TOWN OF CANAAN

HAZARD MITIGATION PLAN

2014

MMI #3843-04

Prepared for the:

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ACKNOWLEDGEMENTS AND CONTACT INFORMATION

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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
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
ICC	International Code Council
IPCC	Intergovernmental Panel on Climate Change
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

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
RSI	Regional Snowfall Index
SCCOG	Southeastern Connecticut Council of Governments
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
TNC	The Nature Conservancy
USD	United States Dollars
USDA	United States Department of Agriculture
USGS	United States Geological Survey

EXECUTIVE SUMMARY

The Town of Canaan has developed the subject hazard mitigation plan along with eight other communities in northwestern Connecticut through a grant to the Northwestern Connecticut Council of Governments (NWCCOG[1]). Although each of the nine towns developed a single-jurisdiction plan, certain components of the planning process were shared throughout the nine-town regional planning area.

Canaan is a rural town of almost 1,200 people situated along the east bank of the Housatonic River. It is often referred to as Falls Village, which is the main village in the town. Residential development pressures are minimal in Canaan and the town continues to maintain a rural character.

The primary goal of this hazard mitigation plan is to prevent loss of life, reduce the damage to property, infrastructure, and natural, cultural and economic resources from natural disasters.

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

- The snow storms of January 2011 caused a barn to collapse.
- Flooding from Tropical Storm Irene was significant and several local roads were flooded including Routes 7, 63 and 126.
- Winter Storm Alfred caused significant tree limbs damage and debris throughout the town. The local electric company, Connecticut Light and Power (CL&P) was critical to the success of the clean-up by loaning a bucket truck to the town.

These storms have tested the resilience of Canaan, demonstrating that the town has considerable capacity to recover from storms.

Vast floodplains cover a large portion of Canaan, particularly in the vicinity of Falls Village between Route 126 and Route 7. This area includes the Housatonic River, the Hollenbeck River and several tributaries as well as Robbins Swamp. Town officials believe that Robbins Swamp, located north and east of the Hollenbeck and Housatonic Rivers, respectively, is a major contributor to flooding in the town.

In addition, beavers (through their dams) reportedly present recurring flood issues in the community. For example, Cobble Road is often closed as a result of flooding due to beavers. Music Mountain is also a chronic flooding area; however flooding impacts in this area are not as significant as they are on Cobble Road.

Canaan is also at risk to winter storms and winds. The town's capabilities relative to winter storms are significant, as the town is located in a part of the state that is accustomed to snowfall.

Canaan has identified a number of mitigation strategies to decrease risks from future floods, wind events, snow storms, wildfires, and earthquakes. 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.

[1] Subsequent to the commencement of the planning process, NWCCOG merged with the former Litchfield Hills Council of Elected Officials to form a 20-town regional planning organization known as the Northwest Hills Council of Governments.

When the town updates its hazard mitigation plan in five years[2], these mitigation strategies will be reviewed for progress and updated as needed.

[2] Updates will be pursued by the town or in connection with the Northwest Hills 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 disasters, pre-disaster hazard mitigation is commonly defined as any sustained action that 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. Public safety and property loss reduction are the driving forces behind this plan. However, careful consideration also must be given to the preservation of history, culture and the natural environment of the region.

This HMP is prepared specifically to identify hazards in the Town of Canaan, 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.

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.

Pre-Disaster Mitigation (PDM) Program

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.

Hazard Mitigation Grant Program (HMGP)

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 came through the HMGP program.

Flood Mitigation Assistance (FMA) Program

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.

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.

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.

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 Canaan's development through interdepartmental and intermunicipal 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.

- ***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.

> ***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.***

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 Canaan:

- 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 Canaan 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 Canaan 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 Canaan'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 Specific Strategies and Actions.* 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.

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.

<u>Location</u>
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

<u>Frequency of Occurrence</u>
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

<u>Magnitude/Severity</u>
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	Frequency of Occurrence	Magnitude/ Severity	Rank
	1 = small 2 = medium 3 = large	0 = unlikely 1 = possible 2 = likely 3 = highly likely	1 = limited 2 = significant 3 = critical 4 = catastrophic	
Nor'Easter Winds	3	3	2	8
Snow	3	3	2	8
Blizzard	3	3	2	8
Riverine Flooding	3	3	2	8
Hurricane Winds	3	1	3	7
Falling Trees/Branches	2	3	2	5
Ice	3	2	2	7
Thunderstorm and Tornado Winds	2	2	2	6
Flooding from Dam Failure	1	1	4	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
1 = possible: between 1 and 10% probability in the next year; or at least one chance in next 100 years
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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%

- ***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.

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

- ***Summary of Specific Strategies and Actions*** provides a summary of the recommended courses of action for Canaan, 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. The Local Mitigation Planning Handbook (March 2013) also supports this type of methodology.

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**:
  - Benefits: Is the proposed strategy socially acceptable to Canaan?
  - Costs: Are there any equity issues involved that would mean that one segment of Canaan 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**:
  - Benefits: Will the proposed strategy work? Will it reduce losses in the long term with minimal secondary impacts?
  - Costs: Is the action technically feasible? Will it create more problems than it will solve? Does it solve the problem or only a symptom?

- **Administrative**:
  - Benefits: Does the project make it easier for the community to administrate future mitigation or emergency response actions?

- Costs: Does Canaan have the capability (staff, technical experts, and/or funding) to implement the action, or can it be readily obtained? Can Canaan perform the necessary maintenance? Can the project be accomplished in a timely manner?

- **Political**:
  - Benefits: 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 Canaan 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 of Canaan is a member of the Northwestern Connecticut Council of Governments (NWCCOG), the regional planning body responsible for Canaan and eight other member municipalities: Cornwall, North Canaan, Salisbury, Sharon, Kent, Warren, Roxbury and Washington. It should be noted that during the planning process, NWCCOG merged with the former Litchfield Hills Council of Elected Officials to form a 20-town regional planning organization.

Ms. Jocelyn Ayer of NWCCOG and Ms. Patricia Mechare, the Town First Selectman coordinated the development of this HMP. The NWCCOG applied for the planning grant from FEMA through the Connecticut Department of Emergency Services and Public Protection (DESPP) Division of Emergency Management and Homeland Security (DEMHS). The adoption of this plan in the Town of Canaan will be coordinated by Town personnel.

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

- ❑ Mr. Patricia Mechare, First Selectman
- ❑ Mr. Tim Downs, Fire Chief/Highway Department

A 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, 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 regional public information meeting was held on November 7, 2013.***

  Karen Bartomioli with the Lakeville Journal attended as well as two members of the general public, who did not sign-in. The following individuals also attended:

  - Gordon Ridgway, Town of Cornwall, First Selectman
  - Skip Kearns, Cornwall resident
  - Heidi Kearns, Cornwall Planning and Zoning
  - David Colbert, Cornwall Planning and Zoning
  - Jack Travers, Former First Selectman, Town of Warren
  - Michael Jastremski, Housatonic Valley Association
  - Jocelyn Ayer, NWCCOG

  The following were points of discussion:

  - The Housatonic Valley Association will be conducting Stream Habitat Continuity Surveys in 2014 and 2015. As these assessments will focus on improving areas where roads cross over streams, there is the potential to tie these surveys into hazard mitigation planning activities.

  - There were questions regarding how the plans are being funded. It was explained that the plan for each community was being 75% funded under a grant through FEMA. The remaining 25% of the funding is being paid for out of NWCCOG member dues.

  - The group had additional questions regarding the FEMA grant programs. It was explained that these particular plans would not affect any funding opportunities to which NWCCOG communities were already entitled. Instead, adoption of the plans opens up additional opportunities to obtain grant funding.

  - The group mentioned that the prevalence of dead end roads in the area make emergency access difficult, particularly when trees fall and strand residents. The representative from Warren indicated that their community had been opening up unimproved sections of roads in order to provide emergency access via a second egress.

  - The Downtown Streetscape project in Kent was mentioned as a potential mitigation area for overhead power lines. It was explained that while moving overhead wires underground is a project eligible for grant funding, such projects are very expensive and often do not generate enough benefits to be considered cost-effective and therefore qualify for a grant.

- A discussion regarding the resizing of culverts took place. One example was how the West Cornwall Bridge overtopped in 1955 causing significant flooding along Main Street. While the current bridge was sized for a particular storm event at the time, as the frequency and magnitude of rainfall has been increasing over the past several decades many communities are finding that their infrastructure can no longer convey the same frequency storm event without overtopping. A standard recommendation in each plan will be to review culvert conveyance based on existing hydrology.

- The group mentioned that beaver dams were a big concern related to flooding, particularly in Cornwall. Town personnel should be contacted to obtain more information regarding these areas and potential mitigation measures.

- Mr. Ridgway discussed the importance of these particular FEMA grants in relation to being able to fund new generators. The Town of Cornwall is seeking a $40,000 grant under HMGP for a new generator at the West Cornwall Fire House. He also mentioned that a section of streambed along River Road is located near the road elevation and a recent flood almost washed out the road. This could potentially be an area where a grant could be useful. Also, the Town has a concern with a privately-owned dam on Popple Swamp Road. The landowner lives in New York State and this is a second home/cottage. The Town is concerned that proper maintenance is not being conducted. The Town has contacted the Dam Safety Division at DEEP but no progress has been made.

- Siltation in Lake Waramaug in Warren was mentioned as an issue. A large area has filled in with silt and the Town would like to obtain a grant to remove the sediment.

- ❑ ***A project data collection meeting was held February 26, 2014.*** Necessary documentation was collected, and problem areas within the town were discussed.
- ❑ ***The Draft Plan was reviewed by the Town in June 2014.***
- ❑ ***The Plan was reviewed by DEMHS in July 2014 and by FEMA in August 2014.***

Public Participation

Residents, business owners, and other stakeholders of Canaan, neighboring communities, and local and regional entities were invited to the public information meeting via the Waterbury Republican- American newspaper on October 30 and November 7 and in the Lakeville Journal on November 14 and via the home page of the Towns of Kent, Cornwall, Washington, Roxbury and Warren. Copies of these announcements are included in Appendix D.

In addition to holding a regional public information meeting for the plan, NWCCOG elected to host a public survey via www.surveymonkey.com. The survey was open from October 11, 2013 through December 15, 2013, with the last participant taking the survey on December 9, 2013. Notification of the survey was posted in the Waterbury Republican-American newspaper on October 30 and November 7, in the Lakeville Journal on November 14. The survey link was also posted on the websites for the Towns of Kent, Warren, Washington, Roxbury and Cornwall. A total of eighty eight people participated in the survey. Table 1-4 provides a summary of the number of responses from each of the NWCCOG municipalities.

Table 1-4
Participant Municipalities

Town	Number of Responses
Washington	7
Kent	24
Cornwall	21
Warren	9
Sharon	6
Roxbury	16
Salisbury	2
Canaan	1
North Canaan	2

One participant from the Town of Canaan responded to the survey. This resident is located on Sand Road.

Participants were asked which recent events, if any, have generated awareness of natural hazards. Table 1-5 summarizes the responses.

Table 1-5
Contributors of Awareness of Natural Hazards

Events	**Number of Participants Selecting**
Winter Storm Nemo in February 2013	26
"Superstorm" Sandy in October 2012	48
"Winter Storm" Alfred in October 2011	50
Hurricane/Tropical Storm Irene in August 2011	37
The Virginia earthquake in August 2011	5
The Springfield, Massachusetts tornado of June 2011	14
The snowstorms of January 2011 that caused buildings to collapse	28

The next question asked responders to rate hazards on a scale of 1 (low threat) to 3 (high threat). Responses are presented in Table 1-6.

Table 1-6
Potential Hazard Threat Based on Survey Response

Hazard	**Number of Participants Selecting**		
	Low Threat	**Moderate Threat**	**High Threat**
Flooding	38	14	9
Hurricanes and Tropical Storms	12	34	15
Tornadoes	17	30	14
Severe Thunderstorms (including hail or downbursts)	10	26	26
Winter Storms (including snow or ice) and Blizzards	4	19	37
Earthquakes	54	6	2
Wildfires and Brush Fires	42	14	6
Dam Failure (could be caused by other hazards)	53	9	0
Landslides	54	7	0

The follow-up question asks which hazards have impacted the participant's home or business. Table 1-7 summarizes these results.

Table 1-7
Impact to Responder's Home or Business

Hazard	Number of Participants Selecting
None – Have not been impacted	9
Flooding	15
Hurricanes and Tropical Storms	34
Tornadoes	6
Severe Thunderstorms (including hail or downbursts)	35
Winter Storms (including snow or ice) and Blizzards	48
Earthquakes	0
Wildfires and Brush Fires	1
Dam Failure (could be caused by other hazards)	0
Landslides	1

When asked if any specific areas of their towns were vulnerable to any of the above hazards, a participant from Canaan entered the following:

- Sand Road and Route 126 due to an inadequate drainage system. Flooding along Route 126 due to Robbins Swamp.

Participants were asked if they had seen an increase in maintenance in their towns due to increased pressure on utility companies to harden overhead utility lines and manage vegetation. Forty responded yes and twenty two responded no.

Participants were asked for their thoughts regarding flood insurance in response to changes that are underway that will increase flood insurance premiums nationwide. The responses are summarized in Table 1-8.

Table 1-8
Responses Regarding Increased Flood Insurance Premiums

Actions	Number of Participants Selecting
I do not have flood insurance and have no opinions about it.	32
I currently have flood insurance and am not concerned about changes in the premium.	1
I currently have flood insurance and will be looking for ways to reduce my premiums, such as elevating my home.	1
I would be supportive of my town looking for ways to reduce flood insurance policies for all policyholders.	25
Other	16

The next question asked what are the most important things that your town government can do to help its residents or organization be prepared for a disaster, and become more resilient over time. Responses are presented in Table 1-9.

Table 1-9
Most Important Community Mitigation Measures Based on Survey Response

Actions	Number of Participants Selecting
Provide outreach and education to residents, businesses, and organizations to help them understand risks and be prepared	39
Provide technical assistance to residents, businesses, and organizations to help them reduce losses from hazards and disasters	28
Conduct projects in the community, such as drainage and flood control projects, to mitigate for hazards and minimize impacts from disasters	30
Make it easier for residents, businesses, and organizations to take their own actions to mitigate for hazards and become more resilient to disasters	22
Improve warning and response systems to improve disaster management	23
Enact and enforce regulations, codes, and ordinances such as zoning regulations and building codes	26

When asked if the responder has taken any actions to reduce the risk or vulnerability to his or her family, home, or organization, responses were as presented in Table 1-10.

Table 1-10
Personal Mitigation Measures Taken Based on Survey Response

Actions	Number of Participants Selecting
Elevated my home or business to reduce flood damage	0
Floodproofed my business to reduce flood damage	2
Installed storm shutters or structural/roof braces to reduce wind damage	2
Taken measures to reduce snow build-up on roofs	29
Cut back or removed vegetation from my overhead utility lines or roof	27
Replaced my overhead utility lines with underground lines	8
Managed vegetation to reduce risk of wildfire reaching my home or business	15
Developed a disaster plan for my family, home, or business	24
Maintain a disaster supply kit for my family, home, or business	34
Participated in public meetings to discuss the Plan of Conservation and Development or open space plans	15
Participated in public meetings to discuss and approve changes to zoning or subdivision regulations	15
I have not taken any of these actions	3

When asked "If you could choose one action that could be taken in your town to reduce vulnerability to hazards and the disasters associated with these hazards, what would it be," a participant from Canaan answered with the following:

- Better maintenance of power lines and faster repair.

When asked to provide any additional comments or questions to be addressed as the town updates its hazard mitigation plan, the following response was included:

- Communications are vital, and often lost due to service outages.

A total of thirty participants provided additional contact information for follow-up.

Overall, the survey revealed that NWCCOG residents see hurricanes, tropical storms, and winter storms as having the highest threat and impacting their own homes the most. Residents are primarily concerned with risks to power lines and overhead utilities during winter and wind storms, and desire more maintenance and removal of trees. Secondary to the concerns about trees and power outages, a few residents have concerns about flooding.

Public Participation Summary

The resident of Canaan that participated in the survey reported that Sand Road and Route 126 were vulnerable to flooding due to an inadequate drainage system, and that flooding occurs along Route 126 due to Robbins Swamp. This resident also stated that power line maintenance needed to be improved and repairs needed to be faster after storms; and indicated that communications are vital but are often lost during outages. These comments have helped inform mitigation strategies described in Chapters 3, 4, 5, and 6; and the four "all hazard" actions listed at the bottom of page 10-1.

Opportunities for the public to review the Plan will be implemented in advance of the public hearing to adopt this plan in 2014. The draft Plan that is required to be submitted to FEMA for review and approval was first posted on the Town website (http://www.canaanfallsvillage.org/) for public review and comment.

1.7 Coordination with Neighboring Communities

For adjacent communities that are part of the NWCCOG, the monthly NWCCOG meetings provided a continuing forum for towns to collaborate and share thoughts about hazards that may span municipal boundaries.

For adjacent communities that are not part of the NWCCOG, 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

The Town of Canaan is located in northwest Litchfield County and is home to a population of approximately 1,100 residents. Canaan is bordered by the municipalities of Cornwall to the south, Norfolk to the east, North Canaan to the north, and Salisbury to the west. Refer to Figures 2-1 and 2-2 for maps showing the regional location of Canaan within the NWCCOG region.

Canaan is located in the northwest region of Connecticut in an area known as Litchfield Hills. The topography of the town is characterized by steep slopes, rocky hills, small hills and valleys, and generally rolling terrain. The Housatonic River, the Hollenbeck River, Wangum Lake Brook, and numerous other small rivers and streams course through the town. The varying terrain of Canaan makes the town vulnerable to an array of natural hazards.

2.2 Existing Land Use

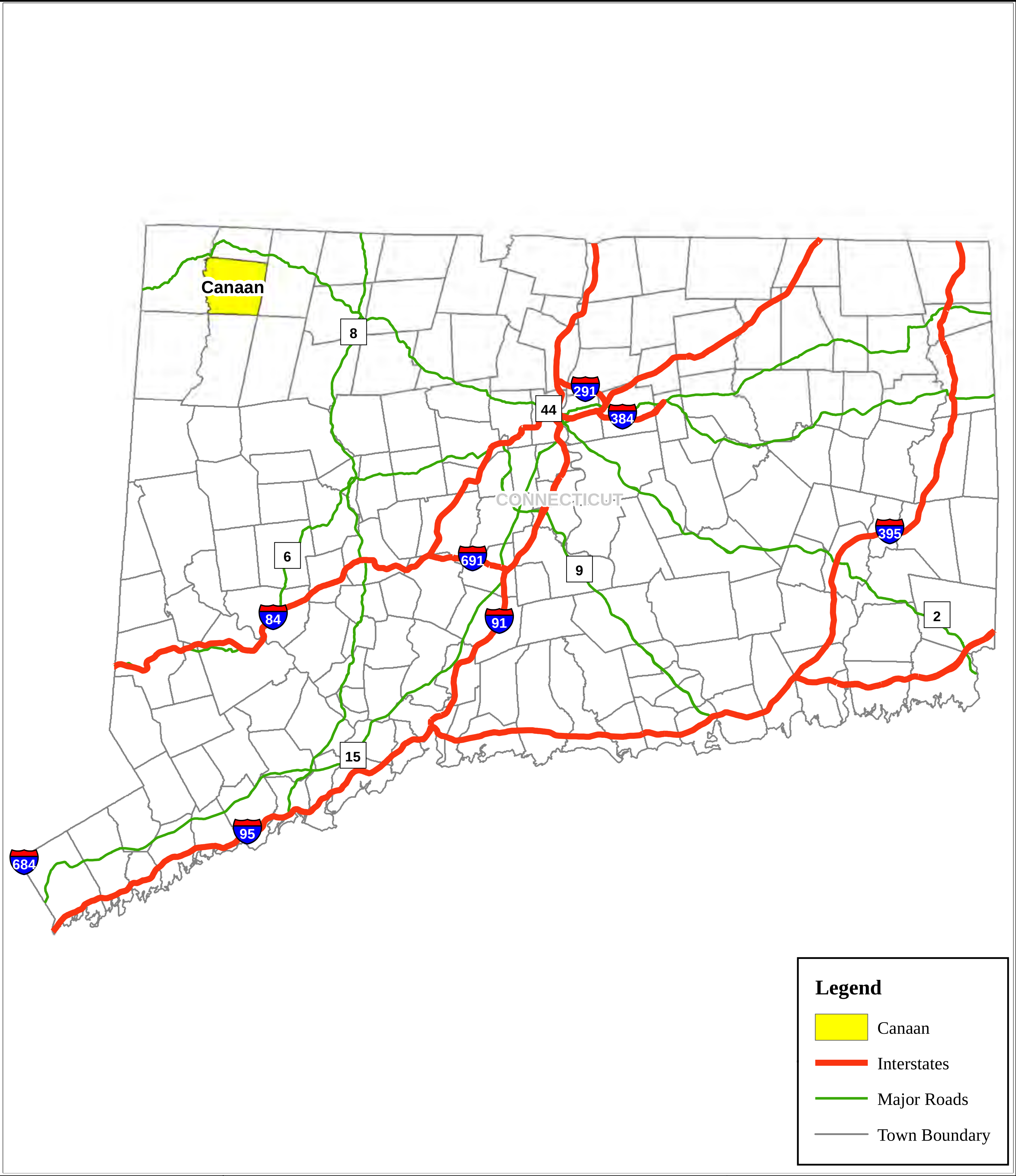
Canaan is a picturesque rural town of approximately 33 square miles, situated east of the Housatonic River. The town is often referred to as Falls Village.

According to the 2013 Plan of Conservation and Development, approximately 55% of the total land area is dedicated or managed open space. Table 2-1 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. According to this data, about 80% of Canaan is forested and approximately 4.7% is developed.

Table 2-1
2006 Land Cover by Area

Land Cover	Area (acres)	Percent of Community
Deciduous Forest	10,013	47.2%
Developed	1,003	4.7%
Turf & Grass	358	1.7%
Coniferous Forest	5,199	24.5%
Agricultural Field	1,762	8.3%
Forested Wetland	1,760	8.3%
Water	355	1.7%
Other Grasses	416	2%
Barren	62	0.3%
Utility (Forest)	65	0.3%
Non-Forested Wetland	219	1%
Tidal Wetland	0	0%
Total	**21,212**	**100%**

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



SOURCE(S):
CT DEEP

Figure 2-1: Canaan Location Map

LOCATION:
Canaan, CT

N

Town of Canaan
Natural Hazard Mitigation Plan

MXD: P:\3843-04\GIS\Maps\Canaan\Figure 2-1-Canaan Location Map.mxd

Map By: JDW
MMI#: 3843-04
Original: 12/9/2013
Revision: 1/23/2014
Scale: 1 inch = 13 miles

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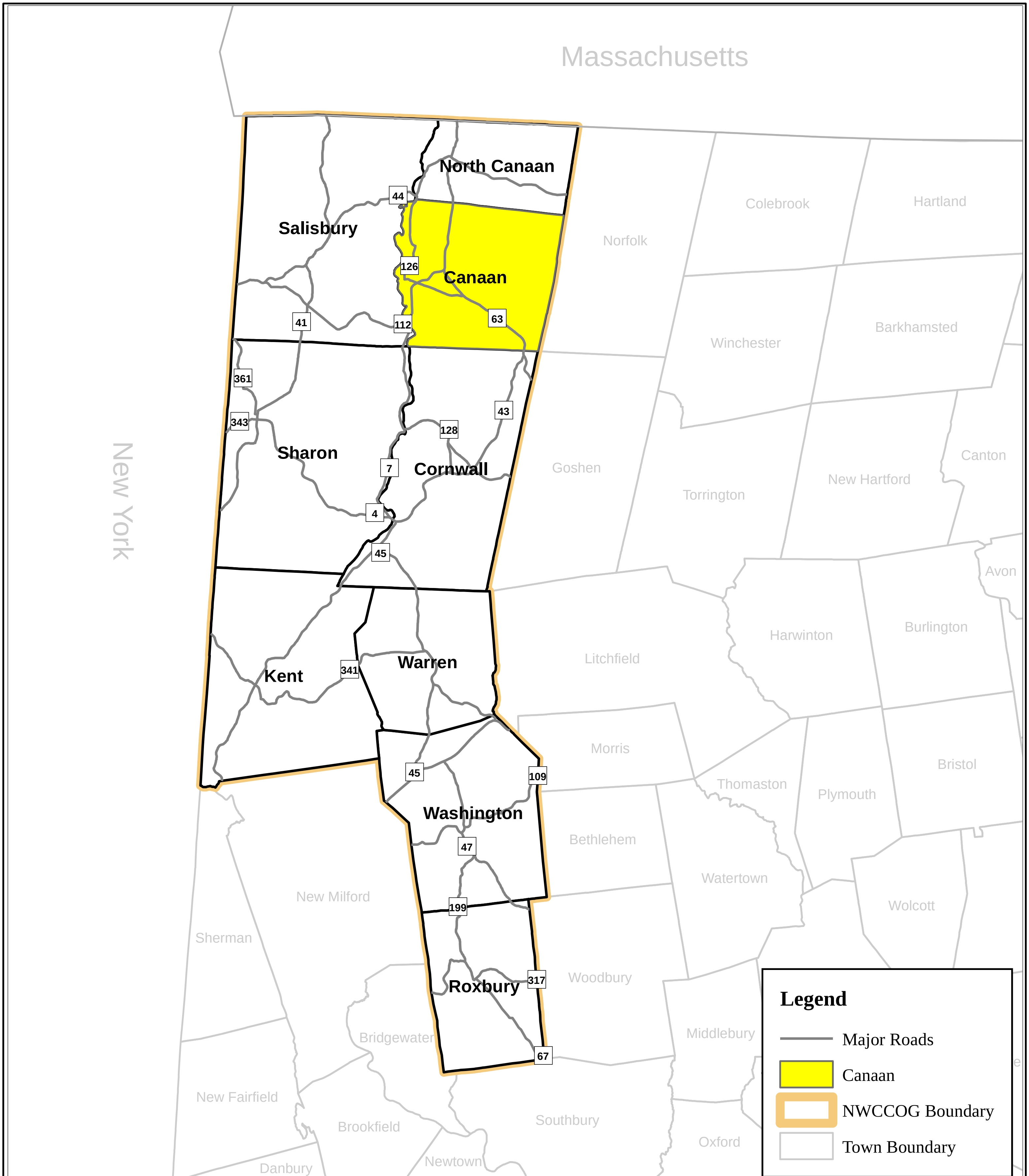

SOURCE(S):
CT DEEP

Figure 2-2: Canaan in the NWCCOG

LOCATION:
Canaan, CT

N

Town of Canaan
Natural Hazard Mitigation Plan

MXD: P:\3843-04\GIS\Maps\Canaan\Figure 2-2- Canaan NWCCOG.mxd

Map By: JDW
MMI#: 3843-04
Original: 12/9/2013
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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 Canaan. The following discussion highlights Canaan's geology at several regional scales. 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.

Canaan is underlain by relatively hard metamorphic and igneous bedrock including a variety of gneiss, schist, marble and granite (Figure 2-4). The bedrock formations trend generally north to south.

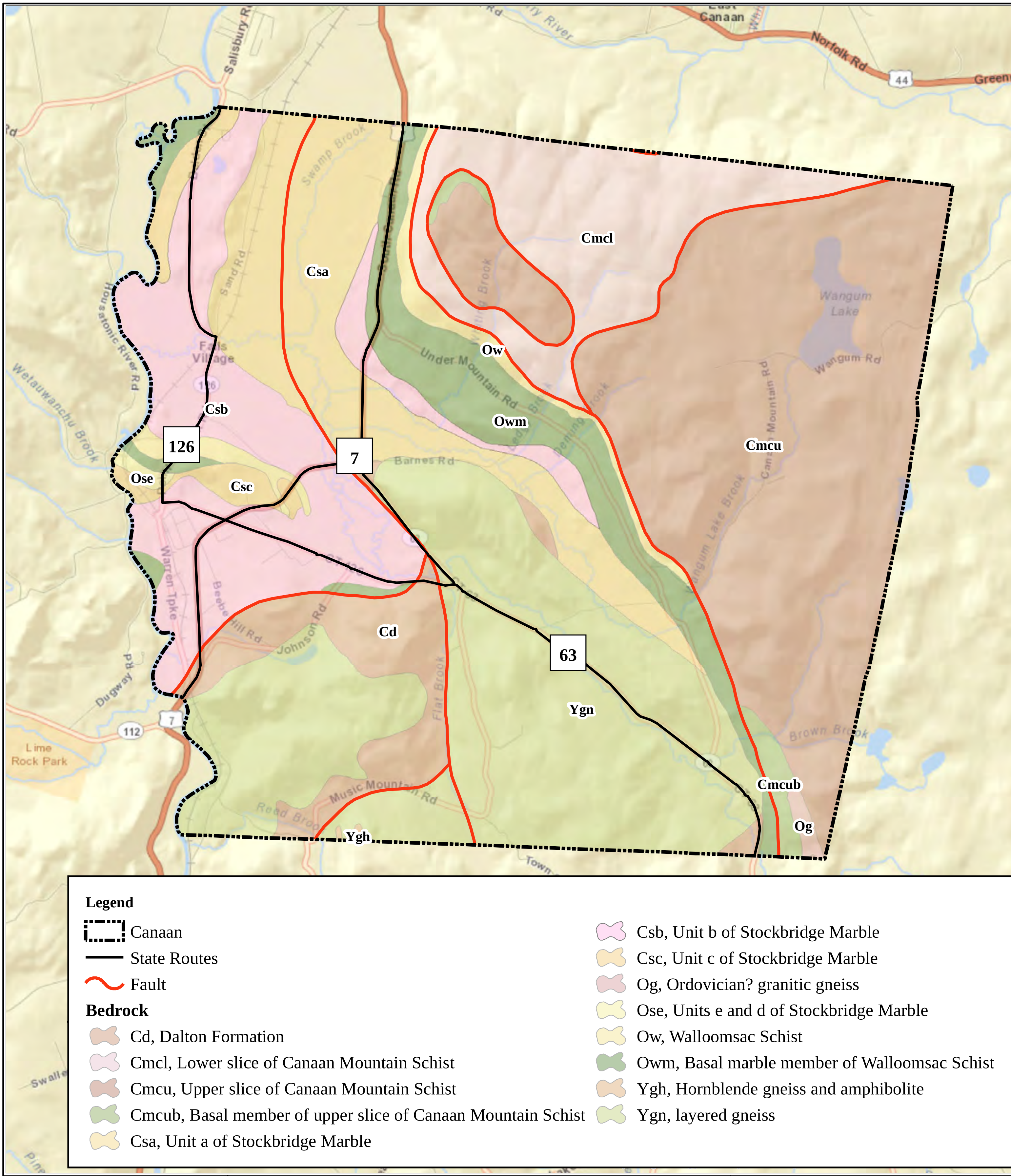
The amount of stratified glacial meltwater deposits present in a community is important as areas of stratified materials are generally coincident with inland floodplains. These materials were deposited at lower elevations by glacial streams, and these valleys were later inherited by the larger of our 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 Canaan 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, Canaan'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.

Canaan is covered primarily (nearly 7%) by glacial till. Tills contain 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 River, Hollenbeck River and Wangum Lake Brook. These deposits primarily contain stratified sands and gravels.

2.4 Climate

Canaan has a climate characterized by moderate but distinct seasons. The mean annual temperature is 48.4 degrees Fahrenheit based on temperature data compiled by the National Climatic Data Center (NCDC), Falls Village weather station, from 1981 to 2010. 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 20.5 inches per year. Mean annual precipitation is 45.8 inches.



SOURCE(S): CT DEEP

Figure 2-3: Bedrock Geology

LOCATION: **Canaan, CT**

Town of Canaan
Natural Hazard Mitigation Plan

MXD: P:\3843-04\GIS\Maps\Canaan\Figure 2-3- Canaan Bedrock Geology.mxd

Map By: JDW
MMI#: 3843-04
Original: 12/10/2013
Revision: 1/22/2014
Scale: 1 inch = 1 mile

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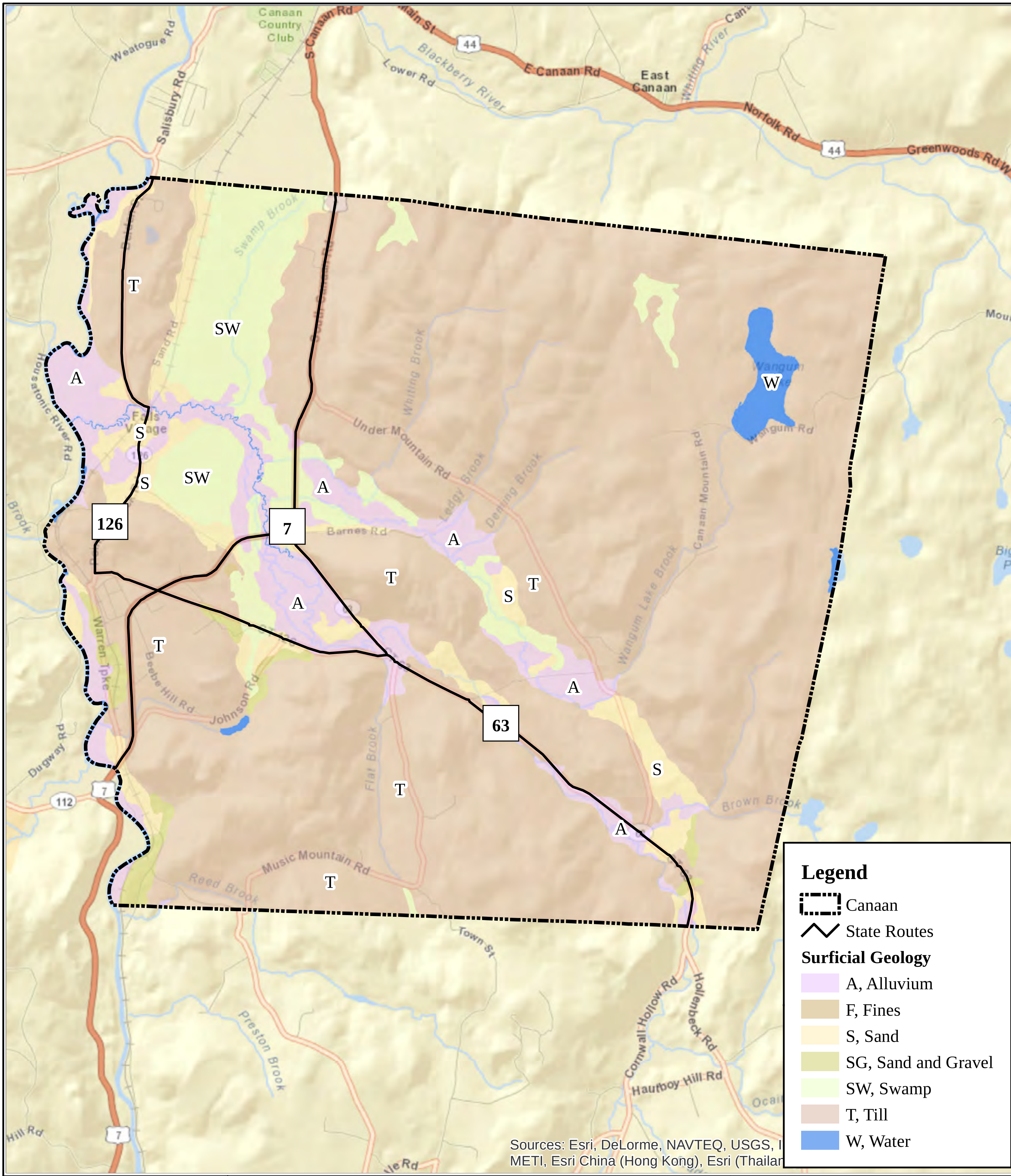

SOURCE(S):
CT DEEP

Figure 2-4: Surficial Geology

LOCATION: **Canaan, CT**

N

Town of Canaan
Natural Hazard Mitigation Plan

MXD: P:\3843-04\GIS\Maps\Canaan\Figure 2-4-Canaan Surficial.mxd

Map By: JDW
MMI#: 3843-04
Original: 12/10/2013
Revision: 1/22/2014
Scale: 1 inch = 1 mile

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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 19th century (Miller et. al., 1997; NCDC, 2005). Likewise, annual precipitation in the town has increased over time.

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.

Like many rural towns near suburban areas in the United States, Canaan experienced a moderate population boom following World War II. This population increase led to concomitant increases in 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 the Stream Habitat Continuity project summary page found in Appendix D.

2.5 Drainage Basins and Hydrology

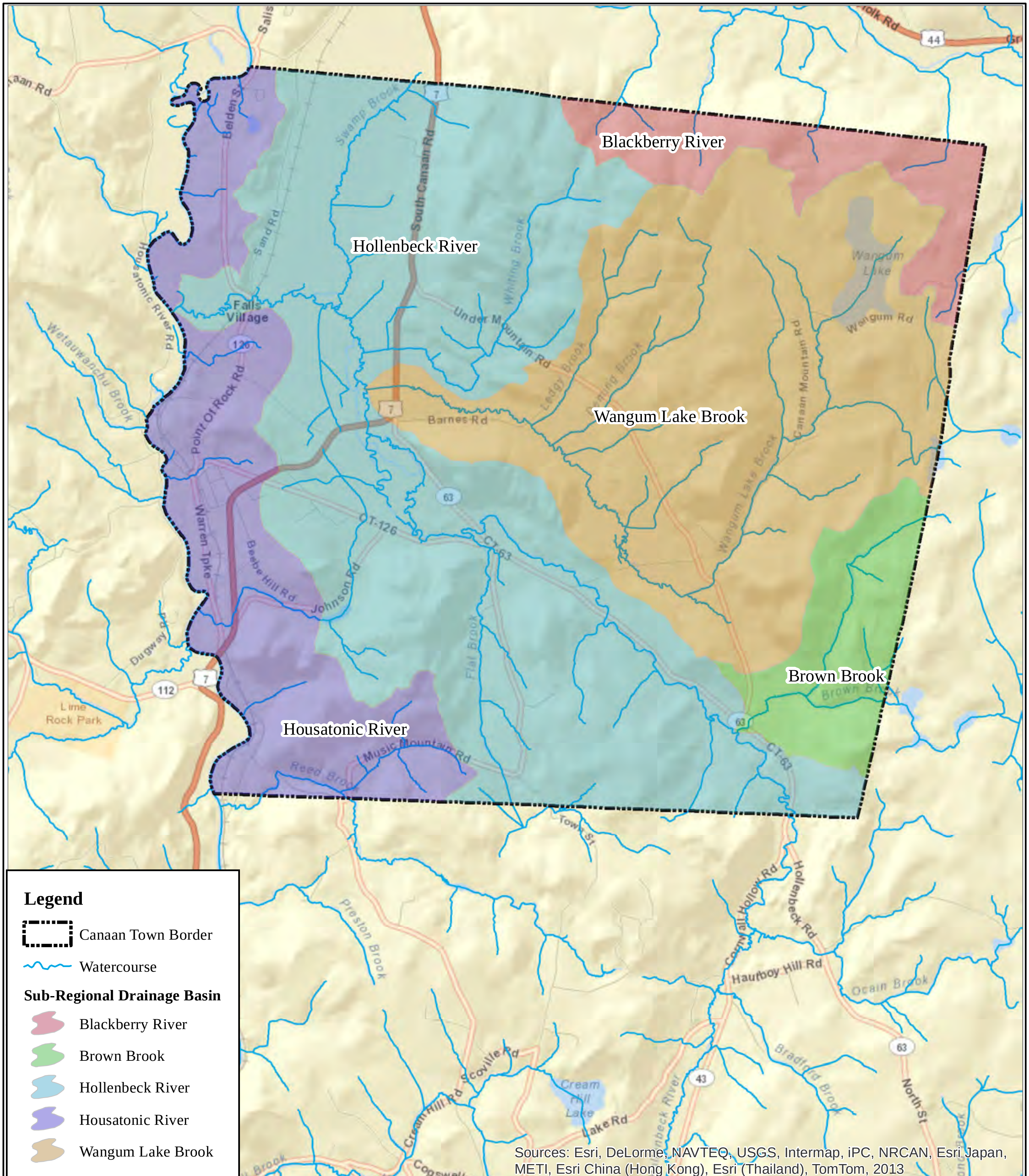
Canaan is divided among the following five subregional drainage basins: Hollenbeck River, Housatonic River, Wangum Lake Brook, Blackberry River and Brown Brook. The watersheds are as shown on Figure 2-5 and described in detail below. The majority of the drainage basins have FEMA-defined Special Flood 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 including Salisbury, North Canaan, Canaan and just south, Sharon and Cornwall. In Canaan, the Housatonic River meanders along Route 7 before entering neighboring Cornwall. 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 100-year floodplains that extend on either side of the river with areas that further extend making up the 500-year floodplains.

Hollenbeck River

Flowing with a northern orientation, the headwaters of the Hollenbeck River begin in Cornwall, just south of Canaan. The drainage basin begins in the northeast corner as it flows into Canaan. The Hollenbeck River enters Canaan in the vicinity of Route 63 and generally meanders in a north-northwest direction until it flows into the Housatonic River to the west of Point of Rock Road. Many tributaries enter into the main channel of the river including Brown Brook and Wangum Lake Brook both which make up sub drainage basins of their own. This pattern of flow has created extensive 100-year floodplains surrounding the last couple miles of river stretch before reaching the Housatonic. Two low hazard classified dams sit along the Hollenbeck River, one in Canaan holding back the Hollenbeck Pond Dam and the other in Cornwall just off Bradford Brook called Van Doren Pond Dam.



SOURCE(S): CT DEEP	Figure 2-5: Sub-Regional Drainage Basins	LOCATION: Canaan, CT

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MXD: P:\3843-04\GIS\Maps\Canaan\Figure 2-5- Canaan Sub-Regional Drainage Basins.mxd

Map By: CMP
MMI#: 3843-04
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Revision: 1/23/2014
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Wangum Lake Brook

Beginning at Wangum Lake, Wangum Lake Brook flows out of the south end continuing south and eventually shifts to the northwest. A single dam is in place at the southern tip of Wangum Lake where the river begins to flow and it is classified as a significant hazard dam. Some small tributaries enter into the brook from the north including Ledgy, Whiting, and Deming Brooks. The river begins to meander heavily for the second half of its extent and becomes adjacent to the also highly sinuous Hollenbeck River. Wangum Lake Brook ends where it flows into the Hollenbeck River. The 100-year floodplains associated with the Hollenbeck River and Wangum Brook merge and become vast.

Blackberry River

The Blackberry River drainage basin is part of a large network of converging streams covering a land area of around 27 square miles. With much of the headwaters in Norfolk, a few large ponds feed the tributaries that flow into the Blackberry River including Bigelow Pond, Tobey Pond and Wood Creek Pond. A few small tributaries begin in Canaan and flow north intersecting with the Blackberry River, responsible for the drainage of the northeast edge of Canaan. The majority of the drainage lies within Norfolk and North Canaan, with a small portion located in the northeast corner of Canaan. The river flows west along Route 44 into North Canaan and flows into the Housatonic River.

Brown Brook

Brown Brook makes up a 5.6 square mile drainage basin with the mouth emptying into the Hollenbeck River. Only a quarter of the basin sits in Canaan while the headwaters and majority of land area reside in Norfolk. The river drains a series of three ponds including Wampee, Bear Swamp and Wapato Ponds and flows to the west receiving input from the North Branch of Brown Brook before reaching the Hollenbeck River.

Overall, the Town of Canaan is primarily at risk from flooding from the Housatonic River, the Hollenbeck River and several brooks and swamps that are tributaries to these watercourses.

2.6 Population and Demographic Setting

According to the U.S. Census, the Town of Canaan had a population of 1,081 in the year 2000. Canaan had a population of 1,234 in 2010, an increase of 14.1%. According to the Town Plan of Conservation and Development (POCD), "this is relatively significant growth for Falls Village (between 1990 and 2000, the population only increased by 24 people). However, this growth rate is not projected to continue. Population projections from the Connecticut State Data Center show that over the next 15 years (between 2010 and 2025) the *total number of Canaan residents will stay the same or grow only slightly* (the least conservative projection shows an increase of 53 people)."

As noted in Table 2-2, Canaan ranks ninth out of the nine NWCCOG municipalities in Connecticut in terms of population.

Canaan has a limited population of people who are linguistically isolated and moderate population of elderly individuals. According to data collected by the U.S. Census Bureau for the period around 2010, 14.2% of the population is aged 65 or over, 0.8% speak English "less than very well."

Elderly, linguistically isolated, and disabled populations have numerous implications for hazard mitigation as they may require special assistance or different means of notification before and during natural hazards.

Table 2-2
Population by Municipality and Region, 2010

NWCCOG Municipality	2010 Population
Warren	1,461
Salisbury	3,741
North Canaan	3,315
Canaan	1,234
Sharon	2,782
Cornwall	1,420
Kent	2,979
Washington	3,578
Roxbury	2,262

Source: Census 2010

2.7 Governmental Structure and Capabilities

The Town of Canaan 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, Inland Wetland Commission, the Zoning Officer, the Building Official, the Fire Department, Emergency Medical Services, and the Highway Department. The Emergency Management Director coordinates emergency preparedness in the Town.

Drainage complaints are routed through the First Selectman's office and the highway department. These complaints are usually received via phone, mail, or email and are recorded in a logbook. The complaints are investigated as necessary until remediation surrounding the individual complaint is concluded.

2.8 Development Trends

According the Town Plan of Conservation and Development, there were 636 total housing units in 2012. The lack of affordable housing in Canaan has directly affected the town’s ability to attract new residents. However, the recent economic downturn was also a contributor and generally slowed housing development in Canaan from 2007 through 2011.

New development in Canaan is minimal and is generally limited to single family homes. However, town officials have indicated that they have obtained an Incentive Housing Zone grant and have applied for the next phase of $50,000. This grant will allow an interested party to conduct appropriate engineering studies on a parcel of land within the incentive zone located on River Road. This could eventually lead to future development within the Town of Canaan.

While there is certainly acreage in the town for additional growth, it is unlikely that development would occur on much of the land due to unsuitable construction conditions such as steep slopes, wetlands and/or floodplains. In addition, approximately 55% of the towns land area is dedicated or managed open space.

Any future growth within the town will need to be addressed in a manner that is in the best interest of the town by maintaining the overall character and rural feel of the community.

2.9 Critical Facilities, Sheltering Capabilities, and Emergency Response Capabilities

Canaan has identified six critical facilities, such as fire, and governmental buildings as well as utilities which are required to ensure that day-to-day management of the town continues. Other facilities such as senior centers and schools are also considered critical facilities since these contain populations that are more susceptible in an emergency or house important supplies. Not all municipal buildings are critical facilities. Table 2-3 presents a list of critical facilities in Canaan.

Table 2-3
Critical Facilities

Facility	Address or Location	Comment	Emergency Power?	Shelter?	In 1% Annual Chance Floodplain?
Falls Village Fire Department	35 Railroad Street	Emergency Operations Center and Primary Shelter	✓	✓	No
Town Hall	108 Main Street	Critical Records/ Back-up shelter	✓	✓	No
Lee H. Kellogg School	47 Main Street	Public School			No
Highway Garage	100 Railroad Street	Regional Emergency Support	✓		No
Senior Center	107 Main Street	Senior Housing			No
Falls Village Day Care Center	35 Page Road	Day Care Facility			No

Sheltering Capabilities

Emergency shelters are an important subset of critical facilities as they are needed in many emergency situations. The Falls Village Fire Department is the primary shelter and the Town Hall is the secondary shelter. Both facilities have standby power. In case of a sustained power outage, it is anticipated that 10 to 20% of the population (110 to 220) would relocate, although not all of those relocating would necessarily utilize the shelter facilities.

It should be noted that at this time the town does not have a full-fledged shelter (i.e. cooking and shower facilities). However, a referendum approved in December 2013 approved $2.3 million in a general obligation bond to finance the remainder of the cost associated with the construction of a new Emergency Management Services facility at 188 Route 7 South along the Housatonic River.

The facility will house the fire and ambulance services and once completed will operate as the official shelter. It is expected that construction will commence in 2014-2015. Due to the proximity of the facility to the Housatonic River, it is important to ensure that the facility is sited outside the SFHA to minimize potential flood impacts. In Connecticut, critical facilities cannot be constructed in SFHAs and 500-year flood zones.

Emergency Response Capabilities

The Emergency Management Director and the Falls Village Fire Department coordinate emergency preparedness in the Town of Canaan. That department develops plans, protocols, and procedures that assure the safety of Canaan's citizens. It also provides training for emergency response personnel, supports state and local emergency response exercises, and provides technical assistance to state and local emergency response agencies and public officials. Its goal is to provide citizens with the highest level of emergency preparedness before, during, and after disasters or emergencies.

The Town's Emergency Operations Center (EOC), including its Emergency Communications Center, is located at the Fire Department.

The Town has an EOP that guides its response to emergencies arising from both natural and anthropogenic hazards. The Town is in the process of subscribing to the CT Alert emergency notification system which directs geographically specific emergency notification telephone calls into affected areas.

State and federal roads are the major transportation arteries (and therefore evacuation routes) into and out of the town. In Canaan, Route 7, is integral in transporting patients to area hospitals.

Emergency services can also be cut off by fallen trees or washed out culverts during certain emergencies. The Town performs tree and tree limb removal, with a focus on critical roadways. During emergencies and following storms, the highway garage responds to calls related to downed trees.

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, sewer backup, or overbank flooding from minor streams.

In general, the potential for flooding is widespread across Canaan, with the majority of major flooding occurring 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 common 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 Canaan is considered likely for any given year, with flood damage potentially having significant effects during extreme events.

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 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.

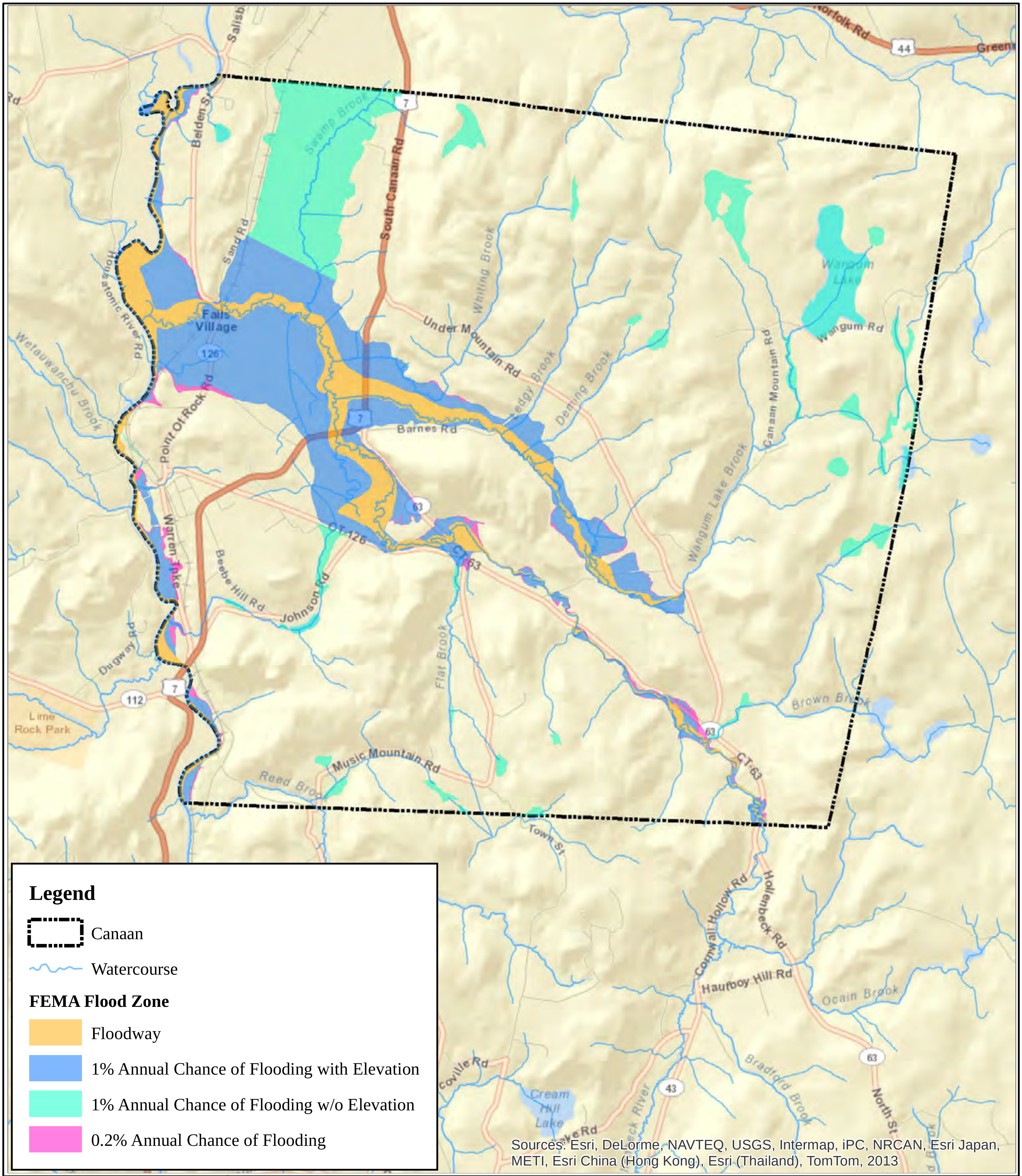
***Floodplains** are lands along watercourses that are subject to periodic flooding; **floodways** are those areas within the floodplains that convey the majority of flood discharge. Floodways are subject to water being conveyed at relatively high velocity and force. The **floodway fringe** contains 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% chance 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 May 3, 1974 and intends to continue participation in the NFIP. SFHAs in Canaan are delineated on a Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS). The FIRM delineates areas within Canaan that are vulnerable to flooding and was most recently published on September 2, 1988.

A regulatory floodplain with AE designation has been mapped along the Housatonic River, the Hollenbeck River, the Blackberry River and many tributaries. Wangum Lake also has an AE designation. 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 Canaan susceptible to flooding based on FEMA flood zones. Table 3-1 describes the various zones depicted on the FIRM panel for Canaan.

According to the Town of Canaan FIS, "one aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the one percent annual chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the base flood can be carried without substantial increases in flood height."



SOURCE(S):
CT DEEP
FEMA

Figure 3-1: FEMA Special Flood Hazard Areas

LOCATION: **Canaan, CT**

Town of Canaan
Natural Hazard Mitigation Plan

MXD: P:\3843-04\GIS\Maps\Canaan\Figure 3-1- Canaan FEMA Flood Hazard.mxd

Map By: JDW
MMI#: 3843-04
Original: 10/8/2013
Revision: 1/23/2013
Scale: 1 inch = 1 mile

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Therefore, floodways are essential tools for local municipalities to utilize in determining minimum standards by either adopting them directly or utilizing them as a basis for additional floodway studies. A floodway designation has been mapped along portions of the Housatonic River and the Hollenbeck River.

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 nuisance 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 prestorm 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

The Town of Canaan has experienced various degrees of flooding in every season of the year throughout its recorded history. Melting snow combined with early spring rains has caused frequent spring flooding. Numerous flood events have 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.

In general, potential flooding problems in Canaan are concentrated along the Housatonic and Hollenbeck Rivers. The highest risk areas along these rivers include Routes 7, 63 and 126. Town officials have also noted that a few years ago the Housatonic flooded the athletic fields at the Housatonic Valley Regional High School. Sand Road in the vicinity of Robbins swamp (the northern part of Route 126) has also been identified as an area of concern.

The most significant flooding in the recorded history of Canaan and Falls Village was the flooding of 1955 associated with Hurricanes Connie and Diane. As noted in Section 4.3, 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. Flooding was particularly severe in the Canaan/Falls Village area, with significant flooding along the Housatonic River and its tributaries.

According to the NCDC Storm Events Database, since 2000 there have been approximately 40 flooding and flash flooding events in Litchfield County. The following are descriptions of historic floods in or adjacent to the Town of Canaan 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.

- July 13, 1996 – The remnants of Hurricane Bertha tracked from the mid-Atlantic region northeast to Quebec, Canada dropping 3 to 5 inches of rain across Litchfield County. This caused flooding of several streams throughout the county along with scattered power outages from wind-blown tree branches onto wires.

- January 19-21, 1999 – Mild weather and rain resulted in rapid melting of snow between January 19th and 20th in Litchfield County. Runoff as well as ice jams breaking up triggered flooding of the Housatonic and Pomperaug Rivers.

- July 29, 1999 – A strong warm front and wind shear aloft produced locally strong thunderstorms across northwestern Connecticut, depositing dime sized hail in Cornwall, south of Canaan.

- September 16, 1999 – The remnants of Hurricane Floyd moved across the eastern seaboard on September 16 and the early hours of the 17th dropping 5 to 8 inches of rainfall in northwestern Connecticut. Specific rainfall amounts included 5.20 inches at Falls Village, 6.35 inches at Colebrook Dam, 7.89 inches at Bulls Bridge and 8.28 inches at Bakersville. Wide spread flooding was prevalent across the region including the Housatonic and Shepaug Rivers and many small streams and tributaries. The rains proved to be destructive flooding and washing out portions of roadways including Route 7 in several areas.

- June 7-9, 2000 – An area of low pressure developed over the Delmarva Peninsula and continued up the coast becoming a full blown nor'easter. Severe rains dumped over

Litchfield County totaling 3.53 inches at Bakersville, 3.87 inches at Bulls Bridge and 2.53 inches at Thomaston Dam. The runoff caused the Housatonic River to rise above flood stage between June 7th and 9th.

- July 15, 2000 – Heavy rainfall from a stalled frontal boundary that interacted with an upper level disturbance, left 3 inches to locally 5 inches of rain in northwestern Connecticut. The runoff caused the Aspetuck River to rise quickly over its banks and flooding was noted on Route 7 in Falls Village. Runoff from the heavy rains also caused the Housatonic River to rise above the seven foot stage at Falls Village but only for a brief time.

- October 9-15, 2005 – Heavy rain fell over western Connecticut through the early morning hours of October 9. During this period, there was over 6 inches of rainfall in much of western New England, triggering widespread flooding. Route 63 in Falls Village was closed due to flooding. The Housatonic River had a flood crest of 7.74 feet at Falls Village, on October 15. Flood stage is 7 feet.

- January 25, 2010 – Heavy rainfall fell across Litchfield County and in addition, warm temperatures caused melting of the snow pack leading to excessive runoff. Flash flooding occurred as heavy rain fell on the frozen ground as well as reports of mud and rock slides. One and a half to two and a half inches of rain were reported across the county.

- 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. Much of the rain had fallen within a 12 hour period and in Litchfield County totals ranged from 5 to 10 inches. Numerous road closures were reported due to flooding, downed trees and power lines causing some evacuations and widespread, long duration power outages. In addition, moderate flooding was reported on the Housatonic River at Falls Village and at Gaylordsville. The Gaylordsville gage was damaged by flood waters. Winds gusted between 35 and 55 mph with stronger gusts exceeding 60 mph causing blow downs of tree with assistance of highly saturated soils. Approximately 25,000 customers were affected by power outages and a Major Disaster Declaration was declared by FEMA.

- Widespread flooding occurred in Canaan during Irene, causing washouts and road closures throughout the town. Power outages were reportedly less than 24 hours.

- September 6, 2011 – A slow moving frontal boundary gradually moved eastward across northwest Connecticut. In addition, copious amounts of moisture from the remnants of Tropical Storm Lee, which made landfall along the Gulf coast, interacted with the frontal system, producing additional heavy rainfall. Total rainfall amounts across northwest Connecticut for the period from Monday into Thursday ranged from 3 to 6 inches. Moderate flooding occurred on the Housatonic River in Licthfield County. The Falls Village river gage located near Water Street in Falls Village exceeded its 7 foot flood stage at 5 pm EST September 6th, its 10 foot moderate flood stage at 11:49 pm September 8th, it crested at 13.47 feet at 6 am September 9th, then remained above its moderate flood stage until 7:15 am September 11th, and finally fell below flood stage at 2:34 pm September 12th. The Gaylordsville river gage located near Route 7, Kent Road, less than a mile north of the Village of Gaylordsville exceeded its 8 foot flood stage at 6 pm EST September 6th, its 10 foot moderate flood stage at 5 pm September 7th, then remained above its moderate flood stage until 9 am September 11th, and finally fell below flood stage at 3 pm September 12th.

3.4 Existing Capabilities

The Town of Canaan has Zoning and Subdivision 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 are used to update the 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:

- ***Flood Hazard Control Measures***: The Town's "Flood Hazard Control Measures" are essentially the local version of the NFIP regulations and are included in the Town of Canaan Ordinances which were adopted in 1988 and revised through 2007. This section of the ordinances deal with Floodplain Management, including establishing areas of special flood hazard, restrictions, development permit requirements, permitted uses, and standards for flood hazard reduction.

  - Section 6(a) states that "new construction or substantial improvement of any residential structure shall have the lowest floor, including basement, elevated at least to two feet above the base flood elevation."
  - Section 6(b) states that "new construction or substantial improvement of any commercial, industrial, or non-residential structure located in Zone Al-30, AE & AH shall have the lowest floor, including basement, elevated at least to two feet above the level of the base flood elevation; or Non-residential structures located in all A-Zones may be flood proofed in lieu of being elevated..."

- ***Zoning Regulations:*** The Zoning regulations were most recently revised in April 27, 2011 and are intended to help maintain and enhance community character and help protect the public health safety and welfare.

  - Section 4.1 outlines the standards for the Housatonic River Overlay Zone and states that "the purpose of this Section s to protect a carefully defined corridor of land along the Housatonic River which is flood prone, environmentally sensitive, and possesses many valuable natural resources."
  - Section 4.2 outlines standards for the Floodplain Overlay Zone and states that this Zone is intended to provide a reasonable degree of notification to persons regarding the location of property which may be subject to the effects of flooding."

- ***Inland Wetlands and Watercourse Regulations***. The regulations were adopted in 1973 and amended in 1975. The purpose of the inland wetlands and watercourses regulations is to protect the quality of the inland wetlands and watercourses within the Town of Canaan 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 1.1 defines "Regulated Activity" as any operation or activity 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, but shall not include the specified activities in Section 2 of these regulations.
  - Section 2-2 states a residential home for which a building permit has been issued or on a subdivision lot, providing the permit has been issued or the subdivision approved as of the effective date of these regulations shall be permitted as of right.
  - Section 3 states that subject to the provisions of Section 2 hereof, regulated activities affecting the wetlands and watercourses of the Town are prohibited except as they may be licensed by the Commission, as herein provided.

- ***Plan of Conservation and Development.*** This 2013 document is the Town's vision statement for future development. It is updated every 10 years.

  - Planning Visions for Falls Village (Page 20) recommends balancing future open space planning with development needs.
  - Planning Visions for Falls Village (Page 21) recommends updating the Inland Wetland and Watercourse Regulations to reflect the most recent DEEP Model Floodplain Management Regulations.
  - Planning Visions for Falls Village (Page 21) recommends reviewing the floodplain ordinance to ensure it meets the National Flood Insurance Program requirements.

  The latter two bullets above have directly led to a mitigation action listed in Section 3.7.

- ***Subdivision Regulations.*** Adopted in 2003, the Town's Subdivision Regulations 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 4.03 states that subdivisions shall be designed and arranged and provisions made to preserve natural features; make best use of the terrain; prevent pollution of wetlands, watercourses and waterbodies; protect the quality and quantity of water supplies and minimize flood damage.
  - Section 4.12(1)(a) states that the subdivider shall be fully responsible for constructing adequate facilities for the control, collection, conveyance and acceptable disposal of stormwater, other surface water and subsurface water whether originating in the subdivision or in a tributary drainage area.
  - Section 4.12(2)(c)(iii) requires that storm drain facilities are constructed and in a manner that will not cause flooding of abutting property from the headwater and backwater produced by bridges, culverts and other structures.
  - Section 4.12(4) states that no storm drain system shall outlet into a natural watercourse, whether continually flowing or intermittent, so as not to exceed the capacity of the watercourse.
  - Section 4.16 states that in areas subject to flooding, proper provisions shall be made for protective flood control measures including, but not limited to the following: storm drainage shall be designed to reduce exposure to flood hazards; roads shall be of such an elevation or shall be suitably protected so as to allow emergency access during flood conditions; roads, drainage and other improvements shall be safe from flood damage; public and private improvements shall be designed to minimize flood damage and shall be capable of use without danger from flooding or flood related damages; all utilities and

services (including water, sewage and electric systems) shall be located and constructed to minimize or eliminate flood damage.

- Section 5.04(3) requires the submittal of a report by a registered professional engineer identifying the proposed drainage plan for the property, existing drainage areas, and the drainage treatment for different areas, including the methodology used to compute pipe sizes and drainage volumes.
- Section 5.04(4) requires the submittal of an erosion and sediment control plan.

Overall, the intent of these 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 Canaan 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 Canaan for participation in the NFIP

<u>NFIP, Flood Insurance, and Community Rating System</u>

Ms. Patricia Mechare, 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 NFIP requirements. Specifically, the town requires two feet of freeboard. The Town is not enrolled in the Community Rating System program.

<u>Drainage and Street Flooding</u>

There are areas of minor street flooding throughout the town, and these are addressed by the Highway Department as necessary. These typically relate to small areas and result in limited, if any, property impacts.

Town officials have noted that flooding often occurs along Sand Road (the northern section of Route 126) and Routes 7, 63 and 126. Much of this flooding is predominantly caused by the proximity of the roads to adjacent floodplain areas including the Housatonic River, the Hollenbeck River and Robbins Swamp. Flooding also occurs along Cobble Road; however this is predominantly due to beaver activity.

The Highway Department is in charge of the maintenance of the town's drainage systems and performs clearing of bridges and culverts and other maintenance as needed. Drainage complaints are routed to the Office of the First Selectman and the Highway Department. The Town uses these reports to identify potential problems and plan for maintenance and upgrades.

Structural Projects

The Amesville/Water Street Bridge which spans the Housatonic River between Salisbury and Falls Village is scheduled for replacement in 2014-15. This bridge is a conduit for the Falls Village Fire Department and Ambulance Services who serve the hamlet of Amesville in Salisbury. Since the bridge is currently closed, the replacement is critical to ensuring appropriate response times in emergency situations.

Communications

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.

In summary, the Town primarily attempts to mitigate future flood damage and flood hazards by restricting building activities in floodprone areas. This process is carried out through both the Planning and Zoning and the Inland Wetlands Commissions. All watercourses are to be encroached minimally or not at all to maintain the existing flood-carrying capacity These regulations rely primarily on the FEMA-defined 1% annual chance flood elevations to determine flood areas. With two feet of freeboard, the town exceeds the minimum criteria established by the NFIP.

3.5 Vulnerabilities and Risk Assessment

This section discusses specific areas at risk to flooding within the town. Flooding can impact a variety of river corridors and cause severe damages in the Town of Canaan but most often occurs in the Housatonic River watershed. Flooding due to poor drainage and other factors is also a persistent hazard 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 the Town of Canaan.

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 are within the 1% annual chance floodplain.

3.5.3 Vulnerability Analysis of Areas Along Watercourses

The primary waterways in the town are the Housatonic River and the Hollenbeck River. The remaining waterways in Canaan are mostly small streams and brooks. Recall from Section 2.5 that floodplains with and without elevations are delineated for the majority of the floodprone brooks in the town. The majority of the brooks have minimal flooding concerns.

As previously mentioned, the most frequently flooded areas in the town are adjacent to the Housatonic and Hollenbeck Rivers, specifically along Routes 7, 63 and 126. Flooding is common along Route 7 due to rising waters from the Housatonic and Hollenbeck Rivers. Of particular note is the low-lying area north of Page Road in the vicinity of Robbins Swamp.

It should also be noted that the portions of the Housatonic Valley Regional High School are located within the 1% annual chance floodplain (as shown in blue in the picture to the right). While it appears that the main building is sufficiently elevated, the proximity of the buildings to the River should be considered relative to potential flood damage.

In addition, it has been reported that the High School may become a regional shelter in the future. An evaluation of ingress and egress may need to be conducted due to the facilities location off of Route 7 (which is known to flood).

Town officials believe that the Robbins Swamp, located north and east of the Hollenbeck and Housatonic Rivers, respectively, is a major contributor to flooding in the town. Due to significant flood concerns, it may be beneficial to conduct a study of the Housatonic River and Hollenbeck River watersheds to determine the best measure for protecting residents, property and structures form future flooding and storm damage.

The Town discourages new construction and substantial reconstruction within the 1% annual chance floodplain by raising concerns during the floodplain permit process. However, given the historic development patterns of the town, many areas within floodplains were developed before floodplain management was even a consideration. New development is strictly managed through the Town's land use process.

Beaver Dams

The Town of Canaan is also concerned with flooding due to beaver activity and dam failures. This is a typical concern in many Connecticut communities. Unfortunately, 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.

Photo courtesy of NBC Connecticut.com

Town of Canaan officials have indicated that Cobble Road continually floods due to beaver activity. Culverts have been replaced throughout the years but it has not necessarily helped to alleviate flooding impacts. Historically, the land owners have not wanted to trap the beavers and therefore, the problem has been ongoing.

Music Mountain is also a chronic flooding area due to beaver activity. However, the land owners have been open to trapping and the flooding problems in this area are not as severe as they are on Cobble Road.

The town may consider replacing culverts frequently impacted by beavers with free span bridges or 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.

3.5.4 *HAZUS-MH* Vulnerability Analysis

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 Canaan from a 1% annual chance riverine flood event occurring along the Hollenbeck River, Housatonic River, and Wangum Lake Brook. 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 D. 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 $153 million of total building replacement value were estimated to exist within the Town of Canaan. Of that total, the HAZUS 1% annual chance riverine flood event estimates a total building-related loss of $15.89 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	$ 111,442,000
Commercial	$ 17,336,000
Other	$ 24,456,000
Total	**$ 153,234,000**

The *HAZUS-MH* simulation estimates that during a 1% annual chance flood event, eight buildings will be at least moderately damaged in the town from flooding. One of these buildings will be substantially damaged and uninhabitable. Table 3-3 presents the expected damages based on building type.

Table 3-3
***HAZUS-MH* Flood Scenario – Building Stock Damages**
Number of Structures Damaged

Occupancy	1-10% Damaged	11-20% Damaged	21-30% Damaged	31-40% Damaged	41-50% Damaged	Substantially Damaged
Residential	0	0	0	3	4	1
Commercial	0	0	0	0	0	0
Other	0	0	0	0	0	0
Total	**0**	**0**	**0**	**3**	**4**	**1**

HAZUS-MH utilizes a subset of critical facilities known as "essential facilities" that are important following natural hazard events. These include one fire station and two schools. The software noted that under the 1% annual chance flood event, none of these facilities would experience damage.

The *HAZUS-MH* simulation estimated that a total of 1,896 tons of debris would be generated by flood damage for the 1% annual chance flood scenario. It is estimated that 76 truckloads (at approximately 25 tons per truck) will be required to remove the debris. The breakdown of debris is as follows:

- Finishes (drywall, insulation, etc.) comprise 525 tons.
- Structural material (wood, brick, etc.) comprise 758 tons.
- Foundation material (concrete slab, concrete block, rebar, etc.) comprise 613 tons.

HAZUS-MH calculated the potential sheltering requirement for the 1% annual chance flood event. The model estimates that 36 households will be displaced due to flooding. Displacement includes households evacuated from within or very near to the inundated areas. Of these households, 17 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 $15.89 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 $3.7 million, commercial losses totaled $1.19 million, and other (municipal and industrial) losses totaled $11 million.

- Total building-related economic losses of $16.05 million are predicted if $0.16 million in business interruption losses are added to the building losses.

In summary, flooding is the most significant hazard to affect the Town of Canaan. Based on the historic record and *HAZUS-MH* simulations of the 1% annual chance flood events, the SFHAs and other areas are vulnerable to flooding damages, which can include direct structural damages, interruptions to business and commerce, emotional impacts, and injury or death.

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 Prevention

> ***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 ordinances. 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:

Planning and Zoning: Zoning and Subdivision ordinances in Canaan 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, including mandating the design and construction of storm drainage facilities provide for a zero percent increase in the peak rate of runoff at the discharge point(s) from the development unless specifically approved by the Commission.

Floodplain Development Regulations: The Town's floodplain ordinance states that the Building Official and the Zoning Administrator shall review all building permits for new construction or substantial improvements to determine whether proposed sites will be reasonably safe from flooding. If a proposed building is in a location that has flood hazard, any proposed new construction or substantial improvement must:

- ❑ Be designed (or modified) and anchored to prevent flotation, collapse, or lateral movement of the structure
- ❑ Use construction materials that are resistant to flood damage
- ❑ Use construction methods and practices that will minimize flood damage
- ❑ Be designed and/or have located electrical, heating ventalition, plumbing, air conditioning, and other service facilities so as to prevent water from entering or accumulating within the components during flooding conditions.

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 and exceed the minimum required elevation with two feet of freeboard required.

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).

Stormwater Management Policies: Development and redevelopment policies to address the prevention of flood damage must include effective stormwater management policies. Developers in Canaan 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.

Drainage System Maintenance: 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.

Education and Awareness: 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 Wetland 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 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:

- ***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.

⇨ ***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.

> ***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.*

⇨ ***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 Canaan residents to prevent damage from 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 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:

- ❑ Discourage development that would disconnect open spaces as discussed in the *Plan of Conservation and Development.*
- ❑ 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 flooding problems in the Town of Canaan are listed below.

Prevention

- ❑ Consider updating the Town's Inland Wetland Regulations[3], which were last amended in 1975, to incorporate certain elements of flood damage prevention. Note that the "Flood Hazard Control Measures" section of the town ordinances is the appropriate location for incorporating the most recent DEEP Model Floodplain Management Regulations.
- ❑ As recommended by the POCD, review the Flood Hazard Control Measures section of the town ordinances to incorporate the most recent DEEP Model Floodplain Management Regulations.
- ❑ 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.

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[3] The POCD recommends updating the Inland Wetland and Watercourse Regulations to reflect the most recent DEEP Model Floodplain Management Regulations, and reviewing the floodplain ordinance to ensure it meets the NFIP requirements.

Property Protection

- Encourage property owners to purchase flood insurance under the NFIP and to report claims when flooding damage occurs.
- Consider conducting a comprehensive evaluation of the Housatonic and Hollenbeck River watersheds to determine appropriate flood mitigation measures.
- Consider constructing a flood wall or berm around the side of the High School that is near the Housatonic River.

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.
- Ensure that the appropriate municipal personnel are trained in flood damage prevention methods.

Natural Resource Protection

- Pursue the acquisition of additional municipal open space inside SFHAs and set it aside as greenways, parks, or other nonresidential, noncommercial, or nonindustrial use.

Structural Projects

- Review culvert conveyances based on existing hydrology and Northeast Regional Climate Center guidance.
- 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.
- Consider replacing culverts frequently impacted by beavers with free span bridges.
- Consider the use of beaver deterrent devices such as beaver stops, beaver bafflers or beaver deceivers.

Emergency Services

- Ensure adequate barricades are available to block flooded areas in floodprone areas of the town.
- Ensure that the Emergency Management Service Facility is sited outside the SFHA and 500-year flood zone as required by State law.
- Consider conducting an ingress/egress evacuation routes analysis for the Housatonic Valley Regional High School.

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

4.0 HURRICANES AND TROPICAL STORMS

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 Canaan 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 Canaan. A hurricane striking Canaan 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.

The Saffir-Simpson Scale

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 Hurricane Watch 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 Hurricane Warning 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), one Category Three Hurricane, five Category Two Hurricanes, eight Category One Hurricanes, and 42 tropical storms have tracked within a 150-nautical-mile radius of Canaan. The representative storm strengths were measured as the peak intensities for each individual storm passing within the 150-mile radius. The 14 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 Canaan Since 1851

Category	June	July	August	September	October
Tropical Storm[1]	4	1	11	14	8
One	0	0	2	4	2
Two	0	0	3	2	0

Three	0	0	0	1	0
Total	**4**	**1**	**16**	**21**	**10**

[1]Three tropical storms occurred in May and one occurred in November.

A description of more recent tropical cyclones near Canaan 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. Flooding was particularly severe in the Canaan/Falls Village area, with significant flooding along the Housatonic River and its tributaries.

- 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 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. Anticipating storm surges along the Atlantic coastline, many states and municipalities issued mandatory evacuations on August 26 and 27, 2011. Many coastal towns ordered a mandatory evacuation to all residents in anticipation of Hurricane Irene's landfall on Saturday, August 27, 2011. The largest damage was done to electrical lines throughout the state of Connecticut. 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.

- 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. Canaan fared pretty well during Hurricane Sandy and no major damages were reported.

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 Canaan is 90 miles per hour. Canaan 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. Connecticut Light & Power, the local electric utility, provides tree maintenance near its power lines. Connecticut Light & Power was under intense scrutiny after storms Irene and Alfred in 2011. However, the Town of Canaan has indicated that they have a great working relationship with CL&P.

Thomas Scott is the tree warden and assists in managing all trees on Town-owned property, including within the street rights-of-way. With its limited budget, the town tends to focus on the most critical roadways.

During emergencies, the Town currently has two shelters available for residents as discussed in Section 2.9. Prior to severe storm events, the Town ensures that communication equipment is 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 City 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 Storms Irene in 2011 and Hurricane Sandy in 2012 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.

Tropical Cyclone Vulnerability

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 Canaan 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. Fortunately, Canaan is less vulnerable to hurricane damage than coastal towns in Connecticut because it does not need to deal with the effects of storm surge.

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.

Based on the population projections in Section 2.6, the population of the Town of Canaan is estimated to slightly decrease through 2025. All 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. As noted in Section 4.1, wind damage from hurricanes and tropical storms has the ability to affect all areas of Canaan while areas susceptible to flooding are even more vulnerable. Areas of known and potential flooding problems are discussed in Section 3.0, and tornadoes (which sometimes develop during tropical cyclones) will be discussed in Section 5.0.

The Town is uncertain whether any Town-owned critical facilities have wind-mitigation measures installed to specifically reduce the effects of wind. Thus, it is believed that nearly all of the critical facilities in the town are as likely to be damaged by hurricane-force winds as any other. Many of the Town's older structures, such as the Town Hall may not meet current building code with respect to wind.

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.

Canaan'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. Homes located within SFHAs are also at risk from flooding as a result of the heavy rainfall that typically occurs during tropical storms and hurricanes.

As the Town of Canaan 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.

HAZUS-MH Simulation

In order to quantify potential hurricane damage, HAZUS-MH simulations were run for historical and probabilistic storms that could theoretically affect Canaan. 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 C 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 Canaan. These two storm tracks produced the highest winds to affect Canaan out of all the hurricanes in the HAZUS-MH software.

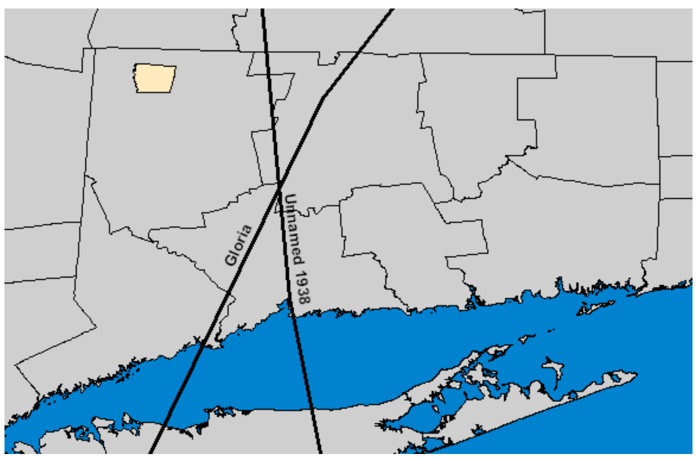


Figure 4-1: Historical Hurricane Storm Tracks

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 Canaan. 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 77 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	36	None	None	None	None	None
20-Years	49	None	None	None	None	None
Gloria (1985)	55	None	None	None	None	None
50-Years	66	None	None	None	None	None
100-Years	77	5	None	None	None	5
200-Years	87	26	1	None	None	27
Unnamed (1938)	95	67	4	None	None	71
500-Years	99	93	8	None	None	101
1000-Years	107	168	27	2	1	198

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	1	None	None	None	1
100-Years	6	None	None	None	6
200-Years	27	1	None	None	28
Unnamed (1938)	71	5	None	None	76
500-Years	99	9	None	None	108
1000-Years	180	31	2	2	215

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 99 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)	Schools (2)
10-Years	None or Minor	None or Minor
20-Years	None or Minor	None or Minor
Gloria (1985)	None or Minor	None or Minor
50-Years	None or Minor	None or Minor
100-Years	None or Minor	None or Minor
200-Years	None or Minor	None or Minor
Unnamed (1938)	None or Minor	None or Minor
500-Years	None or Minor	Minor damage with loss of use to one school
1000-Years	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 20-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	16	310	326
50-Years	None	None	24	451	475
100-Years	8	None	122	2,318	2,448
200-Years	43	None	676	12,840	13,559
Unnamed (1938)	105	None	912	17,320	18,337
500-Years	154	None	987	18,746	19,887
1000-Years	362	None	1,680	31,911	33,953

There are no predicted sheltering requirements for wind damage however, it is likely that hurricanes will also produce heavy rain and flooding that will increase the overall sheltering need in Canaan.

Table 4-7 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 4-7
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)	$17,290	$17,290	None	$17,290
50-Years	$88,980	$93,050	None	$93,050
100-Years	$363,470	$368,320	$220	$368,540
200-Years	$800,100	$820,830	$19,230	$840,060
Unnamed (1938)	$1,445,530	$1,505,050	$39,730	$1,544,780
500-Years	$1,846,690	$1,945,290	$112,030	$2,057,320
1000-Years	$3,691,000	$4,001,790	$362,090	$4,363,880

Losses are minimal for storms with return periods of less than 20-years (49 mph) but increase rapidly as larger storms are considered. For example, a reenactment of the 1938 hurricane would cause approximately $1.5 million in wind damages to Canaan. 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 Canaan. 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 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. Canaan 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 Canaan, 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 Canaan are listed below.

- Develop a town wide tree limb inspection and maintenance programs to ensure that the potential for downed power lines is diminished.
- The Building Department should provide literature regarding appropriate design standards for wind.
- 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.

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 Canaan. 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 Canaan 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 Canaan 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 and could cause significant damage to a small area.

In July 10, 1989 at least three tornadoes moved through Litchfield and New Haven Counties, causing more than $100 million in damage.

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.

<u>Tornadoes</u>

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.

Nonsupercell 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 nonsupercell 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.

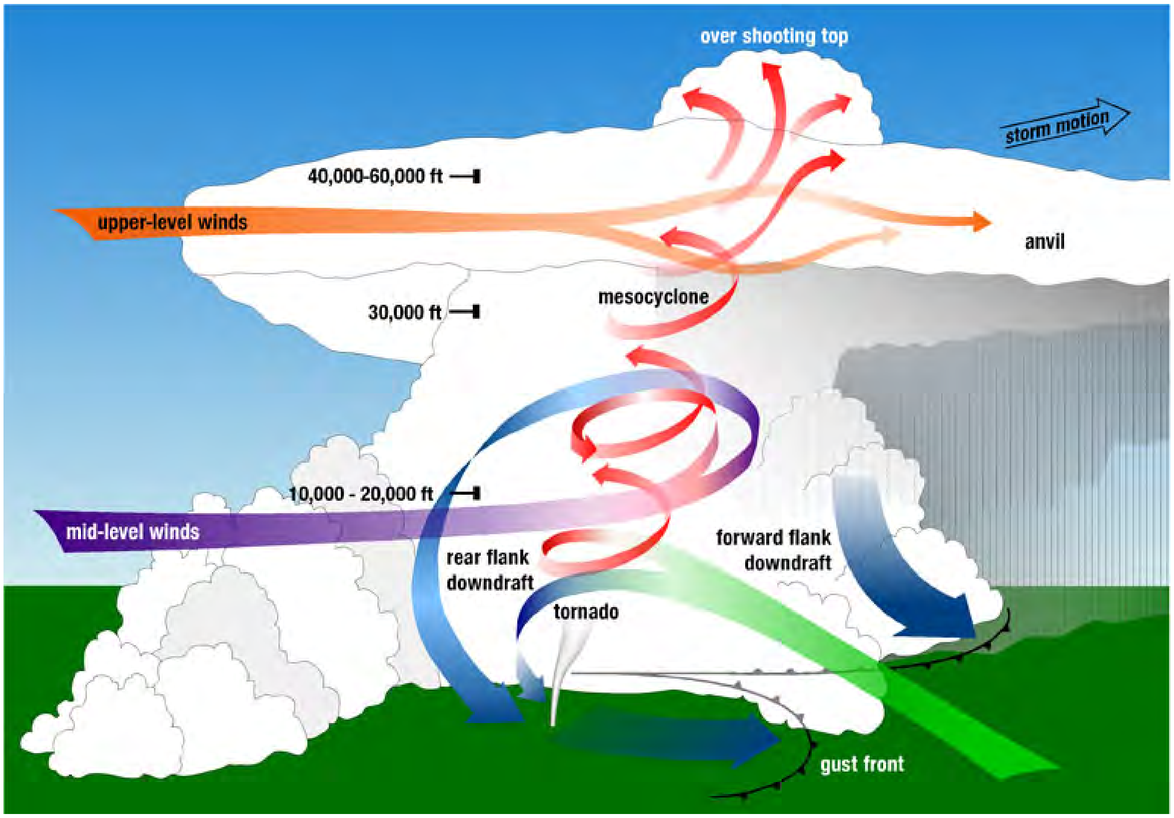
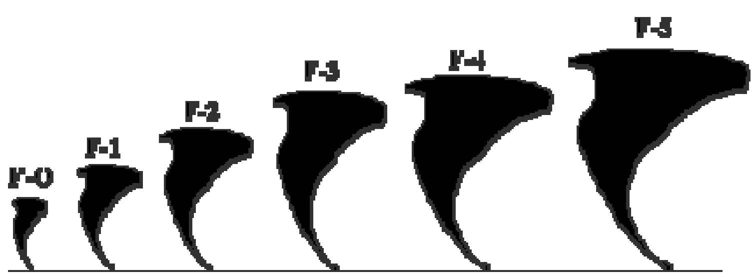


Figure 5-1: Anatomy of a Tornado. Image from NOAA National Severe Storms Laboratory.



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 Canaan is discussed in Section 5.3. Tornadoes are most likely to occur in Connecticut in June, July, and August of each year.

Lightning

Image courtesy of NOAA.

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.

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 Canaan 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.

> ***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.*

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.

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 17 tornado events with reported damages totaling tens of millions of dollars. Table 5-3 summarizes the tornado events near Canaan through July 2013 based on the Wikipedia list.

Table 5-3
Tornado Events Near Canaan From 1648 to July 2012

Date	Location	Fujita Tornado Scale	Property Damage	Injuries / Deaths
June 3, 1836	Dutchess County NY to Salisbury CT	-	NR	NR
May 12, 1959	Salisbury, CT	F2	Tree damage	NR
August 11, 1966	Northern Litchfield County	F2	NR	NR
August 20, 1968	Northern Litchfield County	F1	NR	NR
August 7, 1972	Northern Litchfield County	F1	NR	NR
June 29, 1973	Northwest Litchfield County	F1	NR	NR
June 30, 1976	Northern Litchfield County	F2	NR	NR
June 6, 2002	Salisbury (west of Canaan)	F1	Destroyed approximately two acres of mature forest	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 Canaan (below). A limited selection of summer storm damage in and around Canaan, taken from the NCDC Storm Events database, is listed below:

- June 19, 2006- Thunderstorms formed over southwestern New England with one thunderstorm producing golf ball size hail in Canaan.
- May 24, 2009- Scattered thunderstorms were responsible for nickel sized hail that was reported near Cornwall, just south of Canaan.
- July 16, 2009- Severe thunderstorms moved across Litchfield County with reports of hail across the region. Quarter sized hail was reported in Falls Village, nickel to ping pong sized hail was reported in New Preston and New Milford, and quarter sized hail reported in Woodbury.
- July 21, 2010- A supercell moved across Litchfield County and produced intermittent damage along a track from Sharon to Litchfield with brief tornado touchdowns in East Litchfield, Thomaston, and Terryville.
- June 8, 2011- Sever thunderstorms were triggered across Litchfield County with golf ball sized hail reported in Canaan, quarter sized hail reported in Falls Village and North Kent, and nickel sized hail approximately 5 miles northwest of Litchfield.

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.

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

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.

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
- ❑ Putting emergency personnel on standby at tornado "watch" stage
- ❑ Once subscribed, utilizing the CT Alert notification system to send warnings into potentially affected areas.

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 Canaan has a 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 Canaan 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 Canaan 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 Canaan 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 Canaan 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.

Town personnel note that strong thunderstorms will cause power lines to fall all over the town. Most downed power lines in Canaan 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. Some critical facilities are more susceptible than others to flooding damage due to summer storms. Such facilities susceptible to flooding damage were discussed in Section 3.5.

Loss Estimates – The Town of Canaan reports that most cleanup from thunderstorms is done during working hours. The volunteer fire department responds to downed wires and trees. Cleaning of downed trees from tornadoes and thunderstorms outside of working hours is rare and is usually done by the town crew if electrical wires aren't involved. If it something the town crew cannot handle, which has happened a few times, the Town estimates the cost to be between $500 and $1,500. If downed trees need to be addressed outside of normal hours by the town crew, overtime costs are in the range of $400 to 600.

The 2014 Connecticut Natural Hazard Mitigation Plan provides annual estimated losses on a countywide basis for several hazards. Based on the population of Canaan relative to Litchfield County, the annual estimated loss is $371 for thunderstorms (consistent with the above figures) and $9,880 for tornadoes. The figure for tornadoes is influenced by their infrequent occurrence.

Summary – The entire Town of Canaan 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 for tree removal and minor repairs is generally adequate to handle summer storm damage.

5.6 Potential Mitigation Strategies and Actions

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.

> ***More information is available at:***
>
> *FEMA – http://www.fema.gov/library/*
> *NOAA – http://www.nssl.noaa.gov/NWSTornado/*

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 is currently subscribing to the emergency notification system known as CTAlert 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 town wide tree limb inspection and maintenance programs to ensure that the potential for downed power lines is diminished.
- ❑ The Building Department should provide literature regarding appropriate design standards for wind.
- ❑ 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.

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 Canaan. However, unlike summer storms, winter events and the hazards that result (wind, snow, and ice) have more widespread geographic extent. The entire Town of Canaan 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.

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.

> ***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.***

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 196 of the most notable historic winter storms to impact the Northeast have been analyzed and categorized by RSI through March 2013.

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. According to the NCDC, there have been 134 snow and ice events in the state of Connecticut between 1993 and April 2010, causing over $18 million in damages. Additional examples of recent winter weather events to affect the Canaan 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 and a brown out occurred in the New Preston area. Some specific snowfall totals included: 4 inches at Cornwall and 2 inches at New Preston.

- 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.

- February 12, 2008 – A complex storm system brought a significant wintry mix to much of east central New York and adjacent western New England, beginning Tuesday evening, and ending Wednesday evening. Snow and sleet accumulations generally ranged from 4 to 8 inches across the higher elevations of northern Litchfield County, with amounts generally remaining under 4 inches across the lower elevations within southern Litchfield County. In addition, ice accretion from freezing rain ranged from one tenth of an inch to one quarter of an inch across the higher elevations of northern Litchfield County.

- 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.

- 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 Connecticut during the second week in February.

- October 29, 2011 –Winter Storm Alfred (October 29-30, 2011) dumped 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 Canaan, Winter Storm Alfred caused power outages that lasted approximately one week.

- 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.

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 Canaan

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

Address	Municipality	Date	Description
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
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

Address	Municipality	Date	Description
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 1958-DR for Connecticut. Damage in Canaan was reportedly not significant.

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 40 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.

CTDOT plows all State roads and Interstates. The Town primarily uses Town staff for plowing operations on the remaining miles of roadway. The Town has four routes and five trucks for plowing. The fifth truck is primarily used for plowing parking lots.

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 uses sand and salt for deicing. 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 Canaan, 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 Canaan 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. Drifting snow can occur after large storms, but the effects are generally mitigated through municipal plowing efforts. However, the areas along Music Mountain, Canaan Mountain and Sand Road near Sunset Hill Farm are more prone to drift than others and are a concern to the town.

Icing causes difficult driving conditions throughout the hillier sections of the town. Exposed hilltops are more at risk to high winds and snow drifts. Snowfall characteristics can vary widely between the valleys and the hilltops. The Town's standard of presalting has been helpful in controlling ice in these problem areas.

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. Some critical facilities are more susceptible than others to flooding damage due to winter storms. Such facilities susceptible to flooding damage were discussed in Section 3.5.

For municipal property, the Town budget for tree removal and minor repairs 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.

<u>Loss Estimates</u> – The 2014 Connecticut Natural Hazard Mitigation Plan provides annual estimated losses on a countywide basis for several hazards. Based on the population of Canaan relative to Litchfield County, the annual estimated loss is $620 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. The Town did not submit Public Assistance reimbursements for the winter storm disaster declarations in 2011 and 2013 that are described above.

Summary – The entire Town of Canaan 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.

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 below

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. Utilities in Canaan 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.

> FEMA has produced a Snow Load Safety Guidance Document available at http://www.fema.gov/media-library/assets/documents/29670?id=6652. A copy is available in Appendix F of this plan.

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 Specific Mitigation Strategies and Actions

Most of the recommendations in Section 3.6 for mitigating flooding and 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 Canaan 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.
- The town may consider utilizing snow fencing in areas prone to snow drift.
- Consider posting the snow plowing routes in Town buildings each winter to increase public awareness.
- Emergency personnel should continue to identify areas that are difficult to access during winter storm events and devise contingency plans to access such areas during emergencies.
- The Building Department should provide literature regarding appropriate design standards for mitigating icing, insulating pipes, and retrofits for flat-roofed buildings such as heating coils.

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 Canaan 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, damaging earthquakes are considered a hazard that is unlikely to occur, but that may cause significant effects to a large area of the Town if one occurred.

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.

Additional instances of seismic activity occurring in and around Connecticut are provided below, based on information provided in USGS documents, the Weston

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.

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.
- On March 11, 2008 there was a 2.0 magnitude earthquake with its epicenter three miles northwest of the center of Chester.
- 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.
- A magnitude 2.1 quake occurred near Stamford on September 8, 2012. Dozens of residents reported feeling the ground move, but no injuries were reported.
- 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.
- The most recent earthquake to strike Connecticut was a magnitude 2.7 beneath the Town of Deep River on August 14, 2014.

An earthquake of special consideration was a magnitude 5.8 earthquake that 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 Canaan. 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:

- ***Subdivision Regulations***. The 2003 regulations do not explicitly address the issue of construction on steep slopes. The regulations do require that soil erosion and sediment control plans be developed for proposed projects. In addition, the regulations state that the Commission shall not approve unsuitable land for subdivision unless adequate provisions are made by the subdivider to mitigate the unsuitable conditions. Land may be deemed unsuitable because of flooding, inadequate drainage, steep slopes, depth to bedrock, erosive soils, utility easements or similar features.

- ***Zoning Regulations***. Section 4.3 of the regulations describes standards for the Steep Slope Overlay Zone and states that the purpose of this Section is “to carefully monitor development in areas of steep slopes in order to determine whether public services (such as fire, ambulance, and public works) can be reasonably provided, to minimize soil erosion and sedimentation, and to minimize adverse visual impacts on the rural character of the community. It is not the intent of this Section to prohibit or preclude development in designated areas. Rather, this Section is intended to establish a process whereby property owner’s interests in capitalizing on scenic views or other assets can be balanced with the community’s desire to provide a reasonable level of services and to protect environmentally sensitive steep slopes and hillsides from inappropriate development.”

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 the Town of Canaan 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 Canaan, 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 Canaan. Results are presented in Table 7-2 below.

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

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	1%	< 1%
100	2% to 3%	< 1%
250	6% to 8%	1% to 2%
350	8% to 10%	2% to 3%

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 Canaan 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 Canaan.

HAZUS-MH Simulations

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 Canaan. 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 Canaan. 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	20	3	None	None	23
Stamford – 5.7	15	3	None	None	18
East Haddam – 6.4	58	12	1	None	71

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	26	5	None	None	31
Portland – 5.7	22	4	None	None	26
Stamford – 5.7	18	3	None	None	21
East Haddam – 6.4	65	16	2	None	83

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)	Schools (2)
Haddam – 5.7	Minor damage (86% functionality)	Minor damage (86% functionality)
Portland – 5.7	Minor damage (86% functionality)	Minor damage (86% functionality)
Stamford – 5.7	Minor damage (88% functionality)	Minor damage (88% functionality)
East Haddam – 6.4	Minor damage (72% functionality)	Minor damage (72% functionality)

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

- Highway: 13 major roadway bridges and 6 important highway segments;
- Railway: 2 major segments;
- A potable water system consisting of 112 total kilometers of pipelines;
- A waste water system consisting of 67 total kilometers of pipelines and;
- A total of 45 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 the Town of Canaan may not have the extent of infrastructure assumed by HAZUS.

As shown in Table 7-6, highway bridges are predicted to experience minor damage under each earthquake scenario. Water, 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.

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

Epicenter Location and Magnitude	Transportation Network	Utilities	Fire Damage
Haddam – 5.7	Minor damage to transportation infrastructure ($0.03 million to bridges)	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	Minor damage to transportation infrastructure ($0.03 million to bridges)	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	Minor damage to transportation infrastructure ($0.02 million to bridges)	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.
East Haddam – 6.4	Minor damage to transportation infrastructure ($0.51 million to bridges)	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 $0.04 million.	Fire damage will displace no people.

For all earthquake scenarios there is no estimated debris generation for Canaan. 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 caused no injury at all.

Table 7-7 presents the total estimated losses and direct economic impact that may result from the four earthquake scenarios created for Canaan 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 earthquake. 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	$330,000	$100,000	$430,000
Portland – 5.7	$270,000	$90,000	$350,000
Stamford – 5.7	$180,000	$60,000	$250,000
East Haddam – 6.4	$1,090,000	$36,000	$1,450,000

The maximum simulated damage considering direct losses and infrastructure losses is approximately $1.45 million for the East Haddam 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 Canaan. 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 difficult to predict and can affect the entire Town of Canaan, 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, Canaan would activate its Emergency Operations Plan and initiate emergency response procedures as necessary.

7.7 Summary of Specific Strategies and Actions

The recommended mitigation strategies for mitigating earthquakes in the Town of Canaan are listed below.

- ❑ Consider preventing new residential development in areas prone to collapse.
- ❑ Ensure that municipal departments have adequate backup plans and adequate backup facilities such as portable generators in place in case earthquake damage occurs to critical facilities.
- ❑ 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 15 dams within Town limits, two of which have been classified as high hazard. Additionally, high hazard dams located in surrounding municipalities have the potential to affect the Town of Canaan 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.

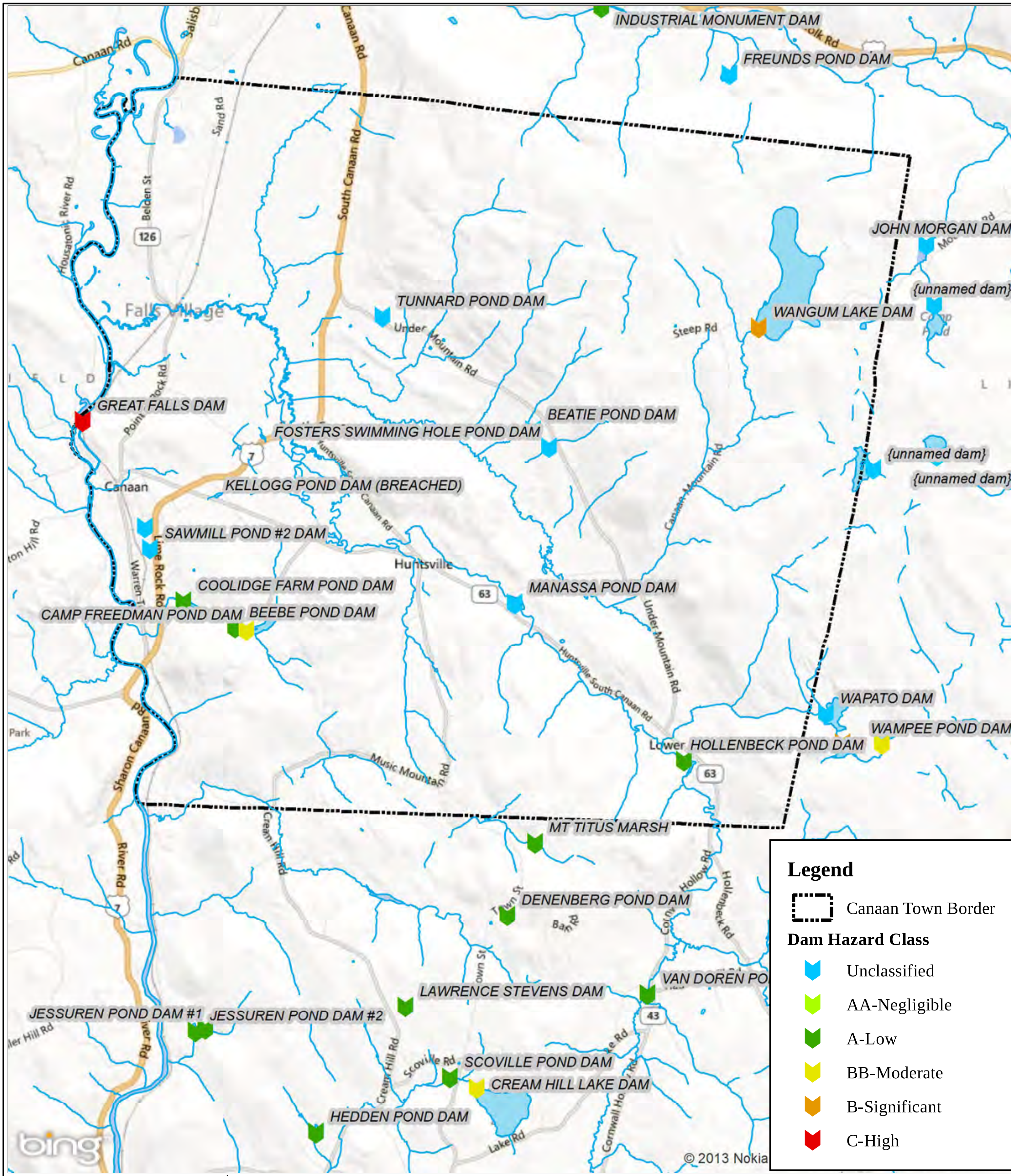
8.2 Hazard Assessment

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 15 DEEP-inventoried dams within the Town of Canaan. These dams are shown in Figure 8-1. Two of these dams are considered high hazard (Class B or C). As shown in Table 8-1, the two high hazard dams in the town are owned by private companies. Two class C dams and four additional Class B dams are located in adjacent municipalities. Failure of these structures may have an impact on Canaan.

This section primarily discusses the possible effects of failure of high and significant 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):
CT DEEP

Figure 8-1: Dams and Hazard Class

LOCATION: **Canaan, CT**

N

Town of Canaan
Natural Hazard Mitigation Plan

MXD: P:\3843-04\GIS\Maps\Canaan\Figure 8-1- Canaan Dams and Hazard Class.mxd

Map By: CMP
MMI#: 3843-04
Original: 01/23/2014
Revision: 1/23/2014
Scale: 1 inch = 1 mile

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Table 8-1
High Hazard Dams with Potential to Affect the Town of Canaan

Number	Name	Location	Class	Owner
2101	Great Falls Dam	Housatonic River, Canaan	C	First Light Power Resources
2104	Wangum Lake	Wangum Lake Brook, Canaan	B	Aquarion Water Company
9802	Bear Swamp Pond Dam	Bear Swamp Pond, Norfolk	B	Great Mountain Forest Corp.

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 8-2
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	City 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.

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.

The dam safety statutes are codified in Section 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 which govern the registration, classification, and inspection of dams. Dams must be inventoried by the owner with the DEEP, according to Connecticut Public Act 83-38.

Dam inspection regulations require that nearly 700 dams in Connecticut be inspected annually. The DEEP currently performs inspections of those dams which 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 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 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 high hazard dam in Canaan is inspected biennially by a licensed engineer and weekly by First Light Power Resources. The Connecticut DEEP routinely performs the inspections and prepares summary reports.

8.5 Vulnerabilities and Risk Assessment

The following section primarily discusses known vulnerable areas located downstream of Class B and C dams. Dam failure analyses have been prepared for many high hazard dams, and these are included in the EAPs. The inundation limits portrayed in the dam failure analysis maps represent *a highly unlikely, worst-case scenario (1,000-year) flood event and should be used for emergency action planning only.* As such, they are appropriate for use in the CTAlert emergency call database. These analyses should not be interpreted to imply that the dams evaluated are not stable, that the routine operation of the dams presents a safety concern to the public, or that any particular structure downstream of the dam is at imminent risk of being affected by a dam failure.

Great Falls Dam (Dam No. 2101) - Housatonic River, Canaan

The Great Falls Dam is a run-of-river dam located on the Housatonic River. It is owned by First Light Power Resources and used to impound a reservoir for hydroelectric generation at the Falls Village Hydrostation. The Housatonic River forms the boundary between Canaan and Salisbury at this location. The dam impounds a reservoir with a surface area of 150 acres, and a storage volume of 1,135 acre-feet from a contributing watershed of 634 square miles.

The concrete dam was constructed in 1913 and consists of a concrete ogee spillway that is 14 feet in height and 300 feet in length. The pumped-storage generation utilizes underground components connecting the upper and lower reservoirs. These components include a powerhouse, water tunnel, shafts, and access tunnel. In March 1987, CL&P constructed a fourth hydroelectric generating unit at the dam.

The dam was designed to pass all flows except the PMF (113,000 cfs), and a Phase II report notes that failure would not cause significant incremental downstream damage. The structure was not designed to have any freeboard during the design flood event.

There was in incident on May 24, 1989 that resulted in 386 feet of canal being washed out and undermined, and a 400-foot section was unstable under railroad loading conditions. Earth backfill on the river side of canal washed out, consisting of 30% of the area between the failure and the bend upstream in the canal.

In accordance with the EAP on file, a test message was sent to downstream residents regarding failure and flooding on the Housatonic River on June 30, 2004. The EAP for the Housatonic Project/Falls Village Development was last updated in 2012. The inundation map developed with the dam breach analysis indicates that the extent of impact includes the Warren Turnpike, high school athletic fields, Route 7, Route 112, the Lime Rock Race Track (adjacent to Salmon Creek), and a covered bridge. The mapping notes that an incremental rise in water surface elevations of 2.04 feet extends 15.3 miles downstream of the Falls Village Dam.

Wangum Lake Dam (Dam No. 2104) - Wangum Lake Brook, Canaan

The Wangum Lake Dam is located at the southern end of Wangum Lake and impounds a storage volume of 543 acre-feet from a contributing watershed of 1.04 square miles. It is owned by the Aquarion Water Company of Connecticut and used to impound a public water supply reservoir.

The earthen dam was constructed in 1890 and is ten feet in height, and 40 feet in length. The structure provides one foot of freeboard for the design storm. The concrete spillway is four feet high and six feet long, with a 12-inch cast iron outlet structure. The USACE completed a Phase I report in 1979 and spillway improvements were completed in 1987.

Wangum Lake Brook flows southwest along Canaan Mountain Road and then northwest to Hollenbeck River and on to the Housatonic River.

The dam was last formally inspected in 2011 by the CT DEEP. GZA prepared an ECP in 2002 that is on file at the CT DEEP. There is no dam breach analysis or inundation map on file.

Bear Swamp Pond Dam (Dam No. 9802) - Norfolk

Bear Swamp Pond Dam is a Class B dam located in Norfolk on the west side of Bear Swamp Pond, near the border of Norfolk and Canaan. Bear Swamp is the middle pond in a series of three ponds that drain into each other. Wampee Pond discharges through a Class BB dam into Bear Swamp, and Bear Swamp discharges to Wapato Pond, which is impounded by an unclassified dam. The three ponds discharge to Brown Brook, a tributary of the Hollenbeck River. Although located in an adjacent town, failure of these dams may create a flood wave downstream in Canaan.

Loss Estimates – HAZUS-MH was utilized to determine the effect of dam failure for the Class C Great Falls Dam. The Dam Emergency Operations Plan was obtained for the analysis. Cross-sectional data and flooding areas from the dam failure analyses for a worst-case scenario breach were imported into the HAZUS-MH flood module.

The HAZUS-MH simulation estimates that approximately five residential buildings will be substantially damaged and uninhabitable. None of Canaan’s essential facilities will be damaged.

The HAZUS-MH simulation estimated that 4,357 tons of debris would be generated by flood damage from the dam failure scenario. The simulation also estimates 174 of truckloads (at approximately 25 tons per truck) that would be required to remove the debris.

HAZUS-MH calculated the potential sheltering requirement for the dam failure scenario. Displacement includes eight households evacuated from within or very near to the inundated areas and two people utilizing public shelters.

HAZUS-MH also calculated the predicted economic losses due to the dam failure scenario. Economic losses are categorized between building-related losses and business interruption losses. The total loss in Canaan is estimated at approximately $20.6 million for a worst-case scenario dam failure.

Table 8-3
HAZUS-MH Flood Scenario – Building Loss Estimates

Stream	Residential	Commercial	Industrial	Others	Total
Failure of Great Falls Dam	$1,880,000	$290,000	$190,000	$18,020,000	$20,380,000

Table 8-4
HAZUS-MH Flood Scenario – Business Interruption Estimates

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

The HAZUS-MH results do not provide casualty estimates. However, it is assumed that casualties may occur under either flood scenario.

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 recommended mitigation strategies for dam failure in the Town of Canaan are listed below.

- ❑ Include dam failure inundation areas in the CT Alert emergency contact database once obtained.
- ❑ Collect EAPs for Class B and C dams and file them with appropriate town departments and emergency personnel.

With the legislature passed in 2013, dam assessment and management capabilities will continue to increase in the state. Subsequent updates to this plan will revisit dams and discuss the outcomes of the legislation and any new regulations administered by the Connecticut DEEP.

9.0 WILDFIRES

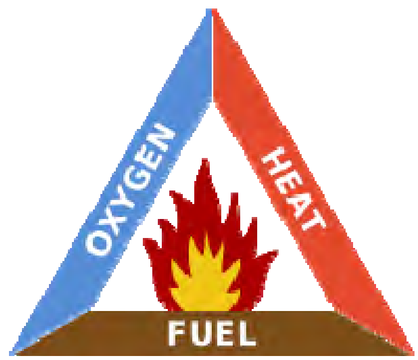
9.1 Setting

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

The Town of Canaan is generally considered a high risk area for small wildfires but a low risk area for large wildfires. Wildfires are of particular concern in outlying areas without public water service and other 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 nonforested areas.

9.2 Hazard Assessment

Wildfires are any nonstructure 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 urban 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 19th century caused the decline of farming in the state, and forests reclaimed abandoned farm fields. In the early 20th 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 20th 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 3,448 acres of land burned in Connecticut from 2002 through 2012 due to 2,334 nonprescribed wildfires, an average of 1.5 acres per fire and 313 acres per year (Table 9-1).

The Connecticut DEEP Forestry Division estimates the average acreage burned per year statewide to be much higher (1,300 acres per year) in the 2014 *Connecticut Natural Hazard Mitigation Plan Update*. The Connecticut DEEP also states that the primary cause of wildland fires in seven of the eight counties is undetermined, with the secondary cause being arson or debris burning. In general, the wildland fires in Connecticut are small and detected quickly, with most of the largest wildfires being contained to less than 10 acres in size.

Table 9-1
Wildland Fire Statistics for Connecticut

Year	Number of Wildland Fires	Acres Burned	Number of Prescribed Burns	Acres Burned	Total Acres Burned
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	**2,334**	**3,448**	**85**	**913**	**4,361**

Source: National Interagency Fire Center

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.

Due to a reduced snowpack and dry conditions, March 2012 was Connecticut's most recent month of high wildfire risk. A forest fire burned about 25 acres at Devil's Hopyard State Park in East Haddam on March 26-27, 2012.

There hasn't been a major forest fire in Canaan in several years, but the town remains concerned about future fires and would like to find ways to reduce risks posed by forest fires.

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 nonwinter 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.

In addition, 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. The Town of Canaan is already compliant with this new program and has a designated Burning Official.

Regulations regarding fire protection are outlined in the *Subdivision Regulation*s.

- ❑ ***Subdivision Regulations, Section 4.14*** for each subdivision, unless modified or waived by the Commission shall provide fire protection facilities, which include the construction of fire ponds, including dry hydrants; construction of underground fire tanks with dry hydrants; construction of approved residential sprinklers or providing a fee in lieu of constructing fire protection facilities. Fire protection facilities shall be constructed in accordance with the National Fire Protection Association standards. In general, such facilities shall contain at least 1,000 gallons of water supply per lot in the subdivision and no less than 10,000 gallons of capacity.

The local fire departments can utilize mutual aid agreements with surrounding towns and assemble up to 60 responders if needed.

There are ten hydrants in the town of Canaan available for firefighting support. There are also three fire ponds in town. Town officials have indicated that one of the ponds is in need of maintenance (dredging).

Unlike the west coast of the United States where the fires are allowed to burn toward development and then stopped, the Canaan Fire Department goes to the fires whenever possible.

This proactive approach is believed to be effective for controlling wildfires. The Fire Department has some water storage capability in its tanker trucks and storage tanks but primarily relies on the use of the municipal water system to fight fires throughout the town whenever possible.

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.

Other capabilities for reducing wildfire risk include:

- Encouraging property owners to widen access roads such that fire trucks and other emergency vehicles can access remote locations.
- Continuing intermunicipal cooperation in firefighting efforts.
- Providing outreach programs on how to properly manage burning and campfires on private property.
- Patrolling Town-owned and State-owned open space and parks to prevent unauthorized campfires.
- Enforcing regulations and permits for open burning.

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 intermunicipal cooperation on such instances is common. However, local risk is not necessarily the same as the overall statewide risk.

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.

Canaan considers the area along the Appalachian Trail to be an elevated wildfire risk area due to the amount of hikers/campers that access the trail each year. In addition, approximately 55% of the town consists of managed or dedicated open space that is 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 Canaan relative to Litchfield County, the annual estimated loss is $358 for wildfires. This figure is relatively low and it may not represent the true risks in Canaan.

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.

Water system maintenance and improvements are an important class of potential mitigation for fires.

The town recognizes that there may not be a simple solution to reduce risks in areas such as the region of elevated wildfire risk located along the Appalachian Trail. For addressing these kinds of remote areas, the town may consider a combination of forest fuel reduction, patrols, monitoring, coordination with DEEP, installing dry hydrants or fire ponds, and public education.

9.7 Summary of Specific Strategies and Actions

The following strategies could be implemented to mitigate fire risk:

- ❑ For the area of elevated wildfire risk located along the Appalachian Trail, the town may consider a combination of all of the available methods of risk reduction.
- ❑ The Town should continue to require the installation of fire protection water in new developments.
- ❑ Evaluate the need for maintenance of the town fire ponds.
- ❑ 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

Recommendations 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, placing utilities underground is a recommendation 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 2.8, the town will be constructing a new Emergency Management Services facility in 2014-2015. Due to the proximity of the facility to the Housatonic River, it is important to ensure that the facility is sited outside the SFHA to minimize potential flood impacts. In Connecticut, critical facilities cannot be constructed in SFHAs and 500-year flood zones.

As noted in Section 2.9, three of the town's critical facilities the Lee H. Kellogg School, the Senior Center and the Falls Village Day Care Center do not have backup generators. Based on the fact that these facilities typically house children and elderly residents, they would be good candidates for standby power.

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. Once obtained, the Town should utilize the CTAlert system 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

For planning purposes, it is important for the town to have long term strategies that are memorialized in this document. Strategies and actions have been presented throughout this document in individual sections as related to each hazard. This section lists specific strategies of the Plan without any priority ranking. Strategies 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 strategies with scores based on the STAPLEE methodology described in Section 1.0.

<u>All Hazards</u>

- ❑ Once subscribed, utilize the existing CTAlert emergency notification system to its fullest capabilities.
- ❑ Encourage residents to purchase and use NOAA weather radios with alarm features.
- ❑ Pursue standby power supplies for those critical facilities that do not have generators such as the senior center and Falls Village Day Care.
- ❑ Ensure that emergency information is available through several different media, such as newspaper, radio, internet and phone.

Flooding

Prevention

- ❑ Consider updating the Town's Inland Wetland Regulations, which were last amended in 1975, to incorporate certain elements of flood damage prevention. Note that the "Flood Hazard Control Measures" section of the town ordinances is the appropriate location for incorporating the most recent DEEP Model Floodplain Management Regulations.
- ❑ As recommended by the POCD, review the Flood Hazard Control Measures section of the town ordinances to incorporate the most recent DEEP Model Floodplain Management Regulations.
- ❑ 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

- ❑ Encourage property owners to purchase flood insurance under the NFIP and to report claims when flooding damage occurs.
- ❑ Consider conducting a comprehensive evaluation of the Housatonic and Hollenbeck River watersheds to determine appropriate flood mitigation measures.
- ❑ Consider constructing a flood wall or berm around the side of the High School that is near the Housatonic River.

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.
- ❑ Ensure that the appropriate municipal personnel are trained in flood damage prevention methods.

Natural Resource Protection

- ❑ Pursue the acquisition of additional municipal open space inside SFHAs and set it aside as greenways, parks, or other nonresidential, noncommercial, or nonindustrial use.

Structural Projects

- ❑ Review culvert conveyances based on existing hydrology and Northeast Regional Climate Center guidance.
- ❑ 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.
- ❑ Consider replacing culverts frequently impacted by beavers with free span bridges.
- ❑ Consider the use of beaver deterrent devices such as beaver stops, beaver bafflers or beaver deceivers.

Emergency Services

- Ensure adequate barricades are available to block flooded areas in floodprone areas of the town.
- Ensure that the Emergency Management Service Facility is sited outside the SFHA and 500-year flood zone as required by State law.
- Consider conducting an ingress/egress evacuation routes analysis for the Housatonic Valley Regional High School.

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

- Develop a town wide tree limb inspection and maintenance programs to ensure that the potential for downed power lines is diminished.
- The Building Department should provide literature regarding appropriate design standards for wind.
- 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.

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.
- The town may consider utilizing snow fencing in areas prone to snow drift.
- Consider posting the snow plowing routes in Town buildings each winter to increase public awareness.
- Emergency personnel should continue to identify areas that are difficult to access during winter storm events and devise contingency plans to access such areas during emergencies.
- The Building Department should provide literature regarding appropriate design standards for mitigating icing, insulating pipes, and retrofits for flat-roofed buildings such as heating coils.

Earthquakes

- Consider preventing new residential development in areas most prone to collapse or liquefaction.
- Ensure that municipal departments have adequate backup plans and adequate backup facilities such as portable generators in place in case earthquake damage occurs to critical facilities.
- 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 CTAlert emergency contact database once obtained.

- Collect EAPs for Class B and C dams and file them with appropriate town departments and emergency personnel.

Wildfires

- For the area of elevated wildfire risk located along the Appalachian Trail, the town may consider a combination of all of the available methods of risk reduction.
- The Town should continue to require the installation of fire protection water in new developments.
- Evaluate the need for maintenance of the town fire ponds.
- Revise and enhance the town's website concerning the local regulatory requirements concerning Open Burning.

10.3 Priority Strategies and Actions

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. While some of these strategies may exceed five years for completion, the town's top five priority strategies are expected to be completed within five years and the actions are as follows:

1. Obtain funding to acquire backup generators for the senior center and Falls Village Day Care Center
2. Consider reviewing and updating the Town's Inland Wetland Regulations, which were last amended in 1975. Note that the "Flood Hazard Control Measures" section of the town ordinance is the appropriate location for incorporating the most recent DEEP Model Floodplain Management Regulations.
3. As recommended by the POCD, review the Flood Hazard Control Measures section of the town ordinance to incorporate the most recent DEEP Model Floodplain Management Regulations.
4. Consider conducting a comprehensive evaluation of the Housatonic and Hollenbeck River watersheds study to determine appropriate flood mitigation and stabilization measures.
5. 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.

10.4 Sources of Funding

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 11.4.

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 the 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 the 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 the 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>U.S. Fire Administration</u>

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.

Other Grant Programs

Flood Mitigation

- 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.*

Erosion Control and Wetland Protection

- 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 Canaan 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 in the Town of Canaan will primarily be responsible for developing and implementing selected projects. **A "local coordinator" will be selected as the primary individual in charge; this is 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 and Office of the First Selectman 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 and Office of the First Selectman 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 Plan in the Town's library of planning documents. **The 2002 Plan of Conservation and Development is due to be updated, which provides an opportunity for the town to incorporate elements of hazard mitigation into the new plan.**

Finally, information and projects in this planning document may be included in the annual budget and capital improvement plans as part of implementing the projects recommended in this plan.

11.2 Progress Monitoring and Public Participation

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

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 F will be filled out for specific project-related actions as appropriate. This worksheet is taken from the *Local Mitigation Planning Handbook.*

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[4]. 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 and the regional planning organization website.

[4] 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 local coordinator and the Office of the First 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 NWCCOG 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 assumes that the current version of this plan was adopted in December 2014 and will therefore expire in December 2019.

Table 11-1
Schedule for Hazard Mitigation Plan Update

Month and Year	Tasks
December 2015	Annual meeting to review plan content and progress
December 2016	Annual meeting to review plan content and progress
June 2017	Ensure that funding for the plan update is included in the fiscal year 2017-2018 budget
December 2017	Annual meeting to review plan content and progress
December 2018	Annual meeting to review plan content and progress
January 2019	Secure consultant to begin updating the plan, or begin updating in-house (Public Works/Engineering Dept.)
August 2019	Forward draft updated plan to DEMHS for review
September 2019 - November 2019	Process edits from DEMHS and FEMA and obtain the Approval Pending Adoption (APA)
December 2019	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:

- The regional planning organization
- Town of Salisbury
- Town of North Canaan
- Town of Norfolk
- Town of Cornwall

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.

Response & Recovery Division

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.

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(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.

Connecticut Department of Economic and Community Development
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.

Connecticut Department of Energy and Environmental Protection
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/

The Connecticut Department of Emergency Services and Public Protection is committed to protecting and improving the quality of life for all by providing a broad range of public safety services, training, regulatory guidance and scientific services utilizing enforcement, prevention, education and state of the art science and technology.

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.

Multidisciplinary Center for Earthquake Engineering and Research (MCEER)
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.

The National Association of Flood & Stormwater Management Agencies (NAFSMA)
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.

National Emergency Management Association (NEMA)
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.

Natural Hazards Center
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 Canaan	Report Sections							Category	Responsible Department[1]	Timeframe	Cost	Potential Funding Sources[3]	Weighted STAPLEE Criteria[4]																Total STAPLEE Score
														Benefits								*Costs*								
		Flooding	Hurricanes and Tropical Storms	Summer Storms and Tornadoes	Winter Storms	Earthquakes	Dam Failure	Wildfires	1. Prevention 2. Property Protection 3. Natural Resource Prot. 4. Structural Projects 5. Public Information 6. Emergency Services			Low = Minimal[2] Intermediate = <$100,000 High = >$100,000		Social	Technical (x2)	Administrative	Political	Legal	Economic (x2)	Environmental	**STAPLEE Subtotal**	Social	Technical (x2)	Administrative	Political	Legal	Economic (x2)	Environmental	**STAPLEE Subtotal**	
	ALL HAZARDS																													
1	Acquire a local emergency notification system like CTAlert and utilize it to its fullest capabilities	x	x	x	x	x	x	x	6	EMD	7/2015-6/2016	Intermediate	EMP	1	0.5	0.5	0	0	0.5	0	**3.5**	0	0	0	0	0	-0.5	0	**-1.0**	**2.5**
2	Encourage residents to purchase and use NOAA weather radios with alarm features	x	x	x	x	x	x	x	6	EMD	7/2015-6/2016	Low	Municipal	1	0	0	0	0	0	0	**1.0**	0	0	0	0	0	0	0	**0.0**	**1.0**
3	Obtain funding to acquire backup generators for the senior center and Falls Village Day Care Center	x	x	x	x	x	x	x	6	EMD	7/2015-6/2017	Intermediate	* HMA, STEAP	1	1	1	0	0	1	0	**6.0**	0	0	0	0	0	-0.5	0	**-1.0**	**5.0**
4	Ensure that emergency information is available through several different media, such as newspaper, radio, internet and phone .	x	x	x	x	x	x	x	5,6	EMD	1/2015-12/2015	Low	Municipal	1	0	0	0	0	0	0	**1.0**	0	0	0	0	0	0	0	**0.0**	**1.0**
	FLOODING - Prevention																													
5	Consider reviewing and updating the Town's Inland Wetland Regulations, which were last amended in 1975. Note that the "Flood Hazard Control Measures" section of the town ordinance is the appropriate location for incorporating the most recent DEEP Model Floodplain Management Regulations.	x	x	x					1	P&Z	1/2015-12/2015	Low	Municipal	1	1	0.5	0	0	0.5	0.5	**5.0**	0	0	0	-0.5	0	0	0	**-0.5**	**4.5**
6	As recommended by the POCD, review the Flood Hazard Control Measures section of the town ordinance to incorporate the most recent DEEP Model Floodplain Management Regulations.	x	x	x					1	P&Z	1/2015-12/2015	Low	Municipal	1	1	0.5	0	0	0.5	0.5	**5.0**	0	0	0	-0.5	0	0	0	**-0.5**	**4.5**
7	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					2	P&Z	1/2016-12/2017	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	x	x	x																										
8	Encourage property owners to purchase flood insurance under the NFIP.	x	x	x					2,5	Building Official	1/2016-12/2017	Low	Municipal	1	0	0	0	0	0	0	**1.0**	0	0	0	0	0	0	0	**0.0**	**1.0**
9	Consider conducting a comprehensive evaluation of the Housatonic and Hollenbeck River watersheds study to determine appropriate flood mitigation and stabilization measures.	x	x	x					2	PW	1/2016-12/2017	Intermediate	HMA, STEAP	1	0.5	0.5	0	0	1	0	**4.5**	0	0	0	0	0	-1	0	**-2.0**	**2.5**
10	Consider constructing a flood wall or berm around the side of the High School that is near the Housatonic River.	x	x	x					2	PW	1/2016-12/2017	High	HMA, STEAP	1	1	1	0	0	1	0	**6.0**	0	0	-0.5	0	0	-1	0	**-2.5**	**3.5**
	FLOODING - Public Education																													
11	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					2,5	P&Z	1/2015-12/2015	Low	Municipal	1	0	0	1	0	0	0	**2.0**	0	0	-0.5	0	0	0	0	**-0.5**	**1.5**
12	Ensure that the appropriate municipal personnel are trained in flood damage prevention methods.	x	x	x					2	P&Z	1/2015-12/2015	Low	Municipal, EMI, CAFM	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	x	x	x																										
13	Pursue acquisition of additional municipal open space in SHFAs and set it aside for greenways, parks, etc.	x	x	x					2,3	First Selectman	7/2018-12/2019	High	HMA, private funds	1	0.5	0.5	0.5	0	0.5	1	**5.0**	0	0	0	0	0	-1	0	**-2.0**	**3.0**
	FLOODING - Structural Projects																													
14	Review culvert conveyances based on existing hydrology and Northeast Regional Climate Center guidance.	x	x	x					1,2	PW	7/2017-6/2018	Intermediate	Municipal	1	0.5	0.5	0	0	0	0.5	**3.0**	0	0	-0.5	0	0	0	0	**-0.5**	**2.5**
15	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					2	PW	7/2018-6/2019	Low	Municipal, STEAP	1	0	0	0	0	0	1	**2.0**	0	0	0	0	0	0	0	**0.0**	**2.0**
16	Consider the use of beaver deterrent devices such as beaver stops, beaver bafflers or beaver deceivers.	x	x	x					2,4	PW	7/2017-6/2018	Intermediate	Municipal	0.5	0.5	0	0	0	0.5	0	**2.5**	0	0	-0.5	0	0	-0.5	0	**-1.5**	**1.0**
17	Consider replacing culverts frequently impacted by beavers with free span bridges										7/2018-6/2019	High	Municipal	1	0.5	0.5	0	0	0.5	0	**3.5**	0	0	-0.5	0	0	-1	0	**-2.5**	**1.0**
	FLOODING - Emergency Services																													
18	Ensure adequate barricades are available to block flooded streets in floodprone areas	x	x	x					6	PW	1/2015-12/2015	Low	Municipal	1	0	0	0	0	0	0	**1.0**	0	0	0	0	0	0	0	**0.0**	**1.0**
19	Ensure the Emergency Management Services facility is sited outside the SFHA and 500-year flood zone as rquired by State law.	x	x	x					6	EMD	1/2015-12/2015	Low	Municipal	1	0	0.5	0	0	0	0	**1.5**	0	0	0	0	0	0	0	**0.0**	**1.5**
20	Consider conducting an ingress/egress evacuation routes analysis for the Housatonic Valley Regional High School.	x	x	x					2,6	EMD	7/2015-6/2016	Low	Municipal	1	0	1	0.5	0	0	0	**2.5**	0	0	-0.5	0	0	-0.5	0	**-1.5**	**1.0**
	WIND DAMAGE RELATED TO HURRICANES, SUMMER STORMS, AND WINTER STORMS																													
21	Develop a town wide tree limb inspection and maintenance program to ensure that the potential for downed power lines is diminished.		x	x	x				2	PW	1/2016-12/2016	Low	Municipal	1	0.5	0.5	0	0	0	0	**2.5**	0	0	0	0	0	0	0	**0.0**	**2.5**
22	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	Building Official, EMD	1/2016-12/2017	Low	Municipal	1	0.5	0	0	0	0	0	**2.0**	0	0	0	0	0	0	0	**0.0**	**2.0**
23	The Building Department should provide literature regarding appropriate design standards for wind.									Building Official	1/2016-12/2016	Low	Municipal	1	0	0	0	0	0	0	**1.0**	0	0	0	0	0	0	0	**0.0**	**1.0**
	WINTER STORMS																													
24	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	PW	1/2015-12/2015	Low	Municipal	1	1	1	0	0	0.5	0	**5.0**	0	0	-0.5	0	0	0	0	**-0.5**	**4.5**
25	The town may consider utilizing snow fencing in areas prone to snow drift				x					PW	1/2018-12/2018	Intermediate	Municipal	1	0	0	0	0	0	0	**1.0**	0	0	0	0	0	-0.5	0	**-1.0**	**0.0**
26	Consider posting the snow plowing routes in Town buildings each winter to increase public awareness.				x				5	PW	1/2017-12/2017	Low	Municipal	1	1	1	0	0	0.5	0	**5.0**	0	0	0	0	0	0	0	**0.0**	**5.0**
27	Emergency personnel should continue to identify areas that are difficult to access during winter storm events and devise contingency plans to access such areas during emergencies.				x				6	EMD, PW	1/2016-12/2016	Low	Municipal, EOC	1	0	0.5	0.5	0	0	0	**2.0**	0	0	0	0	0	0	0	**0.0**	**2.0**
28	The Building Department should provide literature regarding appropriate design standards for mitigating icing, insulating pipes, and retrofits for flat-roofed buildings such as heating coils.				x				5	Building Official	1/2016-12/2016	Low	Municipal	1	0	0	0	0	0	0	**1.0**	0	0	-0.5	0	0	0	0	**-0.5**	**0.5**
	EARTHQUAKES																													
29	Consider preventing residential development in areas prone to collapse					x			1,2	P&Z	1/2018-12/2018	Low	Municipal	1	0.5	0	0	0	0	0	**2.0**	0	0	0	0	0	0	0	**0.0**	**2.0**
30	Ensure that municipal departments have adequate backup facilities in case earthquake damage occurs to municipal buildings.					x			1,2	EMD, PW	1/2019-12/2019	Intermediate	Municipal, EOC, STEAP	1	0	0.5	0	0	0	0	**1.5**	0	0	0	0	0	-0.5	0	**-1.0**	**0.5**
31	Consider bracing vulnerable systems and assets inside critical facilities. This could help protect IT systems, important records and files.					x			2,6	EMD, PW	1/2019-12/2019	High	Municipal, EOC, STEAP	1	0	0.5	0	0	0	0	**1.5**	0	0	0	0	0	-0.5	0	**-1.0**	**0.5**

	Strategies and Actions for the Town of Canaan	Report Sections							Category	Responsible Department[1]	Timeframe	Cost	Potential Funding Sources[3]	Weighted STAPLEE Criteria[4] – Benefits								Weighted STAPLEE Criteria[4] – Costs								Total STAPLEE Score
		Flooding	Hurricanes and Tropical Storms	Summer Storms and Tornadoes	Winter Storms	Earthquakes	Dam Failure	Wildfires	1. Prevention 2. Property Protection 3. Natural Resource Prot. 4. Structural Projects 5. Public Information 6. Emergency Services			Low = Minimal[2] Intermediate = <$100,000 High = >$100,000		Social	Technical (x2)	Administrative	Political	Legal	Economic (x2)	Environmental	**STAPLEE Subtotal**	Social	Technical (x2)	Administrative	Political	Legal	Economic (x2)	Environmental	**STAPLEE Subtotal**	
	DAM FAILURE																													
32	Include dam failure innundation areas in the CT Alert emergency notification system contact database						x		6	EMD	7/2016-6/2017	Low	Municipal	1	0	0.5	0	0	0	0	**1.5**	0	0	0	0	0	0	0	**0.0**	**1.5**
33	Collect EAP's for Class B and C dams and file them with the appropriate town departments and emergency personnel						x		6	EMD	1/2015-12/2015	Low	Municipal	1	0	0.5	0	0	0	0	**1.5**	0	0	0	0	0	0	0	**0.0**	**1.5**
	WILDFIRES																													
34	For the area of elevated wildfire risk located along the Appalachian Trail, consider a combination of all of the available methods of wildfire risk reduction.							x	2,3	Fire Department	1/2017-12/2017	Low	Municipal	1	0.5	0.5	0	0	0	1	**3.5**	0	0	0	0	0	-0.5	0	**-1.0**	**2.5**
35	Evaluate the need for maintenance of the town fire ponds.							x	6	Fire Department	1/2017-12/2017	Low	Municipal	1	0.5	0	0	0	0	1	**3.0**	0	0	-0.5	0	0	0	0	**-0.5**	**2.5**
36	Revise and enhance the town's website concerning the local regulatory requirements concerning Open Burning							x	5	Fire Department	1/2015-12/2015	Low	Municipal	1	0	0	0	0	0	0	**1.0**	0	0	0	0	0	0	0	**0.0**	**1.0**
37	Continue to require the installation of fire protection water in new developments.							x	5	Fire Department	1/2015-12/2016	Low	Municipal	1	0.5	0	0	0	0	0	**2.0**	0	0	0	0	0	-0.5	0	**-1.0**	**1.0**

NOTES

1. Departments:
   - EMD = Emergency Management Director
   - PW = Department of Public Works
   - P&Z = Planning & Zoning Commission
2. Low = To be completed by staff or volunteers where costs are primarily printing, copying, or meetings and costs are less than $10,000; Moderate = Costs are less than $100,000; High = Costs are > than $100,000.
3. 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)
   - EMI = Emergency Management Institute (no charge for town staff)
   - CAFM = Connecticut Association of Flood Managers (www.ctfloods.org)
   - Private = Weantinoge Heritage Land Trust, Inc. and/or the Heritage Land Preservation Trust
   - EMP = Emergency Management Performance grant

3. 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 Canaan
108 Main Street
P.O. Box 47
Falls Village, CT 06031-0047

TOWN of CANAAN 1739 FALLS VILLAGE
"Liberty and Property"

AN EQUAL OPPORTUNITY EMPLOYER, PROVIDER AND HOUSING ADVOCATE

Telephone: 860 824-0707
Fax: 860 824-4506
E-mail: canaan021@comcast.net

A RESOLUTION ADOPTING THE TOWN OF CANAAN HAZARD MITIGATION PLAN WHEREAS, the Town of Canaan 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 Canaan 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 2013 and 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 Canaan; and

WHEREAS, the Plan recommends several hazard mitigation actions/projects that will provide mitigation for specific natural hazards that impact the Town of Canaan, 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 Canaan 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

Canaan;

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 30th day of December, 2014 by the Board of Selectman of Canaan, Connecticut

Patricia Allyn Mechare

First Selectman

IN WITNESS WHEREOF, the undersigned has affixed ~~his~~/her signature and the corporate seal of the Town of Canaan this 5th day of JAN, ~~2014.~~ 2015.

MARY M. PALMER

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 Canaan 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.

The applicant is Michael J. Renzullo, who is a selectman but is applying as founder and executive director of Laurel City Revamp, a nonprofit that aims to clean up and refurbish old downtown mill buildings.

Despite support for the project from the public that attended the hearing, commission members had concerns about what they considered to be incomplete plans and whether the site can accommodate enough parking safely. Renzullo is proposing to have a 24-space parking garage in the basement, a bakery, a gallery and possibly a pub on the first floor and four upscale apartments on the second floor.

CORNWALL

Northwest Corner residents asked about storm damage

Citizens and town officials in Canaan, Cornwall, Falls Village, Kent, Roxbury, Salisbury, Sharon, Warren and Washington are being asked for their input on which storms and other natural hazards have affected their homes, businesses or towns and to give ideas on how future damage can be prevented.

These ideas will be used to create a Natural Hazard Mitigation plan for each town. People can provide their input in two ways, either by attending a meeting which will be held Nov. 7 at 7 p.m. at Cornwall Town Hall (24 Pine St.) or by taking an online survey at surveymonkey.com/s/northwestctplans.

BURLINGTON

Celebration of Veterans Nov. 7 at Mills High School

Lewis S. Mills High School is hosting its annual Celebration of Veterans program Nov. 7, and all veterans who live in Harwinton or Burlington, the towns in the Region 10 school system, are invited.

Luncheon will be from noon to 1 p.m., followed by an assembly in the auditorium from 1 to 2 p.m.

Throughout the day, community members are invited to view students' artwork displayed in the main lobby and adjacent hallway.

For information and to RSVP, call 860-673-0423 x15311. If leaving a phone message, indicate full name and telephone number.

>>> OBITUARIES ON PAGES 6-7B

her time, is shown digging up the bed at the corner of Route 202 and Maple Street to make room for new bulbs that will bloom in the spring.

JOHN MCKENNA
REPUBLICAN-AMERICAN

ELECTION 2013: TORRINGTON, HARWINTON, THOMASTON

Familiar names on Torrington tickets

BY ALEC JOHNSON
REPUBLICAN-AMERICAN

TORRINGTON — The city's political parties both are running slates of local powerhouse candidates for City Council, heavy with experience and names people know in many venues around Torrington.

In an election that guarantees a new mayor and at least three new council members, political leaders hope the well-known candidates will appeal to voters and then go on to impact budgets, economic development and education.

Republicans and Democrats, all of whom have pledged to work with their opponents and with the new mayor after Election Day on the historically cooperative council, say their candidates bring a wealth of diverse experience. Eight candidates, four from each party, are running for six seats. The council's terms are for two years, to the mayor's four-year term.

Republicans Gregg G. Cogswell and Drake L. Waldron and Democrat Paul F. Samele Jr. are seeking re-

See COUNCIL, Page 8B

First selectman rematch stirs Harwinton's interest

BY ALEXA GORMAN
REPUBLICAN-AMERICAN

HARWINTON — A rematch is on Nov. 5 between the first selectman and the former first selectman who lost his seat by 30 votes in 2011.

There have been no debates or joint public appearances, and mailboxes have been largely free of mudslinging on mailers, but acrimony lingers between can-

Criss, 38, and Chiaramonte, 77, both said they want to preserve the town's rural character, to continue to preserve the town's open space and to stabilize the tax base. Both candidates also say they are running on their records.

The similar platforms might raise eyebrows among voters. Criss had an answer for that, too.

"This has been a frustrating election

Mone stands by his record, Mosimann is for planning

BY ALEXA GORMAN
REPUBLICAN-AMERICAN

THOMASTON — First Selectman Ed Mone is basing some of his campaign for a third term on past achievements. Democratic challenger Kristin Mosimann hopes voters look to the future.

"One of our goals is to bring a long-term strategic plan to every decision we

back to bite us."

Mosimann, 45, has served on the Board of Finance for eight years. She said she has been an advocate and educator of changes the board has made to prepare for the future. During her tenure on the board, she fought for the pension reforms and the changes made to retiree medical benefits. The pension reforms switched from

A-12

Kent plans for natural hazards

Plan required to seek grant for generator

BY LYNN MELLIS WORTHINGTON
REPUBLICAN-AMERICAN

CORNWALL — Kent First Selectman Bruce K. Adams will be among those attending a public meeting today at 7 p.m. at Cornwall Town Hall, 24 Pine St., to discuss the mitigation of natural hazards.

Adams said Wednesday that Kent must develop a hazard mitigation plan to qualify for a state grant to purchase a new generator.

All towns are required to have such a plan.

"We've put in an application for a generator at the Community House and we have to have a hazardous mitigation plan in place before you can get the money," Adams said.

Kent is completing its grant application through the Northwestern Connecticut Council of Governments and Adams said the town has been moved to the top of the list.

Residents of Canaan, Cornwall, Kent, North Canaan, Roxbury, Salisbury, Sharon, Warren and Washington are invited to the meeting to give their input on which storms and other natural hazards have affected their homes, businesses, or towns. Ideas will be sought on how future damage can be prevented.

Area residents can also provide input by taking an online survey at www.surveymonkey.com/s/northwestctplans.

Contact Lynn Mellis Worthington at lynnmellw@gmail.com or on Twitter @lynnmellw.

Regional

In The Journal this week

Three-day forecast

Friday.................... **Rain/wind, high 64°/low 38°**
Saturday.................... **Some sun, 59°/35°**
Sunday.................... **Some sun, 48°/25°**

Lakeville Weather History

by The Lakeville Journal

Date	Min.	Max.	Conditions
Oct 23	30	52	Mostly Cloudy
Oct 24	32	63	Mostly Cloudy
Oct 25	27	51	Cloudy
Oct 26	25	56	Partly Sunny
Oct 27	39	55	Partly Sunny
Oct 28	27	59	Partly Sunny
Oct 29	31	48	Mostly Sunny

Great Mountain Forest, its past and its future

Input sought on natural hazard mitigation plan

Citizens and town officials in Canaan/Falls Village, Cornwall, Kent, North Canaan, Roxbury, Salisbury, Sharon, Warren and Washington are being asked for their input on which storms and other natural hazards have affected their homes, businesses or towns, and ideas on how future damage can be prevented.

These ideas will be used to create a natural hazard mitigation plan for each town. People can provide their input in two ways: by attending a public meeting which will be held on Thursday, Nov. 7, at 7 p.m. at the Cornwall Town Hall or by taking an online survey which can be accessed at www.surveymonkey.com/s/northwestctplans.

'Ragtime' at Hotchkiss School

LAKEVILLE — The Hotchkiss Dramatic Association presents "Ragtime: The Musical" from Nov. 14 to 17 in the school's Walker Auditorium. The cast is comprised of 56 students; the show is directed by R. Allen

A-14

POLICE BLOTTER

The following information was provided by the Connecticut State Police at Troop B. All suspects are considered innocent until proven guilty in a court of law.

Car hits guardrail

Liliana Melina Angel, 49, of Ocala, Fla., was driving south on Route 7 in North Canaan on Oct. 19. At about 8:27 a.m., about .7 miles north of Stein Lane, the 2012 Nissan Versa drifted off the right side of the road. It hit a guardrail. The entire side of the car was damaged. Melina Angel was not injured. She was charged with failure to maintain the proper lane.

Evading driver

Eugene Killen, 52, of Sharon was driving north on Route 361 in Sharon Oct. 24. At about 3:49 p.m., he turned onto Silver Lake Shore Road. The front bumper of his 2006 Ford F150 hit the left front quarter panel of a 2012 Subaru Forester driven by Cristina Comeau, 52, of Sharon. Comeau was stopped on Silver Lake Shore Road at the intersection. There were no injuries. Killen continued on without stopping. He was later found and given a written warning for failure to drive right.

Car stolen

A motor vehicle was reported stolen from a Beebe Hill Road residence Oct. 25. Patrice Mc-

December 3, 2013

To:

Richard Byrne, EMD, Town of Norfolk, CT	Ryan Courtien, Town Supervisor, Town of Dover, NY
Jim O'Leary, EMD, Town of Goshen, CT	Bill Flood, Town Supervisor, Town of Amenia, NY
Tom O'Hare, EMD, Town of Litchfield, CT	Edward Harvey, EMD, Town of New Marlborough, MA
Tony Gedraitis, EMD, Town of Morris, CT	Brian Tobin, Selectboard Chair, Town of Mount Washington, MA
Michael Devine, EMD, Town of Bethlehem, CT	Rhonda LaBombard, Town Administrator, Town of Sheffield, MA
Randy Ashmore, EMD, Town of Woodbury, CT	Dana Smith, Dutchess County Department of Emergency Response (NY)
Carol Hubert, Chief of Staff, Town of Southbury, CT	Rick Lynn, Planning Director, LHCEO (CT)
Anne Marie Lindblom, Assistant to the First Selectman, Town of Bridgewater, CT	David Hannon, Deputy Director, HVCEO (CT)
Mike Zarba, Director of Public Works, Town of New Milford, CT	Sam Gold, Acting Executive Director, COGCNV (CT)
Clay Cope, First Selectman, Town of Sherman, CT	Mark Maloy, Berkshire Regional Planning Commission (MA)
John Merwin, Town Supervisor, Town of North East, NY	

RE: Hazard Mitigation Plans for Canaan, Cornwall, Kent, North Canaan, Salisbury, Sharon, Roxbury, Warren, and Washington (Connecticut)
MMI #3843-04-1

Milone & MacBroom, Inc. (MMI) is working with the towns of Canaan, Cornwall, Kent, North Canaan, Salisbury, Sharon, Roxbury, Warren, and Washington to develop hazard mitigation plans. In recent years, 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 are the representative that may be involved with hazard mitigation planning in your municipality, and therefore will have the most valuable input for the plans being developed for Canaan, Cornwall, Kent, North Canaan, Salisbury, Sharon, Roxbury, Warren, and Washington. Please take a moment to share your thoughts for the following:

1. Does your municipality face any shared hazards with Canaan, Cornwall, Kent, North Canaan, Salisbury, Sharon, Roxbury, Warren, or Washington that could be addressed by both communities? Examples could be flooding along a stream that flows across a town boundary or windstorms 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 Canaan, Cornwall, Kent, North Canaan, Salisbury, Sharon, Roxbury, Warren, and Washington 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 either of the undersigned via email (davem@miloneandmacbroom.com or maryellene@miloneandmacbroom.com) or telephone (203-271-1773). A written response is not necessary. Thank you for your time.

David Murphy, P.E., CFM
Managing Project Engineer, Water Resources

Maryellen Edwards
Environmental Scientist

3843-04-1-d213-ltr-move.docx

Meeting Minutes

HAZARD MITIGATION PLAN
Public Information Meeting for NWCCOG Communities
November 7, 2013 7 P.M.

A. Welcome & Introductions

The following individuals attended the public information meeting:

- Gordon Ridgway, Town of Cornwall First Selectman
- Skip Kearns, Cornwall resident
- Heidi Kearns, Cornwall Planning and Zoning
- David Colbert, Cornwall Planning and Zoning
- Jack Travers, Town of Warren
- Michael Jastremski, Housatonic Valley Association
- Karen Bartomioli, Lakeville Journal
- Jocelyn Ayer, NWCCOG
- Scott Bighinatti, Milone & MacBroom, Inc. (MMI)

Two other members of the public attended who did not sign-in. At least one of the members was from the Town of Kent.

B. Power Point Presentation

Mr. Bighinatti gave a presentation describing the background of hazard mitigation planning, the goals at the local level, the availability of grant funding, the types of projects that could be performed, and the types of hazards that could affect the local communities.

C. Public Input and Discussion

Prior to the meeting, Mr. Jastremski provided information on the Stream Habitat Continuity Surveys that the Housatonic Valley Association will be conducting in 2014 and 2015. As these assessments will focus on improving areas where roads cross over streams, there is the potential to tie these surveys into hazard mitigation planning activities.

The group had questions as to how the plans are being funded. Ms. Ayer explained that the plan for each community was being 75% funded under a grant through FEMA. The remaining 25% of the funding is being paid for out of NWCCOG member dues.

The group had additional questions regarding the FEMA grant programs. Mr. Bighinatti explained that these particular plans would not affect any funding opportunities to which NWCCOG communities were already entitled. Instead, adoption of the plans open up additional opportunities to obtain grant funding.

The group mentioned that the prevalence of dead end roads in the area make emergency access difficult, particularly when trees fall and strand residents. The representative from Warren indicated that their community had been opening up unimproved sections of roads in order to provide emergency access via a second egress.

The Downtown Streetscape project in Kent was mentioned as a potential mitigation area for overhead power lines. Mr. Bighinatti explained that while moving overhead wires underground is a project eligible for grant funding, such projects are very expensive often do not generate enough benefits to be considered cost-effective and therefore qualify for a grant.

A discussion regarding the resizing of culverts took place. One example was how the West Cornwall Bridge overtopped in 1955 causing significant flooding along Main Street. While the current bridge was sized for a particular storm event at the time, Mr. Bighinatti explained that as the frequency and magnitude of rainfall has been increasing over the past several decades many communities are finding that their infrastructure can no longer convey the same frequency storm event without overtopping. A standard recommendation in each plan will be to review culvert conveyance based on existing hydrology.

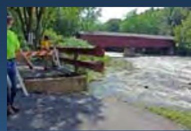
The group mentioned that beaver dams were a big concern related to flooding, particularly in Cornwall. Town personnel should be contacted to obtain more information regarding these areas and existing mitigation measures.

Mr. Ridgway discussed the importance of these particular FEMA grants in relation to being able to fund new generators. The Town of Cornwall is seeking a $40,000 grant under HMGP for a new generator at the West Cornwall Fire House. He also mentioned that a section of streambed along River Road is located near the road elevation and a recent flood almost washed out the road. This could potentially be an area where a grant could be useful. Also, the Town has a concern with a privately-owned dam on Popple Swamp Road. It is owned by an absentee landowner who has reportedly not been doing the proper maintenance on the dam. The Town has contacted the Dam Safety Division at DEEP but no progress has been made.

Siltation in Lake Waramaug Pond in Warren was mentioned as an issue. A large area has filled in with silt that is potentially reducing the flood storage capacity of the pond. The Town would like to get a grant to dredge the sediment.

Natural Hazard Mitigation Plans
Northwestern Connecticut Council of Governments

PDM PRE-DISASTER MITIGATION



HMGP HAZARD MITIGATION GRANT PROGRAM

Presented by:
Scott Bighinatti, CFM
Milone & MacBroom, Inc.

November 7, 2013

MILONE & MACBROOM

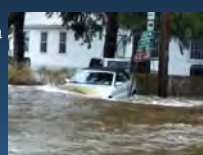
History of Hazard Mitigation Planning

- 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

MILONE & MACBROOM

What is a Natural Hazard?

- An extreme natural event that poses a risk to people, infrastructure, and resources



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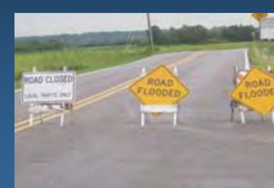
What is Hazard Mitigation?

- 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

MILONE & MACBROOM

How Can the Plans 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 >$20M to distribute under HMGP

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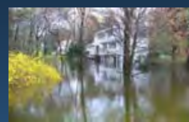
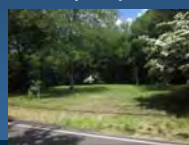
Update on Hazard Mitigation Grant Programs

- 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

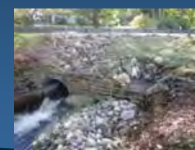


MILONE & MACBROOM®

Update on Hazard Mitigation Grant Programs

Culvert Replacement to be funded by HMGP

Floyd 1999



Irene 2011

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Update on Hazard Mitigation Grant Programs

Riverbank Stabilization to be funded by HMGP

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Components of Hazard Mitigation Planning Process

- Identify natural hazards that could occur in each town
- Assess the vulnerability of structures and populations and identify critical facilities and areas of concern
- Incorporate effects of federally declared disasters and other events 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 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 documents
- State and FEMA approvals
- Local adoptions

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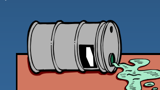
What a Hazard Mitigation Plan Does Not Address

- Terrorism and Sabotage
- Disaster Response and Recovery
- Human Induced Emergencies (some fires, hazardous spills and contamination, disease, etc.)



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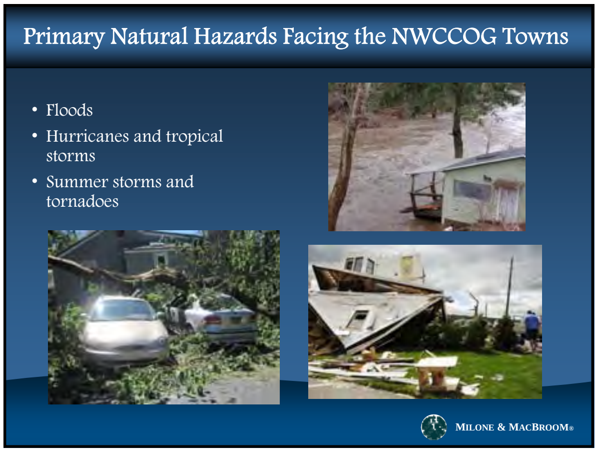
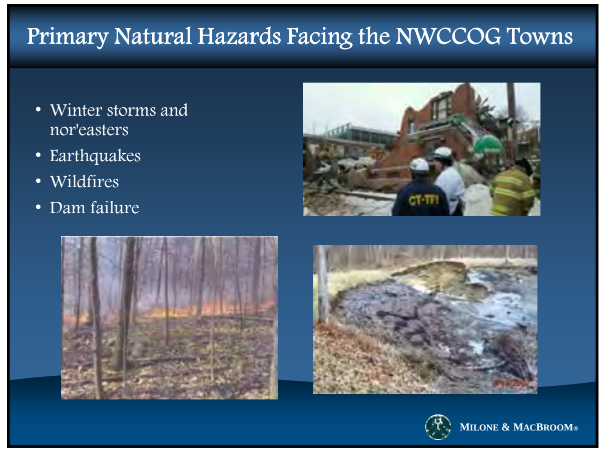
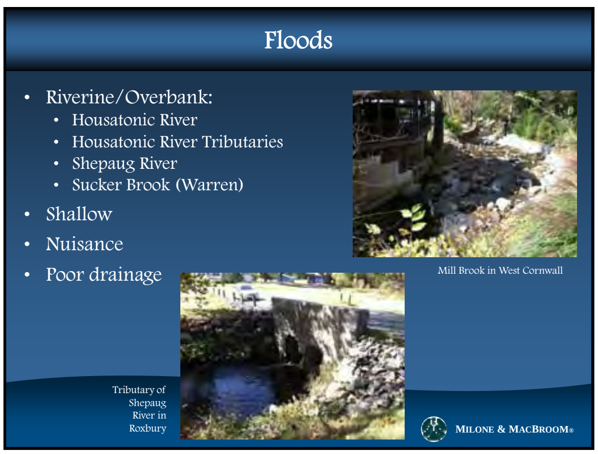
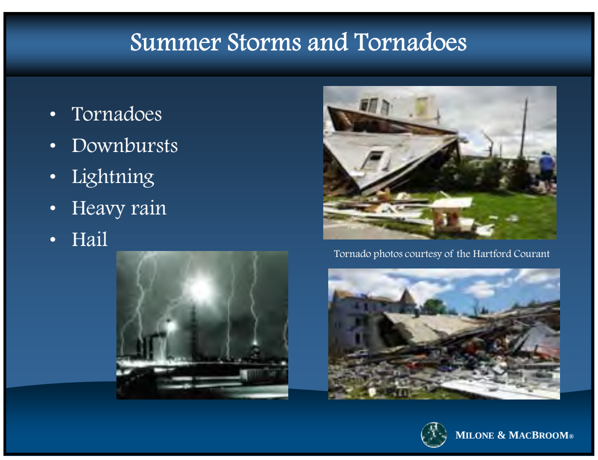

Primary Natural Hazards Facing the NWCCOG Towns
• Floods
• Hurricanes and tropical storms
• Summer storms and tornadoes
MILONE & MACBROOM


Primary Natural Hazards Facing the NWCCOG Towns
• Winter storms and nor'easters
• Earthquakes
• Wildfires
• Dam failure
MILONE & MACBROOM


Floods
• Riverine/Overbank:
• Housatonic River
• Housatonic River Tributaries
• Shepaug River
• Sucker Brook (Warren)
• Shallow
• Nuisance
• Poor drainage
Mill Brook in West Cornwall
Tributary of Shepaug River in Roxbury
MILONE & MACBROOM


Hurricanes and Tropical Storms
• Strong winds
• Heavy rain
• Floods
1955 Flood Images
MILONE & MACBROOM


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
The Blizzard of 1978
STORM SNOWFALL POTENTIAL
INCHES
>18
>12
6-12
3-6
1-3
MILONE & MACBROOM

Winter Storms and Nor'easters

- Collapsed Buildings

Photos courtesy of the Hartford Courant

MILONE & MACBROOM®

Earthquakes

- Connecticut is prone to very low-energy earthquakes
- Can cause dam failure, shaking, liquefaction, slides/slumps

Photos courtesy of FEMA

MILONE & MACBROOM®

Wildfires

- Fire
- Heat
- Smoke
- April is the month of maximum risk in Connecticut

Photos courtesy of FEMA and the Middlebury Fire Department

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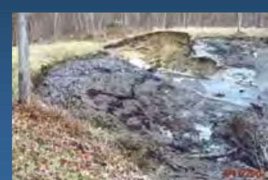
Dam Failure

- 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 are in the region



Recent dam failure in Sherman, CT

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Hazard Mitigation Categories

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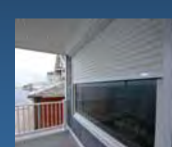
Typical Hazard Mitigation Strategies

- 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
- Harden utilities
- Strengthen tree maintenance
- Enhance fire suppression capabilities
- Public education programs
- Dissemination of public safety information



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Next Steps
• Incorporate input from residents, business owners, and public officials
• Survey will be open through end of November:
https://www.surveymonkey.com/northwestctplans
• Develop mitigation strategies
• Prepare draft plans for review by the municipalities and the public
• Adopt and implement the plans
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Questions & Input

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Development of Hazard Mitigation Plan for the Town of Canaan

Presented by:
Maryellen Edwards
Milone & MacBroom, Inc.

February 26, 2014

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

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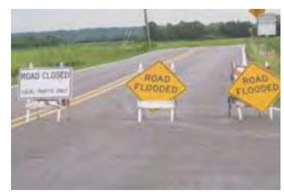
What is Hazard Mitigation?

- 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 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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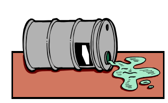
What a Hazard Mitigation Plan Does Not Address

- 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
  - o PDM (Pre-Disaster Mitigation) – annual
  - o FMA (Flood Mitigation Assistance) – annual
  - o HMGP (Hazard Mitigation Grant Program) – after disasters
- Connecticut has $16M to distribute under HMGP – allocated to infrastructure and elevations or acquisitions of floodprone properties

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

FEMA's new cost effectiveness guidelines will make acquisitions and elevations easier

This home in Trumbull was acquired and demolished using a FEMA grant

How Can the Plan be Used?

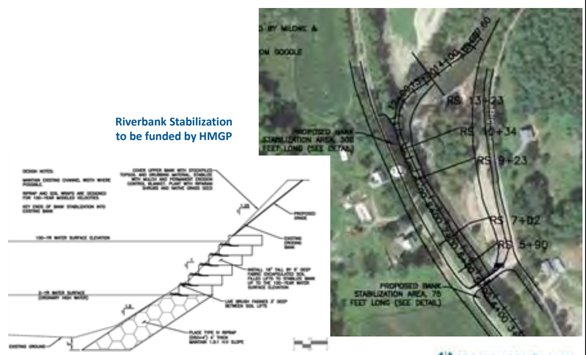
Culvert Replacement to be funded by HMGP

Floyd 1999

Irene 2011

How Can the Plan be Used?

Riverbank Stabilization to be funded by HMGP



Hazards Proposed to Include in the Plan

- Floods
- Hurricanes and tropical storms
- Summer storms and tornadoes

Hazards Proposed to Include in the Plan

- Winter storms and nor'easters
- Earthquakes
- Wildfires
- Dam failure
- Landslides (optional)

Components of Hazard Mitigation Plan Process

- Review natural hazards that could occur in Canaan
- 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

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

Scope of Services and Schedule

- Task 1 – Project Initiation and Data Collection: February 2014
- Task 2 – Risk and Vulnerability Assessment: HAZUS already completed; additional analysis March 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

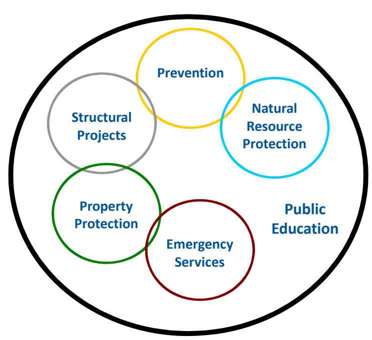
Data Collection and Discussion

- What are Canaan'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?

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

Hazard Mitigation Strategies



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 Canaan

- Goals?
- Strategies and actions?
- What one or two things can be done in Canaan with current budgets?
- What one or two things would be done in Canaan if money was not a concern?

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Next Steps

- 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 Canaan (Falls Village)
February 26, 2014

A meeting was held on February 26, 2014 to begin the hazard mitigation planning process. Handouts were used to provide structure for the meeting. A copy is attached.

The meeting attendees included:

- Ms. Patricia Mechare – First Selectman
- Mr. Tim Downs – Fire Chief/Highway Department
- Ms. Maryellen Edwards – Milone & MacBroom, Inc. (MMI)

The following were discussion points:

Critical Facilities include:

- Lee H. Kellogg School – is a critical facility – it does not have standby power
- Falls Village Volunteer Fire Department is the primary shelter – it has standby power and can accommodate cots
- The Town Hall – is the backup shelter – it does have standby power
- The Highway Garage – does have standby power
- Senior Center – does not have standby power
- Falls Village Day Care Center – does not have standby power

At this time the town does not have a full-fledged shelter – However, the town has received a 2.3 million dollar grant to construct a new Emergency Management Services facility. The facility will house the fire and ambulance services and once completed will operate as the official shelter. It is expected that construction will commence within the next year.

- The town subscribes to the CTAlert Emergency notification system and utilizes this method of notification for town residents.

- The main evacuation routes for the town are State Roads 7, 126, and 63

- Drainage complaints are routed to Highway Department and First Selectman

- Development Trends - very little development – no major developments are planned. Most development is limited to a few single-family homes per year.

- Town officials indicated that a local group has applied for an Incentive Housing Zone Grant to conduct a feasibility study in order to determine if the land is suitable for development.

- Utilities in new developments are required to be placed underground. The town would like to replace overhead utilities with underground but the cost is too great.

- Town officials mentioned that the Housatonic Valley Association has submitted a grant application to conduct stream habitat continuity assessments at culverts in northwest Connecticut. The town plans to send a letter supporting this program.

Flooding:

- Cobble Road continually floods due to beaver activity. The road is currently closed. Culverts have been replaced through the years but it has not necessarily helped with the flooding. Historically, the land owners have not wanted to trap the beavers and therefore the problem has been ongoing.

- Music Mountain is also a chronic flooding area due to beaver activity – the land owners do allow trapping and the problems are not a severe as they are on Cobble Road.

- Chronic flooding also occurs along Routes 7, 63 and 126 – each of these roads flooded during Irene –

- The Housatonic River causes significant flooding in the town – a few years ago the Housatonic flooded the athletic fields at the Housatonic Valley Regional High School. Flooding is also a concern along Arnot Drive

- The NFIP administrator for the town is the First Selectman

- The town fared well during Sandy with respect to flooding (main impacts were tree damage)

- Town officials feel that the Robbins Swamp is a major contributor to flooding in the town.

- Culverts on Music Mountain Road and Barnes Road were recently replaced. The town does not have any other planned culvert replacements at this time.

- The Amesville/Water Street Bridge between Salisbury and Falls Village is scheduled for replacement in 2014-15 – it is currently in the design phase

- The town mentioned their support for the Housatonic Valley Association River and Stream Continuity Project -

Wind

- No specific areas in town are more prone to wind damage than any others. The town is mainly concerned with power outages from limbs hitting the lines – However, the town has a great relationship with CL&P and they have reportedly done a good job of conducting tree maintenance in Canaan. The town has a sufficient budget for tree maintenance.

- Thomas Scott is the tree warden

Winter Storms

- One barn collapsed during the January 2011 winter storms

- The town shovels snow from municipal buildings, including the local schools.

- Following Winter Storm Alfred, CL&P provided the town with a bucket truck for a week in order to allow them to clean up limbs and debris. Power outages lasted approximately a week following Alfred.

- The town has four plowing routes and five trucks. The fifth truck is mainly used for parking lots. The town uses a sand/salt mixture for pretreatment. The town budget of 48,000 is sufficient.

- The roof of an old barn collapsed in February 2014 - from heavy snow accumulation.

- Town officials indicated that the roof of the high school is in need of repair and that a "roof committee" has been created to determine best approach. Replacing the roof may have a positive impact with regard to heavy snows and potential collapses.

Wildfire –

- The town has mutual aid agreements for firefighting – with Millerton New York, Sharon, Cornwall, Salisbury, North Canaan, Norfolk and Sheffield Massachusetts

- The town supplies water to 125 residential and commercial customers from six wells and storage tanks.

- Approximately 55% of the land in Canaan is open space owned by Federal, State, or the Nature Conservancy. The Appalachian Trail and Music Mountain are areas of concern due to the potential for fires associated with campers/hikers.

- The town has ten hydrants in the center of town for firefighting support. There are also three fire ponds. At least one of the ponds is in need of maintenance (dredging).

Dams –

- The town does not have any specific concerns related to Dams – Most are well maintained.

- The Amesville/Water Street Bridge between Salisbury and Falls Village is scheduled for replacement in 2014-15 – it is currently in the design phase.

Mitigation Ideas

- The town has an interest in replacing culverts and burying utilities – if the funds were available.

HVA
www.hvatoday.org

Stream Habitat Continuity Surveys in Your Community

What is stream habitat continuity?
Stream habitat continuity describes the ability of fish and wildlife to move up and down the length of a stream. The Housatonic Valley Association (HVA) has been funded by the GE-Pittsfield Natural Resource Damages fund to conduct stream habitat continuity assessments in the Connecticut portion of the Housatonic River Watershed.

Why is stream continuity being assessed?
These assessments are meant to help us understand where stream habitat continuity has been interrupted by road crossings, and are an important first step in planning work in the stream to restore continuity. In addition to being barriers to fish and wildlife, crossings that break habitat continuity are often a hazard for the traveling public, and can interfere with emergency response during flood events. They can also expensive for municipalities and the state to maintain.

Where will stream continuity be assessed?
In general, stream habitat continuity assessments in your community will focus on places where roads cross over streams. HVA is interested in working with your community to understand which crossings are priorities in terms of highway management, flood preparedness and emergency services. Here's the good news about road/stream crossings; the same design principles that ensure safe passage for fish and wildlife make for safer, more resilient crossings that require less maintenance. Fixing these problematic crossings can be a real win-win for communities and the environment, and HVA wants to focus on crossings where replacement will accomplish multiple objectives.

Who will be conducting the assessments?
The stream habitat continuity assessment method that we'll be using was created by the River and Stream Continuity Project, housed at UMass Extension Service. HVA staff with help from trained volunteers will perform the actual assessments. The Connecticut Department of Energy and Environmental Protection's Inland Fisheries Division will also be conducting assessments in the Housatonic watershed concurrently with HVA.

When will the assessments occur?
Assessments will begin in December 2013, and continue through October of 2015.

HVA staff are available to meet in person to discuss how this project can benefit your town. For more information on this project or to schedule a meeting in your community, please contact Michael S. Jastremski, Water Protection Program Director by phone (860-672-6678), or by email (MJ.HVA@outlook.com).

APPENDIX E
HAZUS DOCUMENTATION

Hazus-MH: Flood Event Report

Region Name: Canaan

Flood Scenario: Hollenbeck River 100 Year

Print Date: Thursday, December 19, 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

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General Description of the 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.

The geographical size of the region is 33 square miles and contains 81 census blocks. The region contains over 0 thousand households and has a total population of 1,081 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 781 buildings in the region with a total building replacement value (excluding contents) of 153 million dollars (2006 dollars). Approximately 90.40% of the buildings (and 72.73% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 781 buildings in the region which have an aggregate total replacement value of 153 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	111,442	72.7%
Commercial	17,336	11.3%
Industrial	2,473	1.6%
Agricultural	1,166	0.8%
Religion	1,582	1.0%
Government	925	0.6%
Education	18,310	11.9%
Total	**153,234**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	53,491	83.5%
Commercial	7,538	11.8%
Industrial	1,300	2.0%
Agricultural	429	0.7%
Religion	904	1.4%
Government	435	0.7%
Education	0	0.0%
Total	**64,097**	**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 2 schools, 1 fire station, no police stations 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:	Canaan
Scenario Name:	Hollenbeck River 100 Year
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 2 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	1	50.00	1	50.00	0	0.00
Total	**0**		**0**		**0**		**1**		**1**		**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	1	50.00	1	50.00	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	0	0	0	0
Schools	2	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 157 tons of debris will be generated. Of the total amount, Finishes comprises 87% of the total, Structure comprises 8% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 6 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 20 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 9 people (out of a total population of 1,081) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 2.40 million dollars, which represents 3.74 % 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 2.40 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 65.79% 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	1.05	0.10	0.03	0.05	1.23
	Content	0.53	0.30	0.04	0.28	1.14
	Inventory	0.00	0.02	0.00	0.01	0.03
	Subtotal	**1.58**	**0.41**	**0.06**	**0.34**	**2.40**
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**	**1.58**	**0.41**	**0.06**	**0.34**	**2.40**

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	1,081	111,442	41,792	153,234
Total	**1,081**	**111,442**	**41,792**	**153,234**
Total Study Region	**1,081**	**111,442**	**41,792**	**153,234**

Hazus-MH: Flood Event Report

Region Name: Canaan

Flood Scenario: Housatonic River 100 Year

Print Date: Thursday, December 19, 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

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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.

The geographical size of the region is 33 square miles and contains 81 census blocks. The region contains over 0 thousand households and has a total population of 1,081 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 781 buildings in the region with a total building replacement value (excluding contents) of 153 million dollars (2006 dollars). Approximately 90.40% of the buildings (and 72.73% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 781 buildings in the region which have an aggregate total replacement value of 153 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	111,442	72.7%
Commercial	17,336	11.3%
Industrial	2,473	1.6%
Agricultural	1,166	0.8%
Religion	1,582	1.0%
Government	925	0.6%
Education	18,310	11.9%
Total	**153,234**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	8,678	31.7%
Commercial	1,567	5.7%
Industrial	211	0.8%
Agricultural	503	1.8%
Religion	0	0.0%
Government	350	1.3%
Education	16,080	58.7%
Total	**27,389**	**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 2 schools, 1 fire station, no police stations 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:	Canaan
Scenario Name:	Housatonic River 100 Year
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 6 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the scenario. There are an estimated 1 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	2	33.33	3	50.00	1	16.67
Total	**0**		**0**		**0**		**2**		**3**		**1**	

Table 4: Expected Building Damage by Building Type

	1-10		11-20		21-30		31-40		41-50		Substantially	
Building 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	2	33.33	3	50.00	1	16.67

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	0	0	0	0
Schools	2	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 1,732 tons of debris will be generated. Of the total amount, Finishes comprises 22% of the total, Structure comprises 43% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 69 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 12 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 8 people (out of a total population of 1,081) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 13.48 million dollars, which represents 49.21 % 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 13.33 million dollars. 1% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 15.47% 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	1.40	0.24	0.05	2.60	4.28
	Content	0.69	0.46	0.09	7.78	9.02
	Inventory	0.00	0.00	0.01	0.03	0.04
	Subtotal	**2.08**	**0.70**	**0.15**	**10.40**	**13.33**
Business Interruption						
	Income	0.00	0.00	0.00	0.04	0.04
	Relocation	0.00	0.00	0.00	0.02	0.02
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.09	0.09
	Subtotal	**0.00**	**0.00**	**0.00**	**0.14**	**0.15**
ALL	**Total**	**2.09**	**0.70**	**0.15**	**10.55**	**13.48**

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	1,081	111,442	41,792	153,234
Total	**1,081**	**111,442**	**41,792**	**153,234**
Total Study Region	**1,081**	**111,442**	**41,792**	**153,234**

Hazus-MH: Flood Event Report

Region Name: Canaan

Flood Scenario: Wangum Lake Brook 100 Year

Print Date: Thursday, December 19, 2013

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.

The geographical size of the region is 33 square miles and contains 81 census blocks. The region contains over 0 thousand households and has a total population of 1,081 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 781 buildings in the region with a total building replacement value (excluding contents) of 153 million dollars (2006 dollars). Approximately 90.40% of the buildings (and 72.73% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 781 buildings in the region which have an aggregate total replacement value of 153 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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Commercial	17,336	11.3%
Industrial	2,473	1.6%
Agricultural	1,166	0.8%
Religion	1,582	1.0%
Government	925	0.6%
Education	18,310	11.9%
Total	**153,234**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	8,351	73.5%
Commercial	1,972	17.4%
Industrial	377	3.3%
Agricultural	223	2.0%
Religion	0	0.0%
Government	435	3.8%
Education	0	0.0%
Total	**11,358**	**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 2 schools, 1 fire station, no police stations 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:	Canaan
Scenario Name:	Wangum Lake Brook 100 Year
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	0	0	0	0
Schools	2	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 7 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 4 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 1,081) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 0.17 million dollars, which represents 1.45 % 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 0.16 million dollars. 2% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 26.06% 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	0.02	0.01	0.00	0.06
	Content	0.01	0.05	0.01	0.02	0.10
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.04**	**0.08**	**0.02**	**0.03**	**0.16**
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**	**0.04**	**0.08**	**0.02**	**0.03**	**0.17**

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	1,081	111,442	41,792	153,234
Total	**1,081**	**111,442**	**41,792**	**153,234**
Total Study Region	**1,081**	**111,442**	**41,792**	**153,234**

Hazus-MH: Hurricane Event Report

Region Name: Canaan

Hurricane Scenario: UN-NAMED-1938-4

Print Date: Tuesday, August 27, 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 33.23 square miles and contains 1 census tracts. There are over 0 thousand households in the region and has a total population of 1,081 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 153 million dollars (2006 dollars). Approximately 90% of the buildings (and 73% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 781 buildings in the region which have an aggregate total replacement value of 153 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	111,442	72.7%
Commercial	17,336	11.3%
Industrial	2,473	1.6%
Agricultural	1,166	0.8%
Religious	1,582	1.0%
Government	925	0.6%
Education	18,310	11.9%
Total	**153,234**	**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 2 schools, 1 fire stations, no 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:	95 mph

Building Damage

General Building Stock Damage

Hazus estimates that about 5 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	5	91.68	0	6.61	0	1.17	0	0.51	0	0.03
Commercial	38	93.89	2	5.44	0	0.63	0	0.03	0	0.00
Education	5	94.11	0	5.46	0	0.42	0	0.01	0	0.00
Government	3	95.12	0	4.59	0	0.29	0	0.00	0	0.00
Industrial	17	94.62	1	4.87	0	0.44	0	0.06	0	0.00
Religion	4	93.90	0	5.78	0	0.32	0	0.00	0	0.00
Residential	635	89.93	67	9.43	4	0.63	0	0.01	0	0.01
Total	**705**		**71**		**5**		**0**		**0**	

Table 3: Expected Building Damage by Building Type

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	3	95.20	0	4.50	0	0.30	0	0.00	0	0.00
Masonry	24	92.04	2	7.03	0	0.83	0	0.10	0	0.01
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	29	94.69	1	4.76	0	0.51	0	0.04	0	0.00
Wood	578	89.96	60	9.42	4	0.60	0	0.01	0	0.01

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
Schools	2	0	0	2

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 18,337 tons of debris will be generated. Of the total amount, 17,320 tons (94%) is Other Tree Debris. Of the remaining 1,017 tons, Brick/Wood comprises 10% 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 4 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 912 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 1,081) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 1.5 million dollars, which represents 1.01 % 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 2 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 95% 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	1,037.04	24.63	3.20	26.32	1,091.18
	Content	408.49	2.08	0.94	1.94	413.46
	Inventory	0.00	0.05	0.18	0.19	0.41
	Subtotal	**1,445.53**	**26.76**	**4.32**	**28.45**	**1,505.05**
Business Interruption Loss						
	Income	0.00	2.57	0.01	0.62	3.20
	Relocation	19.47	2.32	0.13	1.32	23.24
	Rental	9.32	1.22	0.01	0.06	10.61
	Wage	0.00	1.21	0.02	1.45	2.68
	Subtotal	**28.79**	**7.32**	**0.17**	**3.44**	**39.73**
Total						
	Total	**1,474.33**	**34.08**	**4.49**	**31.89**	**1,544.78**

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	1,081	111,442	41,792	153,234
Total	**1,081**	**111,442**	**41,792**	**153,234**
Study Region Total	**1,081**	**111,442**	**41,792**	**153,234**

Hazus-MH: Hurricane Event Report

Region Name: Canaan

Hurricane Scenario: GLORIA

Print Date: Tuesday, August 27, 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 33.23 square miles and contains 1 census tracts. There are over 0 thousand households in the region and has a total population of 1,081 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 153 million dollars (2006 dollars). Approximately 90% of the buildings (and 73% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 781 buildings in the region which have an aggregate total replacement value of 153 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	111,442	72.7%
Commercial	17,336	11.3%
Industrial	2,473	1.6%
Agricultural	1,166	0.8%
Religious	1,582	1.0%
Government	925	0.6%
Education	18,310	11.9%
Total	**153,234**	**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 2 schools, 1 fire stations, no 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:	55 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	5	99.86	0	0.14	0	0.00	0	0.00	0	0.00
Commercial	40	99.79	0	0.21	0	0.00	0	0.00	0	0.00
Education	5	99.78	0	0.22	0	0.00	0	0.00	0	0.00
Government	3	99.77	0	0.23	0	0.00	0	0.00	0	0.00
Industrial	18	99.77	0	0.23	0	0.00	0	0.00	0	0.00
Religion	4	99.84	0	0.16	0	0.00	0	0.00	0	0.00
Residential	706	99.99	0	0.01	0	0.00	0	0.00	0	0.00
Total	**781**		**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	3	99.75	0	0.25	0	0.00	0	0.00	0	0.00
Masonry	26	99.84	0	0.16	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	31	99.75	0	0.25	0	0.00	0	0.00	0	0.00
Wood	642	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
Schools	2	0	0	2

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 326 tons of debris will be generated. Of the total amount, 310 tons (95%) is Other Tree Debris. Of the remaining 16 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 16 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 1,081) 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	8.71	0.00	0.00	0.00	8.71
	Content	8.57	0.00	0.00	0.00	8.57
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**17.29**	**0.00**	**0.00**	**0.00**	**17.29**
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	**17.29**	**0.00**	**0.00**	**0.00**	**17.29**

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	1,081	111,442	41,792	153,234
Total	**1,081**	**111,442**	**41,792**	**153,234**
Study Region Total	**1,081**	**111,442**	**41,792**	**153,234**

Hazus-MH: Hurricane Event Report

Region Name: Canaan

Hurricane Scenario: Probabilistic 10-year Return Period

Print Date: Tuesday, August 27, 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 33.23 square miles and contains 1 census tracts. There are over 0 thousand households in the region and has a total population of 1,081 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 153 million dollars (2006 dollars). Approximately 90% of the buildings (and 73% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 781 buildings in the region which have an aggregate total replacement value of 153 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	1,166	0.8%
Religious	1,582	1.0%
Government	925	0.6%
Education	18,310	11.9%
Total	**153,234**	**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 2 schools, 1 fire stations, no 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	5	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	40	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	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	18	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	4	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	706	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**781**		**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	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	26	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	31	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	642	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
Schools	2	0	0	2

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 1,081) 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

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Connecticut				
Litchfield	1,081	111,442	41,792	153,234
Total	**1,081**	**111,442**	**41,792**	**153,234**
Study Region Total	**1,081**	**111,442**	**41,792**	**153,234**

Hazus-MH: Hurricane Event Report

Region Name: Canaan

Hurricane Scenario: Probabilistic 20-year Return Period

Print Date: Tuesday, August 27, 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 33.23 square miles and contains 1 census tracts. There are over 0 thousand households in the region and has a total population of 1,081 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 153 million dollars (2006 dollars). Approximately 90% of the buildings (and 73% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 781 buildings in the region which have an aggregate total replacement value of 153 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	111,442	72.7%
Commercial	17,336	11.3%
Industrial	2,473	1.6%
Agricultural	1,166	0.8%
Religious	1,582	1.0%
Government	925	0.6%
Education	18,310	11.9%
Total	**153,234**	**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 2 schools, 1 fire stations, no 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 : 20 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	5	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	40	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	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	18	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	4	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	706	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**781**		**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	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	26	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	31	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	642	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
Schools	2	0	0	2

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 1,081) 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	1,081	111,442	41,792	153,234
Total	**1,081**	**111,442**	**41,792**	**153,234**
Study Region Total	**1,081**	**111,442**	**41,792**	**153,234**

Hazus-MH: Hurricane Event Report

Region Name: Canaan

Hurricane Scenario: Probabilistic 50-year Return Period

Print Date: Tuesday, August 27, 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):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

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There are an estimated 0 thousand buildings in the region with a total building replacement value (excluding contents) of 153 million dollars (2006 dollars). Approximately 90% of the buildings (and 73% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 781 buildings in the region which have an aggregate total replacement value of 153 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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Commercial	17,336	11.3%
Industrial	2,473	1.6%
Agricultural	1,166	0.8%
Religious	1,582	1.0%
Government	925	0.6%
Education	18,310	11.9%
Total	**153,234**	**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 2 schools, 1 fire stations, no 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	5	99.77	0	0.23	0	0.00	0	0.00	0	0.00
Commercial	40	99.68	0	0.32	0	0.00	0	0.00	0	0.00
Education	5	99.66	0	0.34	0	0.00	0	0.00	0	0.00
Government	3	99.65	0	0.35	0	0.00	0	0.00	0	0.00
Industrial	18	99.66	0	0.34	0	0.00	0	0.00	0	0.00
Religion	4	99.75	0	0.25	0	0.00	0	0.00	0	0.00
Residential	706	99.95	0	0.05	0	0.00	0	0.00	0	0.00
Total	**780**		**1**		**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	3	99.62	0	0.38	0	0.00	0	0.00	0	0.00
Masonry	26	99.73	0	0.27	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	31	99.63	0	0.37	0	0.00	0	0.00	0	0.00
Wood	642	99.97	0	0.03	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
Schools	2	0	0	2

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 475 tons of debris will be generated. Of the total amount, 451 tons (95%) is Other Tree Debris. Of the remaining 24 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 24 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 1,081) 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. 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 96% 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	59.49	1.73	0.25	2.08	63.55
	Content	29.50	0.00	0.00	0.00	29.50
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**88.98**	**1.73**	**0.25**	**2.08**	**93.05**
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	**88.99**	**1.73**	**0.25**	**2.08**	**93.05**

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	1,081	111,442	41,792	153,234
Total	**1,081**	**111,442**	**41,792**	**153,234**
Study Region Total	**1,081**	**111,442**	**41,792**	**153,234**

Hazus-MH: Hurricane Event Report

Region Name: Canaan

Hurricane Scenario: Probabilistic 100-year Return Period

Print Date: Tuesday, August 27, 2013

Disclaimer:
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Government	925	0.6%
Education	18,310	11.9%
Total	**153,234**	**100.0%**

Essential Facility Inventory

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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 : 100 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	5	99.21	0	0.74	0	0.04	0	0.00	0	0.00
Commercial	40	99.17	0	0.81	0	0.02	0	0.00	0	0.00
Education	5	99.16	0	0.84	0	0.00	0	0.00	0	0.00
Government	3	99.19	0	0.81	0	0.00	0	0.00	0	0.00
Industrial	18	99.18	0	0.82	0	0.00	0	0.00	0	0.00
Religion	4	99.34	0	0.67	0	0.00	0	0.00	0	0.00
Residential	701	99.27	5	0.72	0	0.00	0	0.00	0	0.00
Total	**775**		**6**		**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	3	99.15	0	0.85	0	0.00	0	0.00	0	0.00
Masonry	26	99.05	0	0.91	0	0.04	0	0.00	0	0.00
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	31	99.12	0	0.87	0	0.01	0	0.00	0	0.00
Wood	638	99.31	4	0.68	0	0.01	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
Schools	2	0	0	2

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 2,448 tons of debris will be generated. Of the total amount, 2,318 tons (95%) is Other Tree Debris. Of the remaining 130 tons, Brick/Wood comprises 6% 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 122 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 1,081) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 0.4 million dollars, which represents 0.24 % 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 99% 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	260.17	2.31	0.30	2.24	265.03
	Content	103.29	0.00	0.00	0.00	103.29
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**363.47**	**2.31**	**0.30**	**2.24**	**368.32**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.09	0.03	0.00	0.01	0.12
	Rental	0.09	0.00	0.00	0.00	0.09
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.18**	**0.03**	**0.00**	**0.01**	**0.22**
Total						
	Total	**363.65**	**2.34**	**0.30**	**2.25**	**368.54**

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	1,081	111,442	41,792	153,234
Total	**1,081**	**111,442**	**41,792**	**153,234**
Study Region Total	**1,081**	**111,442**	**41,792**	**153,234**

Hazus-MH: Hurricane Event Report

Region Name: Canaan

Hurricane Scenario: Probabilistic 200-year Return Period

Print Date: Tuesday, August 27, 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 33.23 square miles and contains 1 census tracts. There are over 0 thousand households in the region and has a total population of 1,081 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 153 million dollars (2006 dollars). Approximately 90% of the buildings (and 73% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 781 buildings in the region which have an aggregate total replacement value of 153 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	111,442	72.7%
Commercial	17,336	11.3%
Industrial	2,473	1.6%
Agricultural	1,166	0.8%
Religious	1,582	1.0%
Government	925	0.6%
Education	18,310	11.9%
Total	**153,234**	**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 2 schools, 1 fire stations, no 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 1 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	5	96.98	0	2.58	0	0.32	0	0.11	0	0.00
Commercial	39	97.59	1	2.25	0	0.16	0	0.00	0	0.00
Education	5	97.67	0	2.27	0	0.06	0	0.00	0	0.00
Government	3	97.95	0	2.01	0	0.04	0	0.00	0	0.00
Industrial	18	97.80	0	2.10	0	0.08	0	0.01	0	0.00
Religion	4	97.80	0	2.15	0	0.05	0	0.00	0	0.00
Residential	679	96.25	26	3.62	1	0.13	0	0.00	0	0.00
Total	**753**		**27**		**1**		**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	3	97.93	0	2.03	0	0.04	0	0.00	0	0.00
Masonry	25	96.78	1	2.97	0	0.23	0	0.02	0	0.00
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	30	97.78	1	2.12	0	0.10	0	0.00	0	0.00
Wood	618	96.31	23	3.57	1	0.12	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
Schools	2	0	0	2

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 13,559 tons of debris will be generated. Of the total amount, 12,840 tons (95%) is Other Tree Debris. Of the remaining 719 tons, Brick/Wood comprises 6% 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 2 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 676 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 1,081) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 0.8 million dollars, which represents 0.55 % 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. 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	579.11	9.09	1.20	9.92	599.31
	Content	220.99	0.00	0.16	0.30	221.45
	Inventory	0.00	0.00	0.03	0.04	0.07
	Subtotal	**800.10**	**9.09**	**1.39**	**10.26**	**820.83**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	14.00	0.22	0.01	0.10	14.33
	Rental	4.90	0.00	0.00	0.00	4.90
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**18.89**	**0.22**	**0.01**	**0.10**	**19.23**
Total						
	Total	**819.00**	**9.31**	**1.40**	**10.36**	**840.06**

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	1,081	111,442	41,792	153,234
Total	**1,081**	**111,442**	**41,792**	**153,234**
Study Region Total	**1,081**	**111,442**	**41,792**	**153,234**

Hazus-MH: Hurricane Event Report

Region Name:	Canaan
Hurricane Scenario:	Probabilistic 500-year Return Period
Print Date:	Tuesday, August 27, 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 33.23 square miles and contains 1 census tracts. There are over 0 thousand households in the region and has a total population of 1,081 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 153 million dollars (2006 dollars). Approximately 90% of the buildings (and 73% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 781 buildings in the region which have an aggregate total replacement value of 153 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	111,442	72.7%
Commercial	17,336	11.3%
Industrial	2,473	1.6%
Agricultural	1,166	0.8%
Religious	1,582	1.0%
Government	925	0.6%
Education	18,310	11.9%
Total	**153,234**	**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 2 schools, 1 fire stations, no 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 10 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 : 500 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	4	87.76	0	9.37	0	1.92	0	0.89	0	0.07
Commercial	36	90.83	3	7.87	0	1.21	0	0.08	0	0.00
Education	5	91.06	0	7.92	0	0.98	0	0.03	0	0.00
Government	3	92.63	0	6.67	0	0.69	0	0.02	0	0.00
Industrial	17	91.90	1	7.02	0	0.94	0	0.13	0	0.01
Religion	4	90.73	0	8.50	0	0.75	0	0.02	0	0.00
Residential	604	85.62	93	13.13	8	1.20	0	0.02	0	0.03
Total	**673**		**99**		**9**		**0**		**0**	

Table 3: Expected Building Damage by Building Type : 500 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	3	92.80	0	6.47	0	0.71	0	0.02	0	0.00
Masonry	23	88.60	3	9.74	0	1.46	0	0.18	0	0.02
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	29	92.00	2	6.84	0	1.07	0	0.09	0	0.00
Wood	550	85.63	85	13.17	7	1.16	0	0.02	0	0.03

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
Schools	2	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 19,887 tons of debris will be generated. Of the total amount, 18,746 tons (94%) is Other Tree Debris. Of the remaining 1,141 tons, Brick/Wood comprises 14% 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 987 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 1,081) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 2.1 million dollars, which represents 1.34 % 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 2 million dollars. 4% 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 92% 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	1,324.12	38.73	5.27	40.75	1,408.87
	Content	522.58	5.20	1.98	5.84	535.60
	Inventory	0.00	0.11	0.36	0.35	0.82
	Subtotal	**1,846.69**	**44.04**	**7.61**	**46.95**	**1,945.29**
Business Interruption Loss						
	Income	0.00	7.67	0.09	5.62	13.38
	Relocation	40.04	6.54	0.31	6.92	53.82
	Rental	15.43	3.90	0.03	0.39	19.76
	Wage	0.00	5.48	0.16	19.45	25.09
	Subtotal	**55.48**	**23.58**	**0.59**	**32.38**	**112.03**
Total						
	Total	**1,902.17**	**67.62**	**8.20**	**79.33**	**2,057.32**

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	1,081	111,442	41,792	153,234
Total	**1,081**	**111,442**	**41,792**	**153,234**
Study Region Total	**1,081**	**111,442**	**41,792**	**153,234**

Hazus-MH: Hurricane Event Report

Region Name: Canaan

Hurricane Scenario: Probabilistic 1000-year Return Period

Print Date: Tuesday, August 27, 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.

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There are an estimated 0 thousand buildings in the region with a total building replacement value (excluding contents) of 153 million dollars (2006 dollars). Approximately 90% of the buildings (and 73% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 781 buildings in the region which have an aggregate total replacement value of 153 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	111,442	72.7%
Commercial	17,336	11.3%
Industrial	2,473	1.6%
Agricultural	1,166	0.8%
Religious	1,582	1.0%
Government	925	0.6%
Education	18,310	11.9%
Total	**153,234**	**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 2 schools, 1 fire stations, no 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 34 buildings will be at least moderately damaged. This is over 4% of the total number of buildings in the region. There are an estimated 2 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	4	74.37	1	17.85	0	5.03	0	2.44	0	0.31
Commercial	32	79.48	6	15.60	2	4.44	0	0.47	0	0.00
Education	4	79.58	1	15.70	0	4.36	0	0.36	0	0.00
Government	2	82.80	0	13.66	0	3.31	0	0.23	0	0.00
Industrial	15	81.48	3	14.04	1	3.88	0	0.56	0	0.03
Religion	3	78.83	1	17.37	0	3.56	0	0.24	0	0.00
Residential	507	71.85	168	23.81	27	3.89	2	0.23	1	0.21
Total	**567**		**180**		**31**		**2**		**2**	

Table 3: Expected Building Damage by Building Type : 1000 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	2	83.06	0	13.21	0	3.47	0	0.25	0	0.00
Masonry	20	76.71	5	18.00	1	4.55	0	0.61	0	0.13
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	25	81.52	4	13.56	1	4.37	0	0.55	0	0.00
Wood	461	71.76	154	24.04	24	3.78	1	0.21	1	0.20

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
Schools	2	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 33,953 tons of debris will be generated. Of the total amount, 31,911 tons (94%) is Other Tree Debris. Of the remaining 2,043 tons, Brick/Wood comprises 18% 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 15 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 1,680 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 1,081) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 4.4 million dollars, which represents 2.85 % 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 4 million dollars. 5% 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	2,606.35	111.28	16.40	116.36	2,850.40
	Content	1,084.65	28.17	7.73	27.81	1,148.36
	Inventory	0.00	0.55	1.34	1.14	3.03
	Subtotal	**3,691.00**	**140.00**	**25.47**	**145.31**	**4,001.79**
Business Interruption Loss						
	Income	0.00	17.18	0.26	14.54	31.98
	Relocation	156.30	20.58	1.34	23.10	201.32
	Rental	54.54	11.44	0.11	1.21	67.30
	Wage	0.00	14.16	0.45	46.87	61.49
	Subtotal	**210.84**	**63.36**	**2.17**	**85.73**	**362.09**
Total						
	Total	**3,901.84**	**203.36**	**27.64**	**231.04**	**4,363.88**

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	1,081	111,442	41,792	153,234
Total	**1,081**	**111,442**	**41,792**	**153,234**
Study Region Total	**1,081**	**111,442**	**41,792**	**153,234**

Hazus-MH: Earthquake Event Report

Region Name: Canaan

Earthquake Scenario: East Haddam

Print Date: September 25, 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 33.22 square miles and contains 1 census tracts. There are over 0 thousand households in the region which has a total population of 1,081 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 153 (millions of dollars). Approximately 90.00 % of the buildings (and 73.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 276 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 153 (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 83% 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 2 schools, 1 fire stations, 0 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 2 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 276.00 (millions of dollars). This inventory includes over 44 kilometers of highways, 13 bridges, 224 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	13	43.10
	Segments	6	210.70
	Tunnels	0	0.00
		Subtotal	**253.80**
Railways	Bridges	0	0.00
	Facilities	0	0.00
	Segments	2	22.60
	Tunnels	0	0.00
		Subtotal	**22.60**
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	**276.40**

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	**4.50**

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 18 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	4	0.62	0	0.75	0	1.15	0	1.63	0	1.45
Commercial	34	4.86	4	6.10	2	11.26	0	15.69	0	18.30
Education	4	0.61	0	0.74	0	1.35	0	1.63	0	2.41
Government	3	0.36	0	0.45	0	0.87	0	1.03	0	1.41
Industrial	15	2.18	2	2.72	1	5.41	0	6.85	0	8.33
Other Residential	102	14.60	10	15.62	3	21.09	0	27.56	0	31.22
Religion	3	0.49	0	0.58	0	0.98	0	1.46	0	1.80
Single Family	532	76.28	48	73.04	9	57.90	1	44.14	0	35.08
Total	**698**		**65**		**16**		**2**		**0**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	590	84.64	52	78.99	9	55.66	1	30.44	0	9.54
Steel	32	4.55	4	5.59	2	11.65	0	12.73	0	16.69
Concrete	8	1.16	1	1.33	0	2.67	0	1.73	0	1.67
Precast	2	0.29	0	0.30	0	0.95	0	2.00	0	0.30
RM	15	2.09	1	1.56	1	4.34	0	6.72	0	0.25
URM	51	7.28	8	12.21	4	24.73	1	46.37	0	71.55
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**698**		**65**		**16**		**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	2	0	0	2
EOCs	0	0	0	0
PoliceStations	0	0	0	0
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	6	0	0	6	6
	Bridges	13	0	0	13	13
	Tunnels	0	0	0	0	0
Railways	Segments	2	0	0	2	2
	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	112	4	1
Waste Water	67	2	1
Natural Gas	45	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	445	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 65.00% 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 1,081) 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 1.99 (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 1.45 (millions of dollars); 25 % 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 59 % 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	0.08	0.03	0.00	0.01	0.11
	Capital-Related	0.00	0.03	0.03	0.00	0.00	0.07
	Rental	0.01	0.03	0.02	0.00	0.00	0.06
	Relocation	0.04	0.00	0.03	0.00	0.04	0.12
	Subtotal	**0.06**	**0.14**	**0.11**	**0.00**	**0.05**	**0.36**
Capital Stock Losses							
	Structural	0.09	0.02	0.03	0.00	0.04	0.20
	Non_Structural	0.36	0.08	0.10	0.01	0.13	0.68
	Content	0.09	0.02	0.04	0.01	0.05	0.21
	Inventory	0.00	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.54**	**0.11**	**0.18**	**0.03**	**0.23**	**1.09**
	Total	**0.60**	**0.25**	**0.28**	**0.03**	**0.28**	**1.45**

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	210.67	$0.00	0.00
	Bridges	43.13	$0.51	1.18
	Tunnels	0.00	$0.00	0.00
	Subtotal	**253.80**	**0.50**	
Railways	Segments	22.60	$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	**22.60**	**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	**276.40**	**0.50**	

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	0.83
	Subtotal	**2.24**	**$0.02**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	1.30	$0.01	0.70
	Subtotal	**1.35**	**$0.01**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	0.90	$0.00	0.36
	Subtotal	**0.90**	**$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	**4.48**	**$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	1,081	111	41	153
Total State		**1,081**	**111**	**41**	**153**
Total Region		**1,081**	**111**	**41**	**153**

Hazus-MH: Earthquake Event Report

Region Name: Canaan

Earthquake Scenario: Haddam

Print Date: September 25, 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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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 33.22 square miles and contains 1 census tracts. There are over 0 thousand households in the region which has a total population of 1,081 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 153 (millions of dollars). Approximately 90.00 % of the buildings (and 73.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 276 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 153 (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 83% 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 2 schools, 1 fire stations, 0 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 2 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 276.00 (millions of dollars). This inventory includes over 44 kilometers of highways, 13 bridges, 224 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	13	43.10
	Segments	6	210.70
	Tunnels	0	0.00
		Subtotal	**253.80**
Railways	Bridges	0	0.00
	Facilities	0	0.00
	Segments	2	22.60
	Tunnels	0	0.00
		Subtotal	**22.60**
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	**276.40**

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	**4.50**

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	5	0.63	0	0.77	0	1.15	0	1.50	0	1.16
Commercial	38	5.03	2	6.48	1	11.38	0	15.31	0	16.13
Education	5	0.63	0	0.77	0	1.28	0	1.57	0	2.08
Government	3	0.38	0	0.45	0	0.78	0	0.90	0	1.01
Industrial	17	2.27	1	2.78	0	4.97	0	5.98	0	5.92
Other Residential	110	14.71	4	16.87	1	23.82	0	30.97	0	37.03
Religion	4	0.50	0	0.66	0	1.14	0	1.67	0	2.09
Single Family	568	75.85	19	71.21	3	55.48	0	42.11	0	34.57
Total	**749**		**26**		**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	629	83.98	20	75.10	2	48.89	0	23.02	0	0.00
Steel	36	4.76	1	5.27	0	9.07	0	8.33	0	6.57
Concrete	9	1.21	0	1.23	0	1.87	0	0.84	0	0.44
Precast	2	0.30	0	0.37	0	1.19	0	2.36	0	0.13
RM	16	2.08	0	1.91	0	5.32	0	7.13	0	0.00
URM	57	7.67	4	16.12	2	33.66	0	58.32	0	92.86
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**749**		**26**		**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	2	0	0	2
EOCs	0	0	0	0
PoliceStations	0	0	0	0
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	6	0	0	6	6
	Bridges	13	0	0	13	13
	Tunnels	0	0	0	0	0
Railways	Segments	2	0	0	2	2
	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	112	1	0
Waste Water	67	0	0
Natural Gas	45	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	445	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 73.00% 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 1,081) 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 0.47 (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 0.43 (millions of dollars); 24 % 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 59 % 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	0.02	0.01	0.00	0.00	0.03
	Capital-Related	0.00	0.01	0.01	0.00	0.00	0.02
	Rental	0.00	0.01	0.01	0.00	0.00	0.02
	Relocation	0.01	0.00	0.01	0.00	0.01	0.03
	Subtotal	**0.02**	**0.04**	**0.03**	**0.00**	**0.02**	**0.10**
Capital Stock Losses							
	Structural	0.03	0.01	0.01	0.00	0.01	0.06
	Non_Structural	0.11	0.02	0.03	0.00	0.04	0.21
	Content	0.03	0.00	0.01	0.00	0.02	0.06
	Inventory	0.00	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.17**	**0.03**	**0.05**	**0.01**	**0.07**	**0.33**
	Total	**0.18**	**0.07**	**0.08**	**0.01**	**0.08**	**0.43**

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	210.67	$0.00	0.00
	Bridges	43.13	$0.03	0.07
	Tunnels	0.00	$0.00	0.00
	Subtotal	**253.80**	**0.00**	
Railways	Segments	22.60	$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	**22.60**	**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	**276.40**	**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	0.16
	Subtotal	**2.24**	**$0.00**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	1.30	$0.00	0.13
	Subtotal	**1.35**	**$0.00**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	0.90	$0.00	0.07
	Subtotal	**0.90**	**$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	**4.48**	**$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	1,081	111	41	153
Total State		**1,081**	**111**	**41**	**153**
Total Region		**1,081**	**111**	**41**	**153**

Hazus-MH: Earthquake Event Report

Region Name: Canaan

Earthquake Scenario: Portland

Print Date: September 25, 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 33.22 square miles and contains 1 census tracts. There are over 0 thousand households in the region which has a total population of 1,081 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 153 (millions of dollars). Approximately 90.00 % of the buildings (and 73.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 276 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 153 (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 83% 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 2 schools, 1 fire stations, 0 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 2 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 276.00 (millions of dollars). This inventory includes over 44 kilometers of highways, 13 bridges, 224 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	13	43.10
	Segments	6	210.70
	Tunnels	0	0.00
		Subtotal	**253.80**
Railways	Bridges	0	0.00
	Facilities	0	0.00
	Segments	2	22.60
	Tunnels	0	0.00
		Subtotal	**22.60**
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	**276.40**

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	**4.50**

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

Building Damage

Hazus estimates that about 4 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	5	0.63	0	0.79	0	1.17	0	1.48	0	1.17
Commercial	38	5.04	1	6.62	0	11.53	0	15.09	0	16.12
Education	5	0.63	0	0.78	0	1.29	0	1.54	0	2.07
Government	3	0.38	0	0.46	0	0.78	0	0.88	0	1.01
Industrial	17	2.27	1	2.83	0	4.99	0	5.85	0	5.91
Other Residential	111	14.72	4	17.09	1	24.21	0	30.87	0	36.84
Religion	4	0.50	0	0.67	0	1.17	0	1.66	0	2.09
Single Family	572	75.82	16	70.76	2	54.87	0	42.63	0	34.79
Total	**754**		**22**		**4**		**0**		**0**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	633	83.93	17	74.30	2	47.65	0	23.69	0	0.00
Steel	36	4.76	1	5.32	0	8.92	0	8.06	0	6.35
Concrete	9	1.21	0	1.23	0	1.80	0	0.81	0	0.00
Precast	2	0.30	0	0.39	0	1.23	0	2.33	0	0.15
RM	16	2.08	0	1.97	0	5.46	0	6.99	0	0.00
URM	58	7.72	4	16.79	1	34.93	0	58.12	0	93.50
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**754**		**22**		**4**		**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	2	0	0	2
EOCs	0	0	0	0
PoliceStations	0	0	0	0
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	6	0	0	6	6
	Bridges	13	0	0	13	13
	Tunnels	0	0	0	0	0
Railways	Segments	2	0	0	2	2
	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	112	1	0
Waste Water	67	0	0
Natural Gas	45	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	445	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 73.00% 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 1,081) 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 0.39 (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 0.35 (millions of dollars); 24 % 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 59 % 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	0.02	0.01	0.00	0.00	0.03
	Capital-Related	0.00	0.01	0.01	0.00	0.00	0.02
	Rental	0.00	0.01	0.01	0.00	0.00	0.02
	Relocation	0.01	0.00	0.01	0.00	0.01	0.03
	Subtotal	**0.01**	**0.03**	**0.03**	**0.00**	**0.01**	**0.09**
Capital Stock Losses							
	Structural	0.03	0.01	0.01	0.00	0.01	0.05
	Non_Structural	0.09	0.02	0.02	0.00	0.03	0.17
	Content	0.02	0.00	0.01	0.00	0.01	0.05
	Inventory	0.00	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.14**	**0.03**	**0.04**	**0.01**	**0.06**	**0.27**
	Total	**0.15**	**0.06**	**0.07**	**0.01**	**0.07**	**0.35**

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	210.67	$0.00	0.00
	Bridges	43.13	$0.03	0.06
	Tunnels	0.00	$0.00	0.00
	Subtotal	**253.80**	**0.00**	
Railways	Segments	22.60	$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	**22.60**	**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	**276.40**	**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	**2.24**	**$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	**1.35**	**$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	**0.90**	**$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	**4.48**	**$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	1,081	111	41	153
Total State		**1,081**	**111**	**41**	**153**
Total Region		**1,081**	**111**	**41**	**153**

Hazus-MH: Earthquake Event Report

Region Name: Canaan

Earthquake Scenario: Stamford

Print Date: September 25, 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 33.22 square miles and contains 1 census tracts. There are over 0 thousand households in the region which has a total population of 1,081 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 153 (millions of dollars). Approximately 90.00 % of the buildings (and 73.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 276 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 153 (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 83% 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 2 schools, 1 fire stations, 0 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 2 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 276.00 (millions of dollars). This inventory includes over 44 kilometers of highways, 13 bridges, 224 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	13	43.10
	Segments	6	210.70
	Tunnels	0	0.00
		Subtotal	**253.80**
Railways	Bridges	0	0.00
	Facilities	0	0.00
	Segments	2	22.60
	Tunnels	0	0.00
		Subtotal	**22.60**
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	**276.40**

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	**4.50**

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

Building Damage

Hazus estimates that about 3 buildings will be at least moderately damaged. This is over 0.00 % 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	5	0.63	0	0.81	0	1.19	0	1.42	0	1.01
Commercial	38	5.05	1	6.82	0	11.77	0	14.61	0	14.57
Education	5	0.63	0	0.80	0	1.30	0	1.50	0	1.84
Government	3	0.38	0	0.47	0	0.78	0	0.86	0	0.81
Industrial	17	2.28	1	2.90	0	5.02	0	5.66	0	4.71
Other Residential	112	14.74	3	17.45	1	24.80	0	30.29	0	38.40
Religion	4	0.50	0	0.70	0	1.21	0	1.62	0	2.14
Single Family	576	75.77	12	70.06	2	53.93	0	44.03	0	36.52
Total	**760**		**18**		**3**		**0**		**0**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	637	83.85	13	73.03	1	45.72	0	25.87	0	0.00
Steel	36	4.77	1	5.38	0	8.75	0	7.81	0	1.73
Concrete	9	1.21	0	1.23	0	1.70	0	0.76	0	0.00
Precast	2	0.30	0	0.41	0	1.30	0	2.23	0	0.24
RM	16	2.09	0	2.08	0	5.62	0	6.64	0	0.00
URM	59	7.79	3	17.88	1	36.92	0	56.70	0	98.03
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**760**		**18**		**3**		**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

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	0	0	0	0
Schools	2	0	0	2
EOCs	0	0	0	0
PoliceStations	0	0	0	0
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	6	0	0	6	6
	Bridges	13	0	0	13	13
	Tunnels	0	0	0	0	0
Railways	Segments	2	0	0	2	2
	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	112	1	0
Waste Water	67	0	0
Natural Gas	45	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	445	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 1,081) 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 0.28 (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 0.25 (millions of dollars); 26 % 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 59 % 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	0.01	0.00	0.00	0.00	0.02
	Capital-Related	0.00	0.01	0.01	0.00	0.00	0.01
	Rental	0.00	0.01	0.00	0.00	0.00	0.01
	Relocation	0.01	0.00	0.01	0.00	0.01	0.02
	Subtotal	**0.01**	**0.02**	**0.02**	**0.00**	**0.01**	**0.06**
Capital Stock Losses							
	Structural	0.02	0.00	0.01	0.00	0.01	0.04
	Non_Structural	0.06	0.01	0.02	0.00	0.02	0.12
	Content	0.01	0.00	0.01	0.00	0.01	0.03
	Inventory	0.00	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.09**	**0.02**	**0.03**	**0.00**	**0.04**	**0.18**
	Total	**0.10**	**0.04**	**0.05**	**0.00**	**0.05**	**0.25**

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	210.67	$0.00	0.00
	Bridges	43.13	$0.02	0.05
	Tunnels	0.00	$0.00	0.00
	Subtotal	**253.80**	**0.00**	
Railways	Segments	22.60	$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	**22.60**	**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	**276.40**	**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	0.12
	Subtotal	**2.24**	**$0.00**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	1.30	$0.00	0.10
	Subtotal	**1.35**	**$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	**0.90**	**$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	**4.48**	**$0.00**	

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	1,081	111	41	153
Total State		**1,081**	**111**	**41**	**153**
Total Region		**1,081**	**111**	**41**	**153**

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:

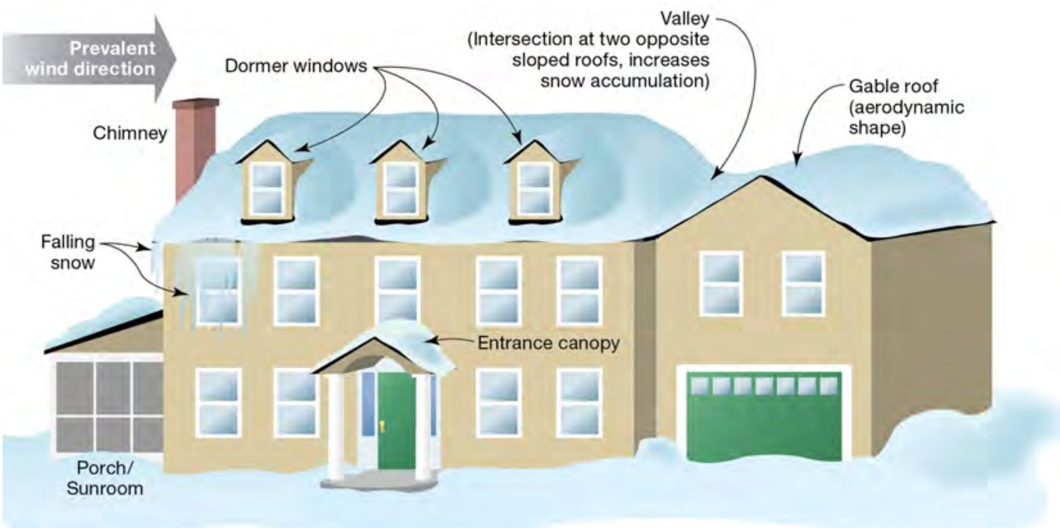
- Sagging ceiling tiles or boards, ceiling boards falling out of the ceiling grid, and/or sagging sprinkler lines and sprinkler heads
- Sprinkler heads deflecting below suspended ceilings
- Popping, cracking, and creaking noises
- Sagging roof members, including metal decking or plywood sheathing
- Bowing 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.

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