazard mitigation plan is updated every three years
  - Local plans are updated every five years

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What is a Natural Hazard?

- An extreme natural event that poses a risk to people, infrastructure, and resources

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What is Hazard Mitigation?

- Actions that reduce or eliminate long-term risk to people, property, and resources from natural hazards and their effects

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Long-Term Goals of Hazard Mitigation

- Reduce loss of life and damage to property and infrastructure
- Reduce the cost to residents, businesses, and taxpayers
- Educate residents and policy-makers about natural hazard risk and vulnerability
- Connect hazard mitigation planning to other community planning efforts
- Enhance and preserve natural resource systems in the community

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How Can the Plan be Used?

- Local municipalities must have a FEMA-approved Hazard Mitigation Plan in place to receive Federal Grant Funds for Hazard Mitigation Projects
  - PDM (Pre-Disaster Mitigation)
  - HMGP (Hazard Mitigation Grant Program)
  - FMA (Flood Mitigation Assistance)
- Connecticut has $16M to distribute under HMGP

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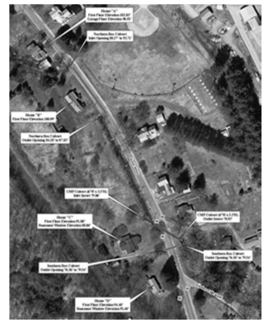
How Can the Plan be Used?

- **Grants can be used for:**
  - o **Building acquisitions or elevations**
  - o **Culvert replacements**
  - o **Drainage projects**
  - o **Riverbank stabilization**
  - o **Landslide stabilization**
  - o **Wind retrofits**
  - o **Seismic retrofits**
  - o **Snow load retrofits**
  - o **Standby power supplies for critical facilities**

This home in Trumbull was acquired and demolished using a FEMA grant

How Can the Plan be Used?

Culvert Replacement to be funded by HMGP

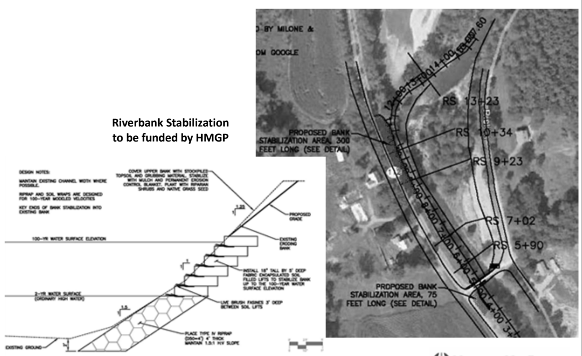


Floyd 1999

Irene 2011

How Can the Plan be Used?

Riverbank Stabilization to be funded by HMGP



Components of Hazard Mitigation Planning Process

- **Identify natural hazards that could occur in Bridgewater**
- **Assess the vulnerability of structures and populations and identify critical facilities and areas of concern**
- **Incorporate effects of federally declared disasters that have occurred in the last few years:**
  - o **March 2010 floods**
  - o **Winter snow loads/collapsing roofs in January 2011**
  - o **Tropical Storm Irene in August 2011 (and T.S. Lee afterward)**
  - o **Winter Storm Alfred in October 2011**
  - o **Hurricane Sandy in October 2012**
  - o **Winter Storm Nemo in February 2013**

Components of Hazard Mitigation Planning Process

- **HAZUS vulnerability/risk analysis**
- **Assess adequacy of mitigation measures currently in place such as regulations and drainage projects**
- **Develop mitigation goals, strategies, and actions**
- **Outreach to neighboring towns**
- **Public participation**
- **Develop plan document**
- **State and FEMA approvals**
- **Local adoption**

What a Hazard Mitigation Plan Does not Address

- **Terrorism and Sabotage**

- **Disaster Response and Recovery**
- **Human Induced Emergencies (some fires, hazardous spills and contamination, disease, etc.)**

Primary Natural Hazards Facing Bridgewater

- **Floods**
- **Hurricanes and tropical storms**
- **Summer storms and tornadoes**



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Primary Natural Hazards Facing Bridgewater

- **Winter storms and nor'easters**
- **Earthquakes**
- **Wildfires**
- **Dam failure**


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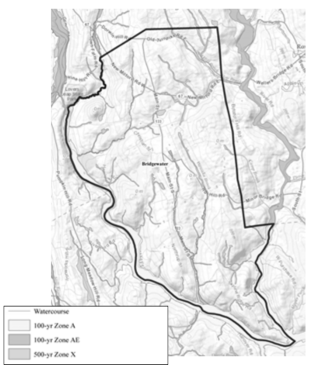
Floods



- **Riverine/Overbank:**
  - **Housatonic River**
  - **Wewaka Brook**
- **Erosion/Scour from Stormwater Flows**
  - **Clapboard Oak Brook downstream of town center**

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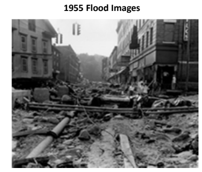
Hurricanes and Tropical Storms

- **Strong winds**
- **Heavy rain**
- **Floods**

1955 Flood Images

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Summer Storms and Tornadoes

- **Tornadoes**
- **Downbursts**
- **Lightning**
- **Heavy rain**
- **Hail**

Tornado photos courtesy of the Hartford Courant


Milone & MacBroom

Winter Storms and Nor'easters

- **Blizzards and nor'easters**
- **Heavy snow and drifts**
- **Freezing rain and ice**
- **Downed trees**


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Winter Storms and Nor'easters

- **Collapsed Buildings**



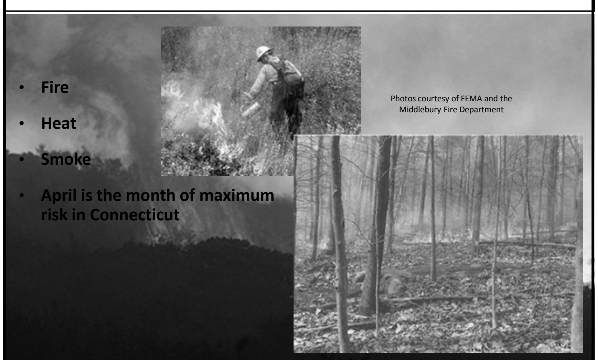
Photos courtesy of the Hartford Courant

Earthquakes

- **Connecticut is prone to very low-energy earthquakes**
- **Can cause dam failure, shaking, liquefaction, slides/slumps**


Photos courtesy of FEMA

Wildfires



- **Fire**
- **Heat**
- **Smoke**
- **April is the month of maximum risk in Connecticut**

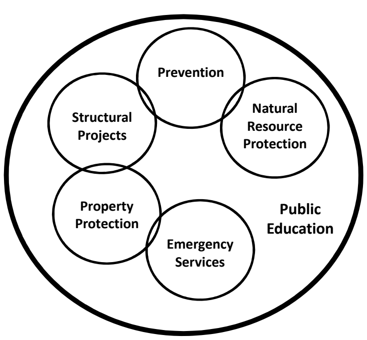
Photos courtesy of FEMA and the Middlebury Fire Department

Dam Failure

- **Severe rains or earthquakes can cause failure**
- **Possibility of loss of life and millions of dollars in damage**
- **Numerous registered high and significant hazard dams in Bridgewater or upstream**

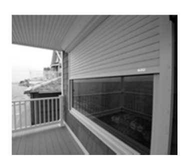
Recent dam failure in Sherman, CT

Hazard Mitigation Categories




Typical Hazard Mitigation Strategies

- **Elevate or remove flood-prone buildings**
- **Wet and dry floodproofing**
- **Move critical facilities from flood zones**
- **Strengthen or reinforce shelters**
- **Remove and replace undersized and/or failing bridges and culverts**
- **Replace overhead utilities with underground utilities**
- **Harden utilities**
- **Strengthen tree maintenance**
- **Enhance fire suppression capabilities**
- **Public education programs**
- **Dissemination of public safety information**

Next Steps

- **Incorporate input from residents, business owners, and public officials**
- **Develop mitigation strategies**
- **Prepare draft plans for review by the town and the public**
- **Adopt and implement the plan**
- **Seek hazard mitigation funds**

MILONE & MACBROOM

Bridgewater Hazard Mitigation Plan Public Meeting
March 11, 2014
Meeting Minutes

A public meeting was held at 6 PM on the evening of March 11, 2014. The public was notified via the Voices News online edition, the Danbury News Times, the town's web site, and the town's email blast. Attendees included:

- David Hannon, HVCEO
- Curtis Reed, First Selectman
- Alan Brown, Selectman
- Leo Null, Selectman
- Ms. Ann Marie Lindblom, Assistant to the First Selectman
- Ron Rotter, EMD
- Brian Sullivan, Foreman, Public Works
- AJ Murphy, Assistant Fire Chief
- Rebecca Devine, Resident
- ___, Resident

Mr. David Murphy, P.E., CFM presented a power point slide show and then turned over the meeting for a general discussion. Discussion points included:

- During a recent house fire, sources of water may not have been close by, contributing to a longer response time. Mr. Sullivan indicated that more proximate sources were present but not available during the fire.
- Hemlock Road culverts may be undersized. Could grants be used to upgrade these?
- Clapboard Oak Brook erosion and scour is a concern. Could grants be used for stabilizing stream banks? Mr. Murphy explained that streambank projects are eligible, but without damage to roads or residents, it may be challenging to demonstrate cost effectiveness.
- The town is "high and dry" for the most part.
- The resident state trooper building experienced poor drainage but it has been remedied. However, mold is still present in the building.
- One of the residents asked if grants could pay for shower or cooking facilities at the Senior Center, which is the shelter. Mr. Murphy explained that standby power could be sought if it is needed to make hot water and allow cooking.
- Attendees asked about what types of tree trimming, utility hardening, or undergrounding activities could be eligible for FEMA funds. Mr. Murphy explained that these projects can be challenging to demonstrate cost effectiveness, but targeting densely populated areas would help. He also noted that it would be less prudent to bury power lines in a location that would lose power by virtue of the transmission from elsewhere getting cut off. Town personal believe that the town center receives power from two directions.
- Residents inquired whether grants could be used to improve Northrup Road before the Route 133 project commences. Northrup Road will likely carry more traffic.
- Attendees asked if mitigation funds could be used to acquire equipment. Mr. Murphy explained that equipment was typically not eligible, but other grants (like Assistance to Firefighters) may be possible. Mr. Hannon asked that other grants be listed in the plan.

- Icing of Second Hill Road is a problem that could be addressed by installing new drainage. Water seeps from the road bank and freezes as it crosses the road. This road has higher traffic counts than anticipated. Mr. Sullivan would install about 200 feet of drainage alone the side of the road and then discharge it somewhere. The town will forward a rough cost estimate and Mr. Murphy will use traffic counts from HVCEO to get a rough estimate of the benefit cost ratio.

July 8, 2014

TO:

Tony Hay, Supervisor, Town of Southeast, NY	Carol Hubert, Chief of Staff, Town of Southbury, CT
Adam Stiebeling, Commissioner of Emergency Services, Putnam County Bureau of Emergency Management (NY)	Anna Rycenga, ZEO, Town of Oxford, CT
Warren Lucas, Supervisor, Town of North Salem, NY	Sam Gold, Executive Director, COGCNV (CT)
Peter Parsons, Supervisor, Town of Lewisboro, NY	Barbara Henry, First Selectman, Town of Roxbury
Dennis Delborgo, Director, Westchester County Office of Emergency Management (NY)	Mark Lyon, First Selectman, Town of Washington
Bill Brennan, First Selectman, Town of Wilton, CT	Bruce Adams, First Selectman, Town of Kent
Gayle Weinstein, First Selectman, Town of Weston, CT	Jocelyn Ayer, Community & Economic Development Director, Northwest Hills Council of Governments (CT)
David Hannon, for South Western Regional Planning Agency (CT)	Brian Bidolli, Executive Director, Greater Bridgeport Regional Council (CT)
Adam Dunsby, First Selectman, Town of Easton, CT	Steve Vavrek, First Selectman, Town of Monroe, CT

RE: Hazard Mitigation Plans for Bethel, Bridgewater, Brookfield, Newtown, New Milford, Redding, and Ridgefield (Connecticut)
MMI #3101-14-1

Milone & MacBroom, Inc. (MMI) is working with the Housatonic Valley Council of Elected Officials (HVCEO) and the towns of Bethel, Bridgewater, Brookfield, Newtown, New Milford, Redding, and Ridgefield to develop hazard mitigation plans. In recent years, the Federal Emergency Management Agency (FEMA) has emphasized the need for communities to work together to address hazards that span municipal boundaries. Thus, these municipalities are interested in coordinating with your jurisdictions relative to hazards that could cross municipal boundaries such as flooding, as well as strategies for hazard mitigation that could be addressed by two or more communities.

We understand that you may be the representative involved with hazard mitigation planning in your municipality and, therefore, will have the most valuable input for the plans being developed for Bethel, Bridgewater, Brookfield, Newtown, New Milford, Redding, and Ridgefield. Please take a moment to share your thoughts for the following:

1. Does your municipality face any shared hazards with Bethel, Bridgewater, Brookfield, Newtown, New Milford, Redding, or Ridgefield that could be addressed by both communities? Examples could be flooding along a stream that flows across a town boundary or wind storms that damage power lines that cross the town boundary.
2. Can you think of any strategies for hazard mitigation that could benefit both communities?
3. Does your municipality currently cooperate with Bethel, Bridgewater, Brookfield, Newtown, New Milford, Redding, or Ridgefield on any of the following:

- Local emergency communications or response
- Road maintenance, drainage system maintenance, public works, etc.
- Communications with electric and other utility providers

You may contact the undersigned via email or telephone. A written response is not necessary. Thank you for your time.

Very truly yours,

MILONE & MACBROOM, INC.

David Murphy, P.E., CFM, Associate
Senior Project Manager, Water Resources Engineering
davem@miloneandmacbroom.com

Maryellen Edwards
Environmental Scientist
maryellene@miloneandmacbroom.com

3101-14-1-jl714-ltr

APPENDIX E
HAZUS DOCUMENTATION

Hazus-MH: Flood Event Report

Region Name: Bridgewater FIT

Flood Scenario: Clapboard Oak Brook

Print Date: Friday, January 03, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 16 square miles and contains 62 census blocks. The region contains over 1 thousand households and has a total population of 1,824 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 950 buildings in the region with a total building replacement value (excluding contents) of 198 million dollars (2006 dollars). Approximately 88.42% of the buildings (and 81.74% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 950 buildings in the region which have an aggregate total replacement value of 198 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	161,450	81.7%
Commercial	20,101	10.2%
Industrial	5,889	3.0%
Agricultural	2,023	1.0%
Religion	2,545	1.3%
Government	2,630	1.3%
Education	2,874	1.5%
Total	**197,512**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	22,519	91.7%
Commercial	703	2.9%
Industrial	365	1.5%
Agricultural	232	0.9%
Religion	0	0.0%
Government	747	3.0%
Education	0	0.0%
Total	**24,566**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 1 school, 1 fire station, 1 police station and no emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Bridgewater FIT
Scenario Name:	Clapboard Oak Brook
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**0**		**0**		**0**		**0**		**0**		**0**	

Table 4: Expected Building Damage by Building Type

Building	1-10		11-20		21-30		31-40		41-50		Substantially	
Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	1	0	0	0
Hospitals	0	0	0	0
Police Stations	1	0	0	0
Schools	1	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 4 tons of debris will be generated. Of the total amount, Finishes comprises 90% of the total, Structure comprises 6% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 1 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 0 people (out of a total population of 1,824) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 0.06 million dollars, which represents 0.22 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 0.06 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 89.09% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	0.03	0.00	0.00	0.00	0.03
	Content	0.02	0.00	0.00	0.01	0.02
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.05**	**0.00**	**0.00**	**0.01**	**0.06**
Business Interruption						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
ALL	**Total**	**0.05**	**0.00**	**0.00**	**0.01**	**0.06**

Appendix A: County Listing for the Region

Connecticut

- Litchfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Connecticut				
Litchfield	1,824	161,450	36,062	197,512
Total	**1,824**	**161,450**	**36,062**	**197,512**
Total Study Region	**1,824**	**161,450**	**36,062**	**197,512**

Hazus-MH: Flood Event Report

Region Name: Bridgewater FIT

Flood Scenario: Wewaka Brook Tributary

Print Date: Friday, January 03, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 16 square miles and contains 62 census blocks. The region contains over 1 thousand households and has a total population of 1,824 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 950 buildings in the region with a total building replacement value (excluding contents) of 198 million dollars (2006 dollars). Approximately 88.42% of the buildings (and 81.74% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 950 buildings in the region which have an aggregate total replacement value of 198 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	161,450	81.7%
Commercial	20,101	10.2%
Industrial	5,889	3.0%
Agricultural	2,023	1.0%
Religion	2,545	1.3%
Government	2,630	1.3%
Education	2,874	1.5%
Total	**197,512**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	17,635	74.8%
Commercial	2,542	10.8%
Industrial	140	0.6%
Agricultural	203	0.9%
Religion	241	1.0%
Government	941	4.0%
Education	1,867	7.9%
Total	**23,569**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 1 school, 1 fire station, 1 police station and no emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Bridgewater FIT
Scenario Name:	Wewaka Brook Tributary
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**0**		**0**		**0**		**0**		**0**		**0**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	1	0	0	0
Hospitals	0	0	0	0
Police Stations	1	0	0	0
Schools	1	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0 tons of debris will be generated. Of the total amount, Finishes comprises 100% of the total, Structure comprises 0% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 0 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 0 people (out of a total population of 1,824) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 0.01 million dollars, which represents 0.03 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 0.01 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 14.29% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	0.00	0.00	0.00	0.00	0.00
	Content	0.00	0.00	0.00	0.01	0.01
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**
Business Interruption						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
ALL	**Total**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**

Appendix A: County Listing for the Region

Connecticut

- Litchfield

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Connecticut				
Litchfield	1,824	161,450	36,062	197,512
Total	**1,824**	**161,450**	**36,062**	**197,512**
Total Study Region	**1,824**	**161,450**	**36,062**	**197,512**

Hazus-MH: Flood Event Report

Region Name: Bridgewater FIT

Flood Scenario: Wewaka Brook

Print Date: Friday, January 03, 2014

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

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The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

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There are an estimated 950 buildings in the region with a total building replacement value (excluding contents) of 198 million dollars (2006 dollars). Approximately 88.42% of the buildings (and 81.74% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 950 buildings in the region which have an aggregate total replacement value of 198 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

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Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	161,450	81.7%
Commercial	20,101	10.2%
Industrial	5,889	3.0%
Agricultural	2,023	1.0%
Religion	2,545	1.3%
Government	2,630	1.3%
Education	2,874	1.5%
Total	**197,512**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	35,251	87.4%
Commercial	4,075	10.1%
Industrial	540	1.3%
Agricultural	337	0.8%
Religion	0	0.0%
Government	0	0.0%
Education	139	0.3%
Total	**40,342**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 1 school, 1 fire station, 1 police station and no emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Bridgewater FIT
Scenario Name:	Wewaka Brook
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**0**		**0**		**0**		**0**		**0**		**0**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	1	0	0	0
Hospitals	0	0	0	0
Police Stations	1	0	0	0
Schools	1	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 1 tons of debris will be generated. Of the total amount, Finishes comprises 100% of the total, Structure comprises 0% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 0 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 0 people (out of a total population of 1,824) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 0.00 million dollars, which represents 0.01 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 0.00 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 33.33% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	0.00	0.00	0.00	0.00	0.00
	Content	0.00	0.00	0.00	0.00	0.00
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Business Interruption						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
ALL	**Total**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Appendix A: County Listing for the Region

Connecticut

- Litchfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Connecticut				
Litchfield	1,824	161,450	36,062	197,512
Total	**1,824**	**161,450**	**36,062**	**197,512**
Total Study Region	**1,824**	**161,450**	**36,062**	**197,512**

Hazus-MH: Hurricane Event Report

Region Name: Bridgewater

Hurricane Scenario: UN-NAMED-1938-4

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 17.24 square miles and contains 1 census tracts. There are over 0 thousand households in the region and has a total population of 1,824 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 0 thousand buildings in the region with a total building replacement value (excluding contents) of 198 million dollars (2006 dollars). Approximately 88% of the buildings (and 82% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 950 buildings in the region which have an aggregate total replacement value of 198 million (2006 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	161,450	81.7%
Commercial	20,101	10.2%
Industrial	5,889	3.0%
Agricultural	2,023	1.0%
Religious	2,545	1.3%
Government	2,630	1.3%
Education	2,874	1.5%
Total	**197,512**	**100.0%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 1 schools, 1 fire stations, 1 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	UN-NAMED-1938-4
Type:	Historic
Max Peak Gust in Study Region:	96 mph

Building Damage

General Building Stock Damage

Hazus estimates that about 7 buildings will be at least moderately damaged. This is over 1% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	11	91.40	1	6.82	0	1.21	0	0.54	0	0.03
Commercial	57	93.72	3	5.67	0	0.60	0	0.01	0	0.00
Education	5	94.59	0	5.11	0	0.30	0	0.00	0	0.00
Government	4	94.70	0	5.00	0	0.30	0	0.00	0	0.00
Industrial	23	93.77	1	5.35	0	0.67	0	0.21	0	0.01
Religion	3	94.12	0	5.64	0	0.24	0	0.00	0	0.00
Residential	748	89.01	86	10.22	6	0.76	0	0.01	0	0.00
Total	**851**		**92**		**7**		**0**		**0**	

Table 3: Expected Building Damage by Building Type

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	12	92.71	1	6.60	0	0.70	0	0.00	0	0.00
Masonry	79	90.54	7	7.82	1	1.43	0	0.20	0	0.01
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	46	94.54	2	5.04	0	0.41	0	0.01	0	0.00
Wood	715	89.25	81	10.05	5	0.69	0	0.01	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	1	0	0	1
Police Stations	1	0	0	1
Schools	1	0	0	1

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 6,766 tons of debris will be generated. Of the total amount, 6,021 tons (89%) is Other Tree Debris. Of the remaining 745 tons, Brick/Wood comprises 20% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 6 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 595 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 1,824) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 1.4 million dollars, which represents 0.72 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 1 million dollars. 2% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 94% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	1,196.09	31.30	10.56	15.67	1,253.61
	Content	111.09	1.24	4.29	2.48	119.10
	Inventory	0.00	0.01	0.90	0.28	1.18
	Subtotal	**1,307.17**	**32.54**	**15.75**	**18.43**	**1,373.89**
Business Interruption Loss						
	Income	0.00	3.81	0.06	0.83	4.69
	Relocation	25.77	3.00	0.31	1.38	30.45
	Rental	8.19	1.79	0.06	0.08	10.11
	Wage	0.00	1.35	0.09	1.95	3.39
	Subtotal	**33.96**	**9.94**	**0.51**	**4.23**	**48.64**
Total						
	Total	**1,341.13**	**42.49**	**16.26**	**22.66**	**1,422.54**

Appendix A: County Listing for the Region

Connecticut
- Litchfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Connecticut				
Litchfield	1,824	161,450	36,062	197,512
Total	**1,824**	**161,450**	**36,062**	**197,512**
Study Region Total	**1,824**	**161,450**	**36,062**	**197,512**

Hazus-MH: Hurricane Event Report

Region Name: Bridgewater

Hurricane Scenario: GLORIA

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 17.24 square miles and contains 1 census tracts. There are over 0 thousand households in the region and has a total population of 1,824 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 0 thousand buildings in the region with a total building replacement value (excluding contents) of 198 million dollars (2006 dollars). Approximately 88% of the buildings (and 82% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 950 buildings in the region which have an aggregate total replacement value of 198 million (2006 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	161,450	81.7%
Commercial	20,101	10.2%
Industrial	5,889	3.0%
Agricultural	2,023	1.0%
Religious	2,545	1.3%
Government	2,630	1.3%
Education	2,874	1.5%
Total	**197,512**	**100.0%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 1 schools, 1 fire stations, 1 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	GLORIA
Type:	Historic
Max Peak Gust in Study Region:	60 mph

Building Damage

General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	12	99.84	0	0.16	0	0.00	0	0.00	0	0.00
Commercial	61	99.78	0	0.22	0	0.00	0	0.00	0	0.00
Education	5	99.77	0	0.23	0	0.00	0	0.00	0	0.00
Government	4	99.76	0	0.24	0	0.00	0	0.00	0	0.00
Industrial	25	99.76	0	0.24	0	0.00	0	0.00	0	0.00
Religion	3	99.82	0	0.18	0	0.00	0	0.00	0	0.00
Residential	840	99.99	0	0.01	0	0.00	0	0.00	0	0.00
Total	**950**		**0**		**0**		**0**		**0**	

Table 3: Expected Building Damage by Building Type

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	13	99.68	0	0.32	0	0.00	0	0.00	0	0.00
Masonry	87	99.77	0	0.23	0	0.00	0	0.00	0	0.00
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	49	99.73	0	0.27	0	0.00	0	0.00	0	0.00
Wood	801	100.00	0	0.00	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	1	0	0	1
Police Stations	1	0	0	1
Schools	1	0	0	1

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0 tons of debris will be generated. Of the total amount, 0 tons (0%) is Other Tree Debris. Of the remaining 0 tons, Brick/Wood comprises 0% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 0 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 1,824) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 0.0 million dollars, which represents 0.01 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 0 million dollars. 0% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 100% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	15.64	0.00	0.00	0.00	15.64
	Content	0.00	0.00	0.00	0.00	0.00
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**15.64**	**0.00**	**0.00**	**0.00**	**15.64**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Total						
	Total	**15.64**	**0.00**	**0.00**	**0.00**	**15.64**

Appendix A: County Listing for the Region

Connecticut

- Litchfield

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Connecticut				
Litchfield	1,824	161,450	36,062	197,512
Total	**1,824**	**161,450**	**36,062**	**197,512**
Study Region Total	**1,824**	**161,450**	**36,062**	**197,512**

Hazus-MH: Hurricane Event Report

Region Name: Bridgewater

Hurricane Scenario: Probabilistic 10-year Return Period

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

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The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

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Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 17.24 square miles and contains 1 census tracts. There are over 0 thousand households in the region and has a total population of 1,824 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 0 thousand buildings in the region with a total building replacement value (excluding contents) of 198 million dollars (2006 dollars). Approximately 88% of the buildings (and 82% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 950 buildings in the region which have an aggregate total replacement value of 198 million (2006 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

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Occupancy	Exposure ($1000)	Percent of Tot
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Agricultural	2,023	1.0%
Religious	2,545	1.3%
Government	2,630	1.3%
Education	2,874	1.5%
Total	**197,512**	**100.0%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 1 schools, 1 fire stations, 1 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 10 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	12	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	61	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	5	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	4	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	25	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	840	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**950**		**0**		**0**		**0**		**0**	

Table 3: Expected Building Damage by Building Type : 10 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	13	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	87	100.00	0	0.00	0	0.00	0	0.00	0	0.00
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	49	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	801	100.00	0	0.00	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	1	0	0	1
Police Stations	1	0	0	1
Schools	1	0	0	1

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0 tons of debris will be generated. Of the total amount, 0 tons (0%) is Other Tree Debris. Of the remaining 0 tons, Brick/Wood comprises 0% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 0 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 1,824) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 0.0 million dollars, which represents 0.00 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 0 million dollars. 0% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 0% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	0.00	0.00	0.00	0.00	0.00
	Content	0.00	0.00	0.00	0.00	0.00
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Total						
	Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Appendix A: County Listing for the Region

Connecticut

- Litchfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Connecticut				
Litchfield	1,824	161,450	36,062	197,512
Total	**1,824**	**161,450**	**36,062**	**197,512**
Study Region Total	**1,824**	**161,450**	**36,062**	**197,512**

Hazus-MH: Hurricane Event Report

Region Name: Bridgewater

Hurricane Scenario: Probabilistic 20-year Return Period

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

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The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 17.24 square miles and contains 1 census tracts. There are over 0 thousand households in the region and has a total population of 1,824 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 0 thousand buildings in the region with a total building replacement value (excluding contents) of 198 million dollars (2006 dollars). Approximately 88% of the buildings (and 82% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 950 buildings in the region which have an aggregate total replacement value of 198 million (2006 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	161,450	81.7%
Commercial	20,101	10.2%
Industrial	5,889	3.0%
Agricultural	2,023	1.0%
Religious	2,545	1.3%
Government	2,630	1.3%
Education	2,874	1.5%
Total	**197,512**	**100.0%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 1 schools, 1 fire stations, 1 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 20 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	12	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	61	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	5	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	4	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	25	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	840	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**950**		**0**		**0**		**0**		**0**	

Table 3: Expected Building Damage by Building Type : 20 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	13	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	87	100.00	0	0.00	0	0.00	0	0.00	0	0.00
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
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Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
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Schools	1	0	0	1

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

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Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 1,824) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 0.0 million dollars, which represents 0.00 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

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	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
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	Rental	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Total						
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Appendix A: County Listing for the Region

Connecticut
- Litchfield

Appendix B: Regional Population and Building Value Data

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Litchfield	1,824	161,450	36,062	197,512
Total	**1,824**	**161,450**	**36,062**	**197,512**
Study Region Total	**1,824**	**161,450**	**36,062**	**197,512**

Hazus-MH: Hurricane Event Report

Region Name: Bridgewater

Hurricane Scenario: Probabilistic 50-year Return Period

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

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The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

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Note:
Appendix A contains a complete listing of the counties contained in the region.

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Building Inventory

General Building Stock

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Religious	2,545	1.3%
Government	2,630	1.3%
Education	2,874	1.5%
Total	**197,512**	**100.0%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 1 schools, 1 fire stations, 1 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 50 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	12	99.64	0	0.36	0	0.00	0	0.00	0	0.00
Commercial	61	99.54	0	0.45	0	0.01	0	0.00	0	0.00
Education	5	99.54	0	0.46	0	0.00	0	0.00	0	0.00
Government	4	99.51	0	0.49	0	0.00	0	0.00	0	0.00
Industrial	25	99.49	0	0.51	0	0.00	0	0.00	0	0.00
Religion	3	99.66	0	0.34	0	0.00	0	0.00	0	0.00
Residential	839	99.83	1	0.17	0	0.00	0	0.00	0	0.00
Total	**948**		**2**		**0**		**0**		**0**	

Table 3: Expected Building Damage by Building Type : 50 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	13	99.32	0	0.68	0	0.00	0	0.00	0	0.00
Masonry	87	99.44	0	0.55	0	0.01	0	0.00	0	0.00
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	49	99.46	0	0.54	0	0.00	0	0.00	0	0.00
Wood	800	99.87	1	0.13	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	1	0	0	1
Police Stations	1	0	0	1
Schools	1	0	0	1

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 4 tons of debris will be generated. Of the total amount, 0 tons (0%) is Other Tree Debris. Of the remaining 4 tons, Brick/Wood comprises 100% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 0 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 1,824) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 0.1 million dollars, which represents 0.06 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 0 million dollars. 1% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 97% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	109.42	2.01	0.59	0.80	112.82
	Content	0.00	0.00	0.00	0.00	0.00
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**109.42**	**2.01**	**0.59**	**0.80**	**112.82**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.01	0.01	0.00	0.00	0.02
	Rental	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.01**	**0.01**	**0.00**	**0.00**	**0.02**
Total						
	Total	**109.43**	**2.02**	**0.59**	**0.80**	**112.84**

Appendix A: County Listing for the Region

Connecticut

- Litchfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Connecticut				
Litchfield	1,824	161,450	36,062	197,512
Total	**1,824**	**161,450**	**36,062**	**197,512**
Study Region Total	**1,824**	**161,450**	**36,062**	**197,512**

Hazus-MH: Hurricane Event Report

Region Name: Bridgewater

Hurricane Scenario: Probabilistic 100-year Return Period

Print Date: Monday, November 18, 2013

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General Building Stock Damage

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Table 2: Expected Building Damage by Occupancy : 100 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	12	98.40	0	1.43	0	0.14	0	0.03	0	0.00
Commercial	60	98.54	1	1.38	0	0.07	0	0.00	0	0.00
Education	5	98.69	0	1.29	0	0.02	0	0.00	0	0.00
Government	4	98.66	0	1.32	0	0.02	0	0.00	0	0.00
Industrial	25	98.48	0	1.45	0	0.06	0	0.01	0	0.00
Religion	3	98.85	0	1.13	0	0.02	0	0.00	0	0.00
Residential	823	97.98	17	1.98	0	0.05	0	0.00	0	0.00
Total	**931**		**18**		**0**		**0**		**0**	

Table 3: Expected Building Damage by Building Type : 100 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	13	98.06	0	1.90	0	0.03	0	0.00	0	0.00
Masonry	85	97.74	2	2.05	0	0.19	0	0.02	0	0.00
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	48	98.54	1	1.43	0	0.03	0	0.00	0	0.00
Wood	786	98.09	15	1.87	0	0.04	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	1	0	0	1
Police Stations	1	0	0	1
Schools	1	0	0	1

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 3,345 tons of debris will be generated. Of the total amount, 3,010 tons (90%) is Other Tree Debris. Of the remaining 335 tons, Brick/Wood comprises 11% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 1 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 298 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 1,824) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 0.5 million dollars, which represents 0.25 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 0 million dollars. 1% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 97% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	440.29	7.18	1.98	3.22	452.68
	Content	16.02	0.00	0.32	0.20	16.54
	Inventory	0.00	0.00	0.07	0.03	0.09
	Subtotal	**456.31**	**7.18**	**2.37**	**3.45**	**469.31**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	17.79	0.10	0.01	0.04	17.95
	Rental	6.32	0.00	0.00	0.00	6.32
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**24.12**	**0.10**	**0.01**	**0.04**	**24.27**
Total						
	Total	**480.43**	**7.28**	**2.38**	**3.49**	**493.58**

Appendix A: County Listing for the Region

Connecticut

- Litchfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Connecticut				
Litchfield	1,824	161,450	36,062	197,512
Total	**1,824**	**161,450**	**36,062**	**197,512**
Study Region Total	**1,824**	**161,450**	**36,062**	**197,512**

Hazus-MH: Hurricane Event Report

Region Name: Bridgewater

Hurricane Scenario: Probabilistic 200-year Return Period

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 17.24 square miles and contains 1 census tracts. There are over 0 thousand households in the region and has a total population of 1,824 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 0 thousand buildings in the region with a total building replacement value (excluding contents) of 198 million dollars (2006 dollars). Approximately 88% of the buildings (and 82% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 950 buildings in the region which have an aggregate total replacement value of 198 million (2006 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	161,450	81.7%
Commercial	20,101	10.2%
Industrial	5,889	3.0%
Agricultural	2,023	1.0%
Religious	2,545	1.3%
Government	2,630	1.3%
Education	2,874	1.5%
Total	**197,512**	**100.0%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 1 schools, 1 fire stations, 1 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 5 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 200 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	11	93.56	1	5.22	0	0.85	0	0.36	0	0.01
Commercial	58	95.27	3	4.33	0	0.40	0	0.01	0	0.00
Education	5	95.93	0	3.91	0	0.16	0	0.00	0	0.00
Government	4	96.00	0	3.84	0	0.16	0	0.00	0	0.00
Industrial	24	95.27	1	4.15	0	0.44	0	0.13	0	0.00
Religion	3	95.67	0	4.20	0	0.13	0	0.00	0	0.00
Residential	770	91.61	66	7.90	4	0.49	0	0.00	0	0.00
Total	**874**		**71**		**5**		**0**		**0**	

Table 3: Expected Building Damage by Building Type : 200 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	12	94.41	1	5.18	0	0.41	0	0.00	0	0.00
Masonry	81	92.67	5	6.19	1	1.00	0	0.13	0	0.00
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	47	95.85	2	3.91	0	0.23	0	0.01	0	0.00
Wood	736	91.84	62	7.73	3	0.43	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	1	0	0	1
Police Stations	1	0	0	1
Schools	1	0	0	1

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 6,177 tons of debris will be generated. Of the total amount, 5,518 tons (89%) is Other Tree Debris. Of the remaining 659 tons, Brick/Wood comprises 17% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 5 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 546 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 1,824) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 1.1 million dollars, which represents 0.58 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 1 million dollars. 2% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 94% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	986.34	23.73	7.62	11.73	1,029.42
	Content	63.83	1.20	2.29	1.47	68.79
	Inventory	0.00	0.00	0.48	0.15	0.64
	Subtotal	**1,050.17**	**24.94**	**10.39**	**13.35**	**1,098.84**
Business Interruption Loss						
	Income	0.00	3.87	0.06	0.84	4.77
	Relocation	22.76	2.72	0.24	1.21	26.94
	Rental	7.71	1.79	0.06	0.08	9.63
	Wage	0.00	1.38	0.09	1.98	3.45
	Subtotal	**30.47**	**9.76**	**0.45**	**4.11**	**44.78**
Total						
	Total	**1,080.64**	**34.69**	**10.84**	**17.46**	**1,143.63**

Appendix A: County Listing for the Region

Connecticut

- Litchfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Connecticut				
Litchfield	1,824	161,450	36,062	197,512
Total	**1,824**	**161,450**	**36,062**	**197,512**
Study Region Total	**1,824**	**161,450**	**36,062**	**197,512**

Hazus-MH: Hurricane Event Report

Region Name: Bridgewater

Hurricane Scenario: Probabilistic 500-year Return Period

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 17.24 square miles and contains 1 census tracts. There are over 0 thousand households in the region and has a total population of 1,824 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 0 thousand buildings in the region with a total building replacement value (excluding contents) of 198 million dollars (2006 dollars). Approximately 88% of the buildings (and 82% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 950 buildings in the region which have an aggregate total replacement value of 198 million (2006 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	161,450	81.7%
Commercial	20,101	10.2%
Industrial	5,889	3.0%
Agricultural	2,023	1.0%
Religious	2,545	1.3%
Government	2,630	1.3%
Education	2,874	1.5%
Total	**197,512**	**100.0%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 1 schools, 1 fire stations, 1 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 30 buildings will be at least moderately damaged. This is over 3% of the total number of buildings in the region. There are an estimated 1 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 500 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	10	79.25	2	15.15	0	3.63	0	1.78	0	0.19
Commercial	51	84.11	8	13.29	2	2.51	0	0.09	0	0.00
Education	4	85.73	1	12.25	0	1.94	0	0.08	0	0.00
Government	3	86.05	0	11.85	0	2.00	0	0.09	0	0.00
Industrial	21	84.34	3	12.08	1	2.77	0	0.74	0	0.07
Religion	3	84.35	0	13.88	0	1.72	0	0.05	0	0.00
Residential	635	75.59	178	21.23	25	3.00	1	0.10	1	0.08
Total	**727**		**193**		**28**		**1**		**1**	

Table 3: Expected Building Damage by Building Type : 500 - year Event

	None		Minor		Moderate		Severe		Destruction	
Building Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	11	82.14	2	14.19	0	3.60	0	0.07	0	0.00
Masonry	69	78.79	14	15.93	4	4.50	1	0.70	0	0.09
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	42	85.84	6	11.67	1	2.36	0	0.14	0	0.00
Wood	609	75.97	169	21.11	22	2.75	1	0.10	1	0.07

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	1	0	0	1
Police Stations	1	0	0	1
Schools	1	0	0	0

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 11,386 tons of debris will be generated. Of the total amount, 10,034 tons (88%) is Other Tree Debris. Of the remaining 1,352 tons, Brick/Wood comprises 27% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 14 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 992 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 1,824) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 3.4 million dollars, which represents 1.72 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 3 million dollars. 3% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 90% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	2,468.48	94.19	36.34	52.42	2,651.43
	Content	456.58	15.91	19.81	14.56	506.87
	Inventory	0.00	0.12	4.04	1.18	5.34
	Subtotal	**2,925.06**	**110.22**	**60.19**	**68.17**	**3,163.64**
Business Interruption Loss						
	Income	0.00	15.36	0.53	3.71	19.60
	Relocation	102.10	14.31	1.99	8.56	126.96
	Rental	28.93	8.66	0.36	0.80	38.76
	Wage	0.00	11.82	0.91	35.98	48.71
	Subtotal	**131.03**	**50.15**	**3.79**	**49.05**	**234.03**
Total						
	Total	**3,056.09**	**160.37**	**63.98**	**117.22**	**3,397.66**

Appendix A: County Listing for the Region

Connecticut

- Litchfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Connecticut				
Litchfield	1,824	161,450	36,062	197,512
Total	**1,824**	**161,450**	**36,062**	**197,512**
Study Region Total	**1,824**	**161,450**	**36,062**	**197,512**

Hazus-MH: Hurricane Event Report

Region Name: Bridgewater

Hurricane Scenario: Probabilistic 1000-year Return Period

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

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Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 17.24 square miles and contains 1 census tracts. There are over 0 thousand households in the region and has a total population of 1,824 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 0 thousand buildings in the region with a total building replacement value (excluding contents) of 198 million dollars (2006 dollars). Approximately 88% of the buildings (and 82% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 950 buildings in the region which have an aggregate total replacement value of 198 million (2006 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
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Agricultural	2,023	1.0%
Religious	2,545	1.3%
Government	2,630	1.3%
Education	2,874	1.5%
Total	**197,512**	**100.0%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 1 schools, 1 fire stations, 1 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 92 buildings will be at least moderately damaged. This is over 10% of the total number of buildings in the region. There are an estimated 5 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 1000 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	7	60.79	3	25.30	1	8.98	1	4.27	0	0.66
Commercial	41	66.62	14	23.52	6	9.07	0	0.79	0	0.00
Education	3	68.48	1	22.23	0	8.47	0	0.82	0	0.00
Government	3	68.88	1	21.51	0	8.74	0	0.87	0	0.00
Industrial	17	66.83	5	21.13	2	9.48	1	2.30	0	0.25
Religion	2	66.84	1	25.02	0	7.52	0	0.62	0	0.00
Residential	481	57.27	279	33.21	69	8.17	6	0.77	5	0.58
Total	**554**		**304**		**79**		**8**		**5**	

Table 3: Expected Building Damage by Building Type : 1000 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	8	63.38	3	22.96	2	12.92	0	0.73	0	0.00
Masonry	53	60.68	22	25.01	10	11.82	2	2.10	0	0.39
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	34	68.53	10	20.80	5	9.63	1	1.04	0	0.00
Wood	463	57.74	267	33.33	61	7.63	6	0.73	5	0.58

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	1	0	0	1
Police Stations	1	0	0	1
Schools	1	0	0	0

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 25,644 tons of debris will be generated. Of the total amount, 22,576 tons (88%) is Other Tree Debris. Of the remaining 3,068 tons, Brick/Wood comprises 27% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 33 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 2,233 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 6 households to be displaced due to the hurricane. Of these, 1 people (out of a total population of 1,824) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 9.4 million dollars, which represents 4.74 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 9 million dollars. 3% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 89% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	5,917.25	262.95	105.04	149.34	6,434.58
	Content	1,761.29	75.75	65.33	54.38	1,956.76
	Inventory	0.00	0.57	12.99	3.41	16.97
	Subtotal	**7,678.55**	**339.27**	**183.37**	**207.14**	**8,408.31**
Business Interruption Loss						
	Income	0.00	30.32	1.52	7.47	39.31
	Relocation	526.34	48.80	7.20	28.39	610.73
	Rental	155.83	28.69	1.02	2.68	188.22
	Wage	0.00	24.12	2.59	81.49	108.21
	Subtotal	**682.17**	**131.93**	**12.33**	**120.03**	**946.46**
Total						
	Total	**8,360.72**	**471.19**	**195.69**	**327.17**	**9,354.78**

Appendix A: County Listing for the Region

Connecticut
- Litchfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Connecticut				
Litchfield	1,824	161,450	36,062	197,512
Total	**1,824**	**161,450**	**36,062**	**197,512**
Study Region Total	**1,824**	**161,450**	**36,062**	**197,512**

Hazus-MH: Earthquake Event Report

Region Name: Bridgewater 1

Earthquake Scenario: East Haddam

Print Date: November 19, 2013

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:
The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

Table of Contents

General Description of the Region

Hazus is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 17.23 square miles and contains 1 census tracts. There are over 0 thousand households in the region which has a total population of 1,824 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 0 thousand buildings in the region with a total building replacement value (excluding contents) of 197 (millions of dollars). Approximately 88.00 % of the buildings (and 82.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 59 and 0 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 0 thousand buildings in the region which have an aggregate total replacement value of 197 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 84% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of 0 beds. There are 1 schools, 1 fire stations, 1 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 0 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 0 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 59.00 (millions of dollars). This inventory includes over 17 kilometers of highways, 2 bridges, 215 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	2	1.70
	Segments	1	57.90
	Tunnels	0	0.00
		Subtotal	**59.60**
Railways	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	0	0.00
		Subtotal	**0.00**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	0	0.00
	Runways	0	0.00
		Subtotal	**0.00**
		Total	**59.60**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	2.20
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**2.20**
Waste Water	Distribution Lines	NA	1.30
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**1.30**
Natural Gas	Distribution Lines	NA	0.90
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.90**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	0	0.00
		Subtotal	**0.00**
		Total	**4.30**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	East Haddam
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-72.40
Latitude of Epicenter	41.50
Earthquake Magnitude	6.40
Depth (Km)	10.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Building Damage

Hazus estimates that about 24 buildings will be at least moderately damaged. This is over 3.00 % of the buildings in the region. There are an estimated 0 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	10	1.21	1	1.49	1	2.33	0	3.41	0	3.20
Commercial	51	6.06	7	7.63	3	14.11	0	20.48	0	24.60
Education	4	0.50	1	0.61	0	1.14	0	1.43	0	2.18
Government	3	0.40	0	0.49	0	0.98	0	1.21	0	1.73
Industrial	21	2.47	3	3.11	1	6.27	0	8.01	0	10.59
Other Residential	70	8.36	8	8.94	3	12.32	0	16.47	0	18.94
Religion	3	0.30	0	0.35	0	0.61	0	0.92	0	1.17
Single Family	678	80.71	66	77.37	13	62.24	1	48.08	0	37.59
Total	**840**		**86**		**22**		**2**		**0**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	719	85.60	69	80.26	12	57.48	1	31.92	0	9.18
Steel	41	4.90	5	6.26	3	13.62	0	16.39	0	21.15
Concrete	9	1.03	1	1.21	1	2.59	0	1.79	0	2.22
Precast	3	0.35	0	0.36	0	1.13	0	2.50	0	0.41
RM	14	1.64	1	1.21	1	3.42	0	5.50	0	0.27
URM	55	6.49	9	10.70	5	21.76	1	41.90	0	66.77
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**840**		**86**		**22**		**2**		**0**	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 0.00% will be operational.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	0	0	0	0
Schools	1	0	0	1
EOCs	0	0	0	0
PoliceStations	1	0	0	1
FireStations	1	0	0	1

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	1	0	0	1	1
	Bridges	2	0	0	2	2
	Tunnels	0	0	0	0	0
Railways	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	0	0	0	0	0
Waste Water	0	0	0	0	0
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	0	0	0	0	0

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	108	4	1
Waste Water	65	2	1
Natural Gas	43	1	0
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	703	0	0	0	0	0
Electric Power		0	0	0	0	0

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 66.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 1,824) will seek temporary shelter in public shelters.

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

· Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
· Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
· Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
· Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**
2 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**
5 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 1.79 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 1.75 (millions of dollars); 16 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 65 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.00	0.04	0.00	0.01	0.05
	Capital-Related	0.00	0.00	0.04	0.00	0.00	0.04
	Rental	0.02	0.01	0.03	0.00	0.00	0.06
	Relocation	0.07	0.00	0.04	0.00	0.02	0.13
	Subtotal	**0.08**	**0.01**	**0.15**	**0.01**	**0.03**	**0.28**
Capital Stock Losses							
	Structural	0.16	0.01	0.04	0.01	0.03	0.25
	Non_Structural	0.65	0.04	0.13	0.04	0.06	0.92
	Content	0.17	0.01	0.06	0.02	0.03	0.29
	Inventory	0.00	0.00	0.00	0.00	0.00	0.01
	Subtotal	**0.98**	**0.07**	**0.24**	**0.07**	**0.12**	**1.47**
	Total	**1.06**	**0.07**	**0.38**	**0.08**	**0.15**	**1.75**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

Table 12: Transportation System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	57.91	$0.00	0.00
	Bridges	1.73	$0.00	0.13
	Tunnels	0.00	$0.00	0.00
	Subtotal	**59.60**	**0.00**	
Railways	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Light Rail	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Bus	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Ferry	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Port	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Airport	Facilities	0.00	$0.00	0.00
	Runways	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
	Total	**59.60**	**0.00**	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	2.20	$0.02	0.89
	Subtotal	**2.16**	**$0.02**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	1.30	$0.01	0.74
	Subtotal	**1.29**	**$0.01**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	0.90	$0.00	0.38
	Subtotal	**0.86**	**$0.00**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Electrical Power	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Communication	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
	Total	**4.31**	**$0.03**	

Table 14. Indirect Economic Impact with outside aid

(Employment as # of people and Income in millions of $)

LOSS		Total	%

Appendix A: County Listing for the Region

Litchfield,CT

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Connecticut					
	Litchfield	1,824	161	36	197
Total State		**1,824**	**161**	**36**	**197**
Total Region		**1,824**	**161**	**36**	**197**

Fire Station Facilities Functionality

November 19, 2013

	Count	Functionality(%) At Day 1
Connecticut		
Litchfield	1	70.50
Total	**1**	**70.50**
Region Total	**1**	**70.50**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Police Station Facilities Functionality

November 19, 2013

	Count	Functionality(%) At Day 1
Connecticut		
Litchfield	1	70.50
Total	**1**	**70.50**
Region Total	**1**	**70.50**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

School Functionality

November 19, 2013

	Count	Functionality (%)
Connecticut		
Litchfield	1	70.50
Total	**1**	**70.50**
Region Total	**1**	**70.50**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Hazus-MH: Earthquake Event Report

Region Name: Bridgewater 1

Earthquake Scenario: Haddam

Print Date: November 19, 2013

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:
The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

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General Description of the Region

Hazus is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 17.23 square miles and contains 1 census tracts. There are over 0 thousand households in the region which has a total population of 1,824 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 0 thousand buildings in the region with a total building replacement value (excluding contents) of 197 (millions of dollars). Approximately 88.00 % of the buildings (and 82.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 59 and 0 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 0 thousand buildings in the region which have an aggregate total replacement value of 197 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 84% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of 0 beds. There are 1 schools, 1 fire stations, 1 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 0 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 0 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 59.00 (millions of dollars). This inventory includes over 17 kilometers of highways, 2 bridges, 215 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	2	1.70
	Segments	1	57.90
	Tunnels	0	0.00
		Subtotal	**59.60**
Railways	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	0	0.00
		Subtotal	**0.00**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	0	0.00
	Runways	0	0.00
		Subtotal	**0.00**
		Total	**59.60**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	2.20
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**2.20**
Waste Water	Distribution Lines	NA	1.30
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**1.30**
Natural Gas	Distribution Lines	NA	0.90
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.90**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	0	0.00
		Subtotal	**0.00**
		Total	**4.30**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	Haddam
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-72.55
Latitude of Epicenter	41.77
Earthquake Magnitude	5.70
Depth (Km)	10.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Building Damage

Hazus estimates that about 5 buildings will be at least moderately damaged. This is over 1.00 % of the buildings in the region. There are an estimated 0 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	11	1.25	0	1.56	0	2.40	0	3.06	0	2.52
Commercial	58	6.31	2	8.36	1	14.94	0	19.99	0	22.29
Education	5	0.52	0	0.64	0	1.10	0	1.33	0	1.86
Government	4	0.42	0	0.50	0	0.87	0	0.99	0	1.19
Industrial	24	2.60	1	3.19	0	5.67	0	6.55	0	7.22
Other Residential	78	8.45	3	9.93	1	14.61	0	18.91	0	23.27
Religion	3	0.31	0	0.42	0	0.75	0	1.07	0	1.41
Single Family	736	80.15	20	75.39	3	59.66	0	48.10	0	40.25
Total	**918**		**27**		**5**		**0**		**0**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	779	84.80	20	75.66	2	49.08	0	25.78	0	0.00
Steel	48	5.20	2	5.97	1	10.50	0	9.96	0	7.88
Concrete	10	1.08	0	1.09	0	1.66	0	0.76	0	0.00
Precast	3	0.36	0	0.47	0	1.57	0	3.04	0	0.21
RM	15	1.63	0	1.56	0	4.46	0	5.71	0	0.00
URM	64	6.93	4	15.25	2	32.74	0	54.75	0	91.91
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**918**		**27**		**5**		**0**		**0**	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 0.00% will be operational.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	0	0	0	0
Schools	1	0	0	1
EOCs	0	0	0	0
PoliceStations	1	0	0	1
FireStations	1	0	0	1

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	1	0	0	1	1
	Bridges	2	0	0	2	2
	Tunnels	0	0	0	0	0
Railways	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	0	0	0	0	0
Waste Water	0	0	0	0	0
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	0	0	0	0	0

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	108	1	0
Waste Water	65	0	0
Natural Gas	43	0	0
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	703	0	0	0	0	0
Electric Power		0	0	0	0	0

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 75.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 1,824) will seek temporary shelter in public shelters.

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**
2 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**
5 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 0.37 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 0.37 (millions of dollars); 16 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 65 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.00	0.01	0.00	0.00	0.01
	Capital-Related	0.00	0.00	0.01	0.00	0.00	0.01
	Rental	0.00	0.00	0.01	0.00	0.00	0.01
	Relocation	0.01	0.00	0.01	0.00	0.00	0.03
	Subtotal	**0.02**	**0.00**	**0.03**	**0.00**	**0.01**	**0.06**
Capital Stock Losses							
	Structural	0.04	0.00	0.01	0.00	0.01	0.06
	Non_Structural	0.14	0.01	0.03	0.01	0.01	0.19
	Content	0.03	0.00	0.01	0.00	0.01	0.05
	Inventory	0.00	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.21**	**0.01**	**0.05**	**0.01**	**0.02**	**0.31**
	Total	**0.22**	**0.02**	**0.08**	**0.02**	**0.03**	**0.37**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

Table 12: Transportation System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	57.91	$0.00	0.00
	Bridges	1.73	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Subtotal	**59.60**	**0.00**	
Railways	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Light Rail	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Bus	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Ferry	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Port	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Airport	Facilities	0.00	$0.00	0.00
	Runways	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
	Total	**59.60**	**0.00**	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	2.20	$0.00	0.14
	Subtotal	**2.16**	**$0.00**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	1.30	$0.00	0.12
	Subtotal	**1.29**	**$0.00**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	0.90	$0.00	0.06
	Subtotal	**0.86**	**$0.00**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Electrical Power	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Communication	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
	Total	**4.31**	**$0.01**	

Table 14. Indirect Economic Impact with outside aid

(Employment as # of people and Income in millions of $)

LOSS		Total	%

Appendix A: County Listing for the Region

Litchfield,CT

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Connecticut					
	Litchfield	1,824	161	36	197
Total State		**1,824**	**161**	**36**	**197**
Total Region		**1,824**	**161**	**36**	**197**

Fire Station Facilities Functionality

November 19, 2013

	Count	Functionality(%) At Day 1
Connecticut		
Litchfield	1	85.80
Total	**1**	**85.80**
Region Total	**1**	**85.80**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Police Station Facilities Functionality

November 19, 2013

	Count	Functionality(%) At Day 1
Connecticut		
Litchfield	1	85.80
Total	**1**	**85.80**
Region Total	**1**	**85.80**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

School Functionality

November 19, 2013

	Count	Functionality (%)
Connecticut		
Litchfield	1	85.80
Total	**1**	**85.80**
Region Total	**1**	**85.80**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Hazus-MH: Earthquake Event Report

Region Name: Bridgewater 1

Earthquake Scenario: Portland

Print Date: November 19, 2013

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:
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The replacement value of the transportation and utility lifeline systems is estimated to be 59 and 0 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 0 thousand buildings in the region which have an aggregate total replacement value of 197 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 84% of the building inventory. The remaining percentage is distributed between the other general building types.

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For essential facilities, there are 0 hospitals in the region with a total bed capacity of 0 beds. There are 1 schools, 1 fire stations, 1 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 0 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 0 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 59.00 (millions of dollars). This inventory includes over 17 kilometers of highways, 2 bridges, 215 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	2	1.70
	Segments	1	57.90
	Tunnels	0	0.00
		Subtotal	**59.60**
Railways	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	0	0.00
		Subtotal	**0.00**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	0	0.00
	Runways	0	0.00
		Subtotal	**0.00**
		Total	**59.60**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	2.20
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**2.20**
Waste Water	Distribution Lines	NA	1.30
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**1.30**
Natural Gas	Distribution Lines	NA	0.90
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.90**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	0	0.00
		Subtotal	**0.00**
		Total	**4.30**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	Portland
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-72.60
Latitude of Epicenter	41.60
Earthquake Magnitude	5.70
Depth (Km)	10.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Building Damage

Hazus estimates that about 7 buildings will be at least moderately damaged. This is over 1.00 % of the buildings in the region. There are an estimated 0 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	11	1.24	1	1.52	0	2.32	0	2.87	0	2.70
Commercial	57	6.29	3	8.08	1	14.44	0	18.61	0	22.53
Education	5	0.52	0	0.63	0	1.08	0	1.25	0	1.82
Government	4	0.41	0	0.49	0	0.87	0	0.94	0	1.18
Industrial	23	2.59	1	3.12	0	5.62	0	6.21	0	7.26
Other Residential	77	8.43	3	9.70	1	14.10	0	17.85	0	23.28
Religion	3	0.31	0	0.40	0	0.71	0	1.00	0	1.40
Single Family	728	80.20	26	76.07	4	60.85	0	51.27	0	39.83
Total	**908**		**35**		**7**		**1**		**0**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	771	84.90	27	76.91	3	51.53	0	31.65	0	0.00
Steel	47	5.19	2	5.88	1	10.64	0	9.80	0	8.40
Concrete	10	1.07	0	1.11	0	1.80	0	0.77	0	0.35
Precast	3	0.36	0	0.44	0	1.46	0	2.80	0	0.28
RM	15	1.63	1	1.48	0	4.21	0	5.53	0	0.00
URM	62	6.85	5	14.19	2	30.36	0	49.45	0	90.97
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**908**		**35**		**7**		**1**		**0**	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 0.00% will be operational.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	0	0	0	0
Schools	1	0	0	1
EOCs	0	0	0	0
PoliceStations	1	0	0	1
FireStations	1	0	0	1

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	1	0	0	1	1
	Bridges	2	0	0	2	2
	Tunnels	0	0	0	0	0
Railways	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 % After Day 1	with Functionality > 50 % After Day 7
Potable Water	0	0	0	0	0
Waste Water	0	0	0	0	0
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	0	0	0	0	0

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	108	1	0
Waste Water	65	0	0
Natural Gas	43	0	0
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	703	0	0	0	0	0
Electric Power		0	0	0	0	0

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 74.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 1,824) will seek temporary shelter in public shelters.

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

· Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
· Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
· Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
· Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**
2 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**
5 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 0.54 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 0.54 (millions of dollars); 15 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 66 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.00	0.01	0.00	0.00	0.02
	Capital-Related	0.00	0.00	0.01	0.00	0.00	0.01
	Rental	0.01	0.00	0.01	0.00	0.00	0.02
	Relocation	0.02	0.00	0.01	0.00	0.01	0.04
	Subtotal	**0.03**	**0.00**	**0.04**	**0.00**	**0.01**	**0.08**
Capital Stock Losses							
	Structural	0.05	0.00	0.01	0.00	0.01	0.08
	Non_Structural	0.20	0.01	0.04	0.01	0.02	0.29
	Content	0.05	0.00	0.02	0.01	0.01	0.08
	Inventory	0.00	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.30**	**0.02**	**0.07**	**0.02**	**0.04**	**0.45**
	Total	**0.33**	**0.02**	**0.11**	**0.02**	**0.04**	**0.54**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

Table 12: Transportation System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	57.91	$0.00	0.00
	Bridges	1.73	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Subtotal	**59.60**	**0.00**	
Railways	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Light Rail	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Bus	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Ferry	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Port	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Airport	Facilities	0.00	$0.00	0.00
	Runways	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
	Total	**59.60**	**0.00**	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	2.20	$0.00	0.18
	Subtotal	**2.16**	**$0.00**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	1.30	$0.00	0.15
	Subtotal	**1.29**	**$0.00**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	0.90	$0.00	0.08
	Subtotal	**0.86**	**$0.00**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Electrical Power	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Communication	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
	Total	**4.31**	**$0.01**	

Table 14. Indirect Economic Impact with outside aid

(Employment as # of people and Income in millions of $)

LOSS		Total	%

Appendix A: County Listing for the Region

Litchfield,CT

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Connecticut					
	Litchfield	1,824	161	36	197
Total State		**1,824**	**161**	**36**	**197**
Total Region		**1,824**	**161**	**36**	**197**

Fire Station Facilities Functionality

November 19, 2013

	Count	Functionality(%) At Day 1
Connecticut		
Litchfield	1	83.30
Total	**1**	**83.30**
Region Total	**1**	**83.30**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Police Station Facilities Functionality

November 19, 2013

	Count	Functionality(%) At Day 1
Connecticut		
Litchfield	1	83.30
Total	**1**	**83.30**
Region Total	**1**	**83.30**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

School Functionality

November 19, 2013

	Count	Functionality (%)
Connecticut		
Litchfield	1	83.30
Total	**1**	**83.30**
Region Total	**1**	**83.30**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Hazus-MH: Earthquake Event Report

Region Name: Bridgewater 1

Earthquake Scenario: Stamford

Print Date: November 19, 2013

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:
The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

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General Description of the Region

Hazus is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 17.23 square miles and contains 1 census tracts. There are over 0 thousand households in the region which has a total population of 1,824 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 0 thousand buildings in the region with a total building replacement value (excluding contents) of 197 (millions of dollars). Approximately 88.00 % of the buildings (and 82.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 59 and 0 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 0 thousand buildings in the region which have an aggregate total replacement value of 197 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 84% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of 0 beds. There are 1 schools, 1 fire stations, 1 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 0 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 0 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 59.00 (millions of dollars). This inventory includes over 17 kilometers of highways, 2 bridges, 215 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	2	1.70
	Segments	1	57.90
	Tunnels	0	0.00
		Subtotal	**59.60**
Railways	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	0	0.00
		Subtotal	**0.00**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	0	0.00
	Runways	0	0.00
		Subtotal	**0.00**
		Total	**59.60**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	2.20
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**2.20**
Waste Water	Distribution Lines	NA	1.30
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**1.30**
Natural Gas	Distribution Lines	NA	0.90
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.90**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	0	0.00
		Subtotal	**0.00**
		Total	**4.30**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	Stamford
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-73.60
Latitude of Epicenter	41.15
Earthquake Magnitude	5.70
Depth (Km)	10.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Building Damage

Hazus estimates that about 19 buildings will be at least moderately damaged. This is over 2.00 % of the buildings in the region. There are an estimated 0 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	10	1.22	1	1.48	0	2.28	0	3.23	0	2.83
Commercial	52	6.13	6	7.64	2	13.97	0	19.66	0	22.70
Education	4	0.50	0	0.61	0	1.12	0	1.35	0	1.99
Government	3	0.40	0	0.49	0	0.95	0	1.11	0	1.51
Industrial	21	2.51	2	3.08	1	6.04	0	7.36	0	9.22
Other Residential	72	8.38	7	9.05	2	12.61	0	16.69	0	19.45
Religion	3	0.30	0	0.36	0	0.62	0	0.93	0	1.18
Single Family	689	80.56	57	77.29	11	62.41	1	49.67	0	41.12
Total	**856**		**74**		**18**		**2**		**0**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	731	85.42	59	79.83	10	56.85	1	32.92	0	11.34
Steel	43	5.00	5	6.14	2	12.80	0	14.23	0	16.98
Concrete	9	1.04	1	1.19	0	2.40	0	1.47	0	1.36
Precast	3	0.35	0	0.37	0	1.18	0	2.52	0	0.43
RM	14	1.64	1	1.24	1	3.53	0	5.40	0	0.23
URM	56	6.55	8	11.23	4	23.25	1	43.47	0	69.65
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**856**		**74**		**18**		**2**		**0**	

*Note:
RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 0.00% will be operational.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	0	0	0	0
Schools	1	0	0	1
EOCs	0	0	0	0
PoliceStations	1	0	0	1
FireStations	1	0	0	1

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	1	0	0	1	1
	Bridges	2	0	0	2	2
	Tunnels	0	0	0	0	0
Railways	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	0	0	0	0	0
Waste Water	0	0	0	0	0
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	0	0	0	0	0

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	108	2	1
Waste Water	65	1	0
Natural Gas	43	0	0
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	703	0	0	0	0	0
Electric Power		0	0	0	0	0

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 68.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 1,824) will seek temporary shelter in public shelters.

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**
2 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**
5 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 1.59 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 1.57 (millions of dollars); 14 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 65 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.00	0.03	0.00	0.01	0.04
	Capital-Related	0.00	0.00	0.03	0.00	0.00	0.03
	Rental	0.02	0.00	0.02	0.00	0.00	0.05
	Relocation	0.05	0.00	0.03	0.00	0.02	0.10
	Subtotal	**0.07**	**0.01**	**0.12**	**0.01**	**0.03**	**0.23**
Capital Stock Losses							
	Structural	0.14	0.01	0.03	0.01	0.02	0.21
	Non_Structural	0.58	0.04	0.12	0.04	0.06	0.83
	Content	0.18	0.01	0.06	0.02	0.03	0.30
	Inventory	0.00	0.00	0.00	0.00	0.00	0.01
	Subtotal	**0.89**	**0.06**	**0.22**	**0.07**	**0.11**	**1.34**
	Total	**0.96**	**0.07**	**0.33**	**0.08**	**0.13**	**1.57**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

Table 12: Transportation System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	57.91	$0.00	0.00
	Bridges	1.73	$0.00	0.02
	Tunnels	0.00	$0.00	0.00
	Subtotal	**59.60**	**0.00**	
Railways	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Light Rail	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Bus	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Ferry	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Port	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Airport	Facilities	0.00	$0.00	0.00
	Runways	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
	Total	**59.60**	**0.00**	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	2.20	$0.01	0.43
	Subtotal	**2.16**	**$0.01**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	1.30	$0.00	0.36
	Subtotal	**1.29**	**$0.00**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	0.90	$0.00	0.19
	Subtotal	**0.86**	**$0.00**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Electrical Power	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Communication	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
	Total	**4.31**	**$0.02**	

Table 14. Indirect Economic Impact with outside aid

(Employment as # of people and Income in millions of $)

LOSS		Total	%

Appendix A: County Listing for the Region

Litchfield,CT

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Connecticut					
	Litchfield	1,824	161	36	197
Total State		**1,824**	**161**	**36**	**197**
Total Region		**1,824**	**161**	**36**	**197**

Hospital Functionality

November 19, 2013

		At Day 1		At day 3		At day 7		At day 30		At day 90	
	Total # of Beds	# of Beds	%	# of Beds	%	# of Beds	%	# of Beds	%	# of Beds	%
Total											
Total											
Region Total											

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Fire Station Facilities Functionality

November 19, 2013

	Count	Functionality(%) At Day 1
Connecticut		
Litchfield	1	73.50
Total	**1**	**73.50**
Region Total	**1**	**73.50**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Police Station Facilities Functionality

November 19, 2013

	Count	Functionality(%) At Day 1
Connecticut		
Litchfield	1	73.80
Total	**1**	**73.80**
Region Total	**1**	**73.80**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

School Functionality

November 19, 2013

	Count	Functionality (%)
Connecticut		
Litchfield	1	74.00
Total	**1**	**74.00**
Region Total	**1**	**74.00**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

APPENDIX F
FEMA SNOW LOAD GUIDANCE

FEMA Snow Load Safety Guidance

FEMA

www.FEMA.gov

This flyer summarizes warning signs of overstress conditions during a snow event, key safety issues and risks a snow event poses to buildings, and what to do after a snow event.

Warning Signs of Overstress Conditions during a Snow Event

Overstressed roofs typically display some warning signs. Wood and steel structures may show noticeable signs of excessive ceiling or roof sagging before failure. The following warning signs are common in wood, metal, and steel constructed buildings:

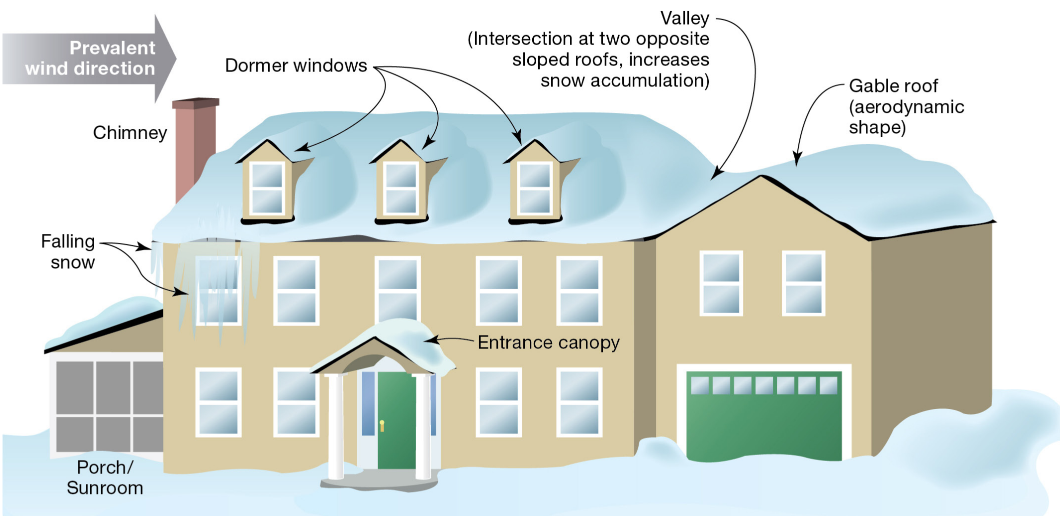
- Sagging ceiling tiles or boards, ceiling boards falling out of the ceiling grid, and/or sagging sprinkler lines and sprinkler heads
- Sprinkler heads deflecting below suspended ceilings
- Popping, cracking, and creaking noises
- Sagging roof members, including metal decking or plywood sheathing
- Bowing truss bottom chords or web members
- Doors and/or windows that can no longer be opened or closed
- Cracked or split wood members
- Cracks in walls or masonry
- Severe roof leaks
- Excessive accumulation of water at nondrainage locations on low slope roofs

Warning! If any of these warning signs are observed, the building should be promptly evacuated and a local building authority and/or a qualified design professional should be contacted to perform a detailed structural inspection.

Key Safety Issues and Risks

Snow accumulation in excess of building design conditions can result in structural failure and possible collapse. Structural failure due to roof snow loads may be linked to several possible causes, including but not limited to the following:

- **Unbalanced snow load from drifting and sliding snow.** When snow accumulates at different depths in different locations on a roof, it results in high and concentrated snow loads that can potentially overload the roof structure.
- **Rain-on-snow load.** Heavy rainfall on top of snow may cause snow to melt and become further saturated, significantly increasing the load on the roof structure.
- **Snow melt between snow events.** If the roof drainage system is blocked, improperly designed or maintained, ice dams may form, which creates a concentrated load at the eaves and reduces the ability of sloped roofs to shed snow. On flat or low slope roof systems, snow melt may accumulate in low areas on roofs, creating a concentrated load.
- **Roof geometry.** Simple roofs with steep slopes shed snow most easily. Roofs with geometric irregularities and obstructions collect snow drifts in an unbalanced pattern. These roof geometries include flat roofs with parapets, stepped roofs, saw-tooth roofs, and roofs with obstructions such as equipment or chimneys.



Unbalanced Snow Load from Drifting and Sliding Snow on Residential Structure

What to Do After a Snow Event

After a snow event, snow removal may be in order. To determine whether snow removal is necessary, one may enlist valuable resources such as a local building authority and/or a qualified design professional, who will be familiar with the snow conditions of the region and the design capacities of local buildings per the building code. If it is determined that the snow should be removed, snow removal should only be performed by qualified individuals. The qualified individual should follow necessary protocols for safe snow removal to minimize risk of personal injury and lower the potential for damaging the roof covering during the snow removal process.

> Warning! Snow removal is a dangerous activity that should only be done by qualified individuals following safety protocols to minimize risks. If at any time there is concern that snow loads may cause a collapse of the roof structure, cease all removal activity and evacuate the building.

If subsequent snow events are anticipated, removing snow from the roof will minimize the risk of accumulating snow causing structural damage. One benefit of immediate snow removal is that the effort required to remove the snow from the rooftop is reduced.

Safety Measures for Snow Removal

Below are some safety measures to take during snow removal to minimize risk of personal injury.

- Any roof snow removal should be conducted following proper OSHA protocol for work on rooftops. Use roof fall arrest harnesses where applicable.
- Always have someone below the roof to keep foot traffic away from locations where falling snow or ice could cause injuries.
- Ensure someone confirms that the area below removal site is free of equipment that could be damaged by falling snow or ice.
- Whenever snow is being removed from a roof, be careful of dislodged icicles. An icicle falling from a short height can still cause damage or injury.
- When using a non-metallic snow rake, be aware that roof snow can slide at any moment. Keep a safe distance away from the eave to remain outside of the sliding range.
- Buried skylights pose a high risk to workers on a roof removing snow. Properly mark this hazard as well as other rooftop hazards.

Methods of Snow Removal

Below are some recommended methods of snow removal that allow the qualified individual to remove snow safely and minimize risk of personal injury and property damage.

- Removing snow completely from a roof surface can result in serious damage to the roof covering and possibly lead to leaks and additional damage. At least a couple of inches of snow should be left on the roof.
- Do not use mechanical snow removal equipment. The risk of damaging the roof membrane or other rooftop items outweighs the advantage of speed.
- Do not use sharp tools, such as picks, to remove snow. Use plastic rather than metal shovels.
- Remove drifted snow first at building elevation changes, parapets, and around equipment.
- Once drifted snow has been removed, start remaining snow removal from the center portion of the roof.
- Remove snow in the direction of primary structural members. This will prevent unbalanced snow loading.
- Do not stockpile snow on the roof.
- Dispose of removed snow in designated areas on the ground.
- Keep snow away from building exits, fire escapes, drain downspouts, ventilation openings, and equipment.
- If possible, remove snow starting at the ridge and moving toward the eave for gable and sloped roofs.
- In some cases a long-handled non-metallic snow rake can be used from the ground, thereby reducing the risk. Metal snow rakes can damage roofing material and pose an electrocution risk and should be avoided.
- Upon completion of snow removal, the roofing material should be inspected for any signs of damage. Additionally, a quick inspection of the structural system may be prudent after particularly large snow events.

If you have any additional questions on this topic or other mitigation topics, contact the FEMA Building Science Helpline at FEMA-Buildingsciencehelp@fema.dhs.gov or 866-927-2104.

You may also subscribe to the FEMA Building Science e-mail list serve, which is updated with publication releases and FEMA Building Science activities.

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