TOWN OF BROOKFIELD
HAZARD MITIGATION PLAN

ADOPTED NOVEMBER 2014

MMI # 3101-14

Prepared for the:

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

LIST OF ACRONYMS (Continued)

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

EXECUTIVE SUMMARY

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

Brookfield is a suburban town of 16,452 that contains a busy commercial corridor along Federal Road (U.S. Route 202) and residential neighborhoods throughout the town. Brookfield occupies an area of ridges and valleys nestled between Candlewood Lake to the west and the Housatonic River to the east. The Still River flows through the center of the town, joining the Housatonic River in neighboring New Milford. The primary goal of this hazard mitigation plan is to prevent loss of lives and reduce the damage to property, infrastructure, and important economic resources from natural disasters.

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

- The snow storms of January 2011 spurred the town to remove snow from many roofs, and several barns collapsed. The public assistance reimbursement was $66,442.
- Flooding from Tropical Storm Irene was moderate, but the storm brought down many trees and power outages in the town lasted up to eight days. The public assistance reimbursement was $75,579.
- Winter Storm Alfred caused more than a week without power, and significant quantities of tree and tree limb debris were generated. The shelter was open for several days to accommodate overnight visitors. The public assistance reimbursement was $1.2 million.
- Hurricane Sandy caused additional wind damage and debris generation. The public assistance reimbursement was $88,250.

Brookfield experienced a more localized event in May 2011 that rivaled the damage caused by some of the statewide disasters. Straight-line winds blew through the town and caused a power outage of three to four days.

Development is robust in Brookfield compared to other communities in Connecticut. The "Four Corners" are at the intersection of Federal Road and Route 25 is expected to continue developing with commercial and residential land uses, and more than 250 units of multi-family housing is approved in this area. Most of the outlying parts of the town will remain at lower residential densities, and subdivisions are typically small.

Brookfield remains primarily at risk to floods. The main source of flooding is the Still River. Most of the non-residential land uses in Brookfield are located along Federal Road and therefore along the Still River corridor, and many of these businesses have some level of flood risk. The lack of residential flood risk along the Still River is considered an asset. However, the town's primary focus for flood mitigation at the present time is the Meadowbrook Manor neighborhood located in the Still River sub-regional drainage

[1] The planning area included the City of Danbury and the Towns of Bethel, Bridgewater, Brookfield, Newtown, New Fairfield, New Milford, Redding, Ridgefield, and Sherman. Subsequent to the commencement of the planning process, HVCEO merged with Southwestern Regional Planning Agency to form a 20-town regional planning organization.

basin, between Hoyt's Pond and Lime Kiln Brook. These homes have suffered varying degrees of flood damage due to undersized drainage systems, and the town wishes to assist with repairs and upgrades to the drainage systems in this area to alleviate flooding.

The town's capabilities relative to winter storms are significant. However, several steep and winding roads in Brookfield are at elevated risk to accidents during winter storms. Similarly, the town's capabilities relative to wind events are significant, with a relatively large annual budget for aggressive tree and tree limb maintenance along roads and utility lines. The local utility company also assists with tree and tree limb maintenance.

Brookfield has identified a number of mitigation strategies to decrease risks from future floods and other hazards. The town has also identified methods of increasing emergency service capabilities, such as securing standby power supplies and potentially relocating the Public Works facility from a flood hazard area. 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 new 20-town regional planning organization.

1.0 INTRODUCTION

1.1 Background and Purpose

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

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

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

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

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 Brookfield's development through interdepartmental and inter-municipal coordination.

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

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

- ***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.

- ***Complement future Community Rating System (CRS) efforts.*** Implementation of certain mitigation measures may increase a community's rating with the NFIP and thus the benefits that it derives from FEMA. The Town does not participate in the Community Rating System (CRS).

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 Update and correspondence with local officials, the following have been identified as hazards that can potentially affect the Town of Brookfield:

> The only hazard given attention in the 2014 Connecticut Hazard Mitigation Plan Update but not addressed in the Brookfield Hazard Mitigation Plan is drought. However, this is the lowest-ranked hazard of those discussed in the state's plan, with a "medium-low" composite risk score for Fairfield 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.

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

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

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

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

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

Table 1-2
Hazard Event Ranking

Natural Hazards	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	
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
Hurricane Winds	3	1	3	7
Ice	3	2	2	7
Thunderstorm and Tornado Winds	2	2	2	6
Flooding from Dam Failure	1	1	4	6
Riverine Flooding	2	3	1	6
Shaking	3	1	2	6
Flooding from Poor Drainage	1	3	1	5
Lightning	1	3	1	5
Falling Trees/Branches	1	3	1	5
Hail	1	2	1	4
Fire/Heat	1	2	1	4
Smoke	1	2	1	4

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

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

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

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

- ***Existing Capabilities*** provides 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 Brookfield.

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

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

1.4 Discussion of STAPLEE Ranking Method

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

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

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

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

- **Administrative**:
  - <u>Benefits</u>: Does the project make it easier for the community to administrate future mitigation or emergency response actions?
  - <u>Costs</u>: Does Brookfield have the capability (staff, technical experts, and/or funding) to implement the action, or can it be readily obtained? Can Brookfield 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 Brookfield have the authority to implement the proposed action? Are there any potential legal consequences? Will the community be liable for the actions or support of actions, or for lack of action? Is the action likely to be challenged by stakeholders who may be negatively affected?
- **Economic**:
  - Benefits: Are there currently sources of funds that can be used to implement the action? What benefits will the action provide? Does the action contribute to community goals, such as capital improvements or economic development?
  - Costs: Does the cost seem reasonable for the size of the problem and the likely benefits? What burden will be placed on the tax base or local economy to implement this action? What proposed actions should be considered but be tabled for implementation until outside sources of funding are available?
- **Environmental**:
  - Benefits: Will this action beneficially affect the environment (land, water, endangered species)?
  - Costs: Will this action comply with local, state, and federal environmental laws and regulations? Is the action consistent with community environmental goals?

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

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

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

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

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

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

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

1.5 Discussion of Benefit-Cost Ratio

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

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

1.6 Documentation of the Planning Process

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

Mr. David Hannon of HVCEO and Mr. Ralph Tedesco, Town's Director of Public Works coordinated the development of this HMP; the adoption of this plan in the Town of Brookfield will be coordinated by all Town personnel.

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

- Mr. Ralph Tedesco, P.E., Director of Public Works
- Mr. Wayne Gravius, Fire Marshal
- Ms. Katherine Daniel, AICP, Community Development Director
- Mr. David Hannon, Housatonic Valley Council of Elected Officials (HVCEO)
- Mr. James Purcell, Police/EMD
- Mr. Bill Davidson, Board of Selectmen

- ❑ Mr. Howard Lasser, Selectman
- ❑ Mr. George Walker, Selectman

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

- ❑ ***A project kickoff meeting with the Director of Public Works and Town personnel was held October 30, 2013.*** Necessary documentation was collected, and problem areas within the town were discussed.

- ❑ ***A public information meeting was held on November 19, 2013.*** Preliminary finds were presented at the meeting and public comments were solicited.

  The following individuals attended:

  - Mr. Bill Davidson, Board of Selectmen
  - Mr. Ralph Tedesco, Director of Public Works
  - Mr. David Hannon, HVCEO
  - Four Brookfield residents from the Meadow Brook Manor Neighborhood.

  The following were points of discussion:

  - Candlewood Lake Road and Federal Road are two areas that are historically known for flooding.

  - Located in the Limekiln Brook watershed, the Meadowbrook Manor Neighborhood has been experiencing stormwater system issues with clogged curb-inlets and outfalls; an outfall pipe located on Hillside Court has been scoured with much of the stabilizing soil matrix being eroded away. Mr. Ralph Tedesco indicated that a plan to divert water flow with a new outfall pipe has been developed.

  - An HMGP grant has been applied for and is being reviewed by DEMHS. Approval of the subject Hazard Mitigation Plan will help ensure that a grant can be awarded.

  - Bill Davidson and Ralph Tedesco indicated to the residents from Meadow Brook Manor Neighborhood that there are roughly four phases or steps that the Town is taking to remedy flooding related issues: review and approval of the water diversion permit application, adoption of the Hazard Mitigation Plan, the application for hazard mitigation grants, and design of the drainage project.

  - A future referendum will have to take place for the residents of Brookfield to approve or reject the Town implementing the estimated $2 million project for Meadowbrook Manor.

- ***The Draft Plan was reviewed by the Town in May 2014.*** Mr. Ralph Tedesco of the Town reviewed the Plan, discussed components with appropriate Town staff including those listed above, and provided detailed comments to improve the Plan.

- ***The Plan was reviewed by DEMHS in July 2014 and reviewed by FEMA in August-September 2014. FEMA's approval pending adoption was issued in October 2014.***

Public Participation Summary

Residents, business owners, and other stakeholders of Brookfield, neighboring communities, and local and regional entities were invited to the public information meeting via the local newspapers; *the Brookfield Patch* and *the Danbury New Times*, and via the home page of the Town's website. Copies of these announcements are included in Appendix D.

All of the public comments have been related to flooding, and the above bullet points from the public meeting of November 19, 2013 are discussed in Section 3.5 of this document. Flooding in Meadowbrook Manor has been (and remains) the areas of greatest public interest in the town. Mitigation actions proposed in this document have resulted from public commentary.

Additional opportunities for the public to review the Plan were implemented in advance of the public hearing to adopt this plan in 2014, contingent on receiving conditional approval from FEMA. The draft that was sent for FEMA review was posted on the Town website (www.brookfieldct.gov) to provide opportunities for public review and comment, and a review hardcopy was made available in the Town hall and Brookfield Library. Such comments will be incorporated into the final draft where applicable. The public and interested parties will be notified of the opportunity to review the Plan via the website and in the local newspaper the Brookfield Patch.

1.7 Coordination with Neighboring Communities

Brookfield has coordinated with neighboring municipalities both within and outside the HVCEO planning area in the past relative to hazard mitigation and emergency preparedness and will continue to do so. Brookfield is bordered by the municipalities of New Milford and Bridgewater to the north, Newtown to the east, Danbury and Bethel to the south, and to the west New Fairfield. The monthly HVCEO meetings have provided a continuing forum for the member municipalities to collaborate and share thoughts about hazards that may span municipal boundaries. In addition, a letter was mailed to the hazard mitigation planning contacts for all 12 local jurisdictions surrounding the HVCEO planning region. Representatives from Putnam County (NY), Westchester County (NY), the Northwest Hills Council of Governments (CT), Greater Bridgeport Regional Council (CT), and Council of Governments Central Naugatuck Valley (CT) were copied on this correspondence.

At least three organizations have an interest in preserving the Still River and its watershed. Spearheaded by Danbury's Health Department, the Still River Alliance was organized in 1995 as a consortium of three different groups consisting of public agencies, conservation organizations and landowners/private citizens. The Town of Brookfield has an existing greenway trail along a section of the Still River behind the Town Hall. It is a long term goal of the Still River Alliance to link up with the Brookfield Trail along the River.

The Candlewood Lake Authority (CLA) is an organization consisting of appointed officials from the five lake municipalities; Brookfield, Danbury, New Fairfield, New Milford and Sherman. The CLA is charged with managing recreation, public safety, and specific environmental initiatives regarding the lake. The Executive Director of the Authority, Mr. Larry Marsicano, was contacted to provide an opportunity for the Authority to participate in the planning process. Because local officials from Brookfield were already involved with the planning process, some redundancy exists as any concerns related to the lake have already been raised during the project meetings. During the development of the Danbury, New Fairfield, and Sherman plans, Mr. Marsicano recommended that First Light Power Resources, the owner of Candle wood Lake, be contacted regarding management of the dams and dikes that impound the lake. Refer to Section 8.0 for a review of the Emergency Action Plan for the dams and dikes.

2.0 COMMUNITY PROFILE

2.1 Physical Setting

Incorporated in 1778, the Town of Brookfield is located in northern Fairfield County and home to a population of 16,452 (2010 U.S. Census). Brookfield is bordered by the municipalities of New Milford and Bridgewater to the north, Newtown to the east, Danbury and Bethel to the south, and to the west New Fairfield. Refer to Figures 2-1 and 2-2 for maps showing the regional location of Brookfield within the HVCEO region.

Brookfield is located in the southern foot hills of the Berkshire Mountains. The broad central Still River Valley is a defining feature of the town's topography. The town is characterized by higher elevations away from the town center which drain into the Still River corridor. The Still River flows north cutting through the center of town into southern New Milford before it eventually joins the Housatonic River. The two largest lakes in Connecticut border the Town of Brookfield. Candlewood Lake to the west was formed by a hydroelectric dam south of the Rocky River and Lake Lillinonah to the east, was formed by Shepaug Dam on the Housatonic River. The highest elevation in Brookfield is about 730 feet in the east central part of town, east of Route 25. The low point is just under 200 feet along the easternmost point of Lake Lillinonah. The varying terrain of Brookfield makes the town vulnerable to an array of natural hazards.

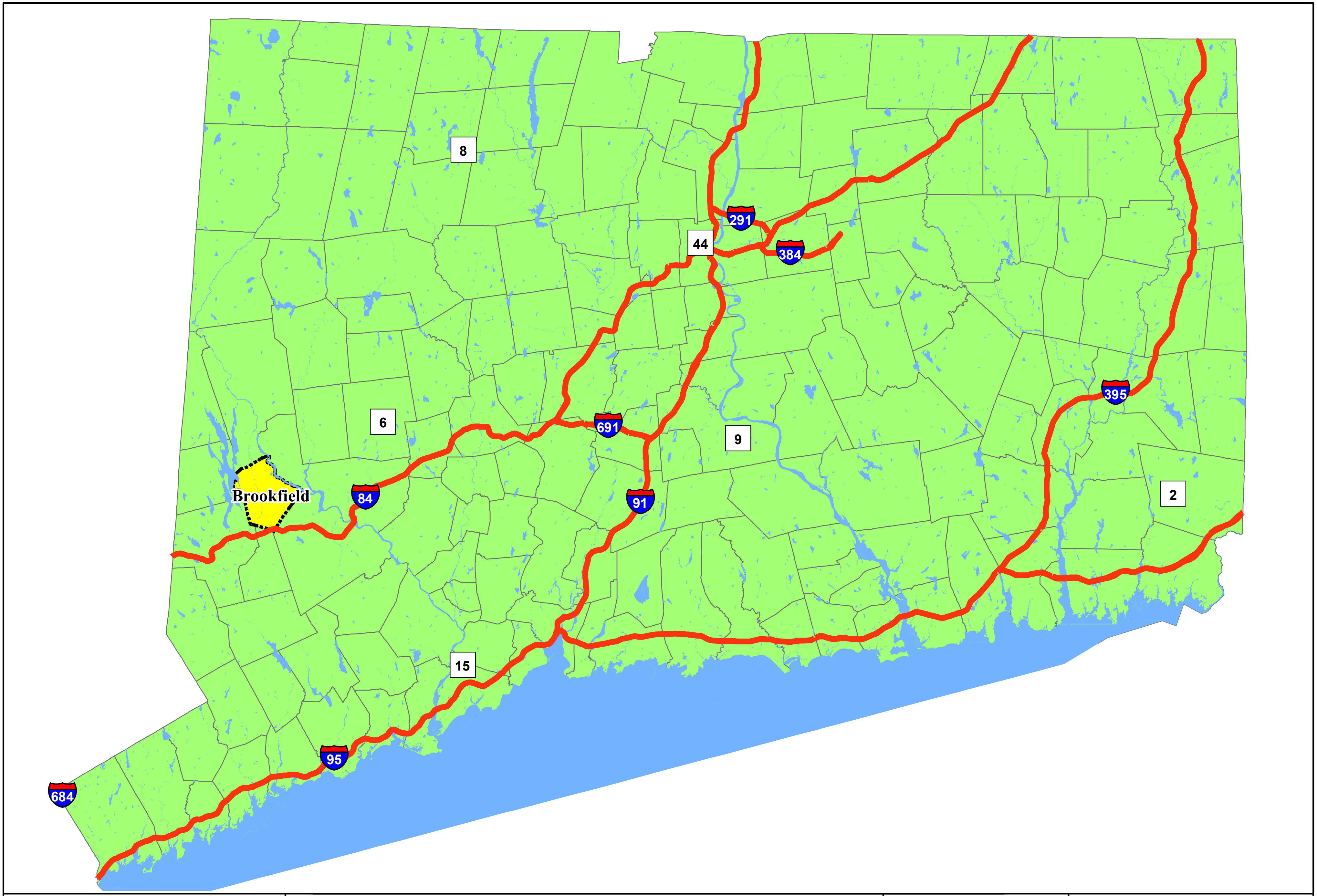
2.2 Existing Land Use

Brookfield is a suburban town that contains a busy commercial corridor along Federal Road (U.S. Route 202) and residential neighborhoods throughout the town. Brookfield occupies an area of ridges and valleys bisected by the Still River, squeezed between Candlewood Lake to the west and Lake Lillinonah to the east.

> **From the 2002 Town of Brookfield Plan of Conservation and Development (POCD):**
>
> **"Despite [significant growth in commercial and industrial land], for a town of Brookfield's size, a relatively small percentage of land (632 acres or 6% of the total land area developed) is categorized as a commercial or industrial use."**

Since the early 1700s the Still River has been the site of commercial activity. This area was known as the Iron Works District with iron furnaces, sawmills, grist mills, cotton mills, hat factories and lime kilns. Since the 1980s, Brookfield has been transforming from a colonial New England town to a local shopping and consumer goods destination with low-to-moderate commercial uses. The area surrounding Candlewood Lake has also seen increase in residential growth and volume of summer traffic.

Today commercial and residential development is growing in Brookfield, compared to other communities in Connecticut. The Federal Road (U.S. Route 202) corridor is the "economic engine" of Brookfield since it is the location of most existing commercial uses and the primary area for accommodating intensive development in the future, whereas the "Four Corners" area at the intersection on Federal Road and Route 25 is currently the pulse of development in Brookfield. The proximity of Brookfield to the Still River / Route 7 corridor and Interstate 84 has helped promote economic development. Some controversy regarding large-scale commercial and residential development is part of ongoing local conversation.



SOURCE:
CT DEEP

N

Figure 2-1: Location Map of Brookfield

Town of Brookfield
Hazard Mitigation Plan

LOCATION:
Brookfield, CT

Map By: CPS
MMI#: 3101-14
MXD:
Date: 01/14/2014
Scale: 1 in = 11 miles

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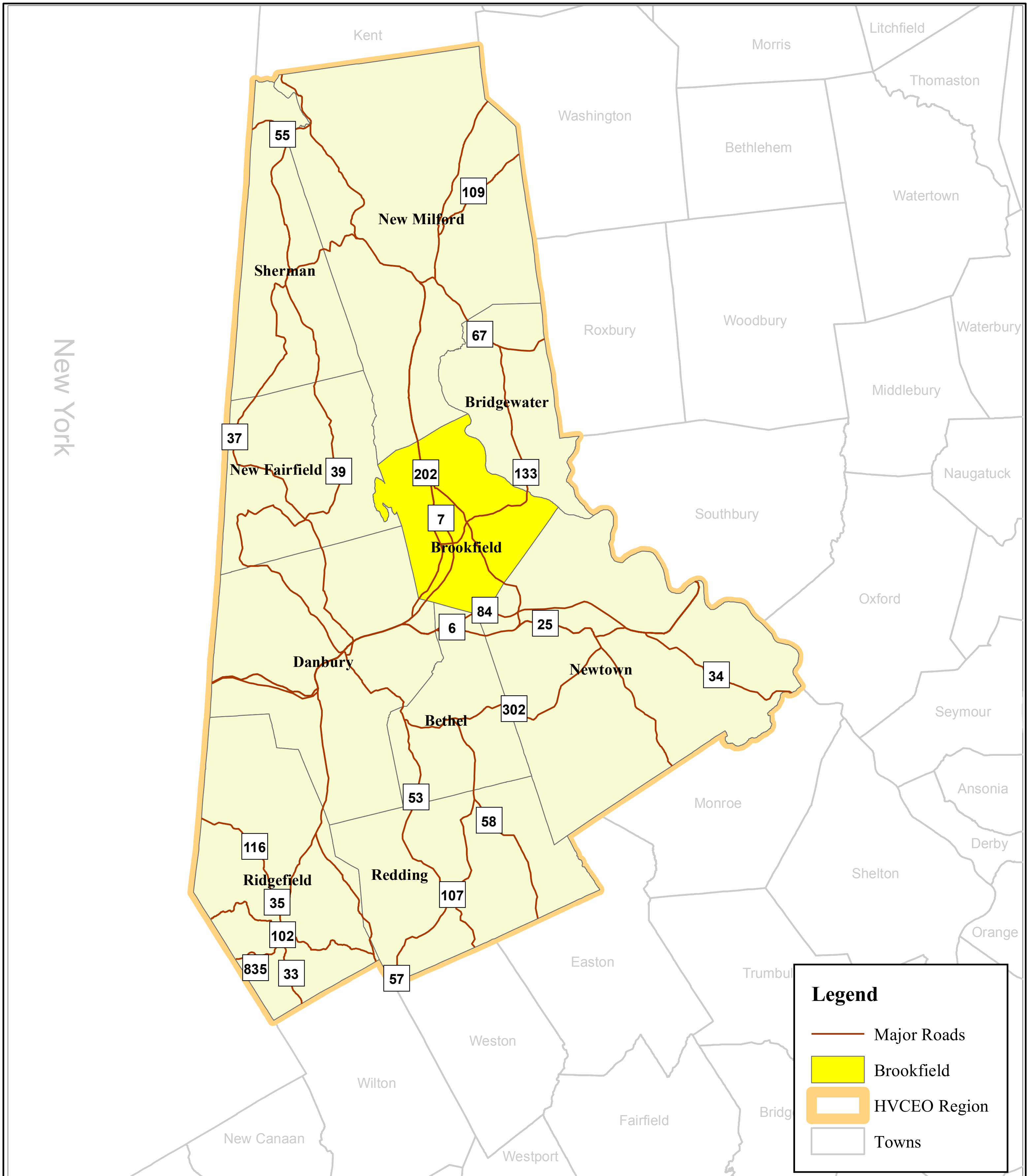

SOURCE(S):
CT DEEP

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

LOCATION:
Brookfield, CT

N

Town of Brookfield
Hazard Mitigation Plan

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

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

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Many of Brookfield residents appear to favor the slowing rate of residential growth. According to the town's 2002 Plan of Conservation and Development (POCD) 5,865 acres or 45% of Brookfield's total land area is currently occupied by residential development. Historically, low-density single family residential uses have been scattered throughout a variety of neighborhoods in the town. Multi-family units are moderate-density developments in small scale projects located in the core of the town adjacent to commercial and civic uses. Table 2-1 summarizes 2014 land use data provided by the Town of Brookfield, Community Development Director.

TABLE 2-1
2014 Land Use/Development Potential

Use	Acres	Number of Parcels	Percent of Developed Land	Percent of Total Land
Residential	**6,590.74**	**5061**	**53.7%**	**48.8%**
Single Family	6,494.55	5012	-	-
Multi-Family	96.19	49	-	-
Business	**649.95**	**251**	**5.3%**	**4.8%**
Retail/Service/Office	361.80	144	-	-
Mixed Use	38.14	32	-	-
Industrial	250.01	75	-	-
Public & Institutional Uses	**326.01**	**59**	**2.7%**	**2.4%**
Public	222.72	19	-	-
Private	103.29	40	-	-
Public Land and Open Space	**3,299.28**	**168**	**26.9%**	**24.4%**
Dedicated Open Space	**2,374.65**	**121**	**19.3%**	**17.6%**
TOB Open Space	1,875.33	75		
Land Trust Open Space	322.23	12		
Conserved Land/Private Open Space	177.09	34		
Managed Open Space	**924.63**	**47**	**7.5%**	**6.9%**
State of CT Lands	683.77	17		
Managed Land	99.84	14		
PL490 Lands	141.02	16		
Other	**1,414.18**	**22**	**11.5%**	**10.5%**
Utility Land	536.32	18		
Transportation	73	1		
Water	804.86	3		
Vacant	**1,217.54**	**488**		
Residential Land	852.51	414		
Commercial Zones - total	147.44	25		
Industrial Zones - total	184.75	33		
Unbuildable land	32.84	16		
Developed/Committed	**12,280.16**		**100%**	**91%**
Vacant/Undeveloped		**1,217.51**		**9%**
Total Land Area	**13,497.70**			

Source: Town of Brookfield, Community Development Director

Table 2-2 summarizes 2006 land cover data which was derived from satellite imagery. Areas shown as turf and grass are maintained grasses such as residential and commercial lawns or golf courses. Development is generally spread throughout the community and not particularly concentrated in any one area. According to this data, about 50% of Brookfield is forested and approximately 26.20% is developed.

Table 2-2
2006 Land Cover by Area

Land Cover	Area within Town (acres)	Percent of Community
Deciduous Forest	5,559	42.60%
Developed	3,418	26.20%
Turf & Grass	1,896	14.50%
Coniferous Forest	764	5.90%
Water	517	4%
Barren	261	2%
Agricultural Field	242	1.90%
Forested Wetland	202	1.60%
Other Grasses	117	0.90%
Non-forested Wetland	39	0.30%
Utility (Forest)	21	0.20%
Tidal Wetland	0	0%
Total	**13,036**	**100%**

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

For many years a small parcel of land that was part of New Fairfield was separated from the rest of New Fairfield by Candlewood Lake. In 1961, this land was annexed from New Fairfield to Brookfield and it is now called Candlewood Shores and Arrowhead Point. This area is one of the most densely developed portions of Brookfield.

Many of the remaining historic structures in the town have been preserved. In 1991 the Brookfield Center was inducted into the National Register of Historic Places. The district represents the original settlement of the Town of Brookfield and contains a total of 67 structures, residential, religious, and municipal, over a 43 acre area.

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 Brookfield. The following discussion highlights Brookfield'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.

The Town of Brookfield is located in the northeastern part of the Appalachian Orogenic Belt, also as the Appalachian Highlands. The Appalachian Highlands extend from Maine south into Mississippi and Alabama and were formed during the orogeny that occurred when the supercontinent Pangaea assembled during the late Paleozoic era. The region is generally characterized by deformed sedimentary rocks cut through by numerous thrust faults.

Bedrock Geology – Connecticut bedrock geology is comprised of several "terranes." Terranes are geologic regions that reflect the role of plate tectonics in Connecticut's natural history.

The bedrock beneath the Town of Brookfield is part of the Newark Terrane. This terrane formed when Pangaea split apart.

The Town of Brookfield's bedrock consists primarily of gneiss and schist. The bedrock alignment trends generally south-southeast to north-northwest through the town. Table 2-3 and Figure 2-3 present the bedrock geology in the Town of Brookfield.

Table 2-3
Bedrock Geology

Formation	Area within Town (acres)	Percent of Town
Ratlum Mountain Schist	3,041	23%
Brookfield Gneiss	2,863	21.90%
Gneiss of Highlands masifs	2,252	17%
Rowe Schist	1,991	15%
Stockbridge Marble	1,279	9.81%
Dalton Formation	714	5%
Basal Marble Member of Walloomsac Schist	494	3.78%
Ordovician Granite Gneiss	344	2.60%
Amphibolite Unit in Ratlum Mountain Schist	58	1.91%
Total	**13,036**	**100%**

Source: Connecticut Department of Energy & Environmental Protection GIS Data

The four primary bedrock formations in the town are Ratlum Mountain Schist, Brookfield Gneiss, Gneiss of Highlands masifs, and Rowe Schist.

- Ratlum Mountain Schist consists of gray, medium-grained, interlayered schist and granofels, composed of quartz, oligoclase, muscovite (in the schist), biotite, and garnet, also staurolite and kyanite in the schist.
- Brookfield Gneiss consists of Dark and light, commonly speckled or banded, medium- to coarse-grained, massive to poorly foliated gneiss, composed of plagioclase, biotite, and hornblende, generally with quartz and K-feldspar, the latter commonly as megacrysts 1 to 3 cm across (also plagioclase megacrysts in darker rocks), locally associated with amphibolite or hornblende schist.
- Gneiss of Highland masifs consists of granitic gneiss, gneiss and schist.
- Light-gray to silvery, fine- to medium-grained, generally poorly layered schist, composed of quartz, muscovite, biotite, oligoclase, and generally garnet, staurolite, and kyanite or sillimanite. Layers of granofels common; also some layers of amphibolite, quartz-spessartine rock (coticule), and calc-silicate rock.

Cameron's Line, an Ordovician suture fault, is the one fault line mapped in the Town of Brookfield. Formed as part of the continental collision known as the Taconic Orogeny around 450 million years ago, the lines extends from Bethel and Danbury, bisecting Brookfield in a path following the Still River, then extending north into New Milford.

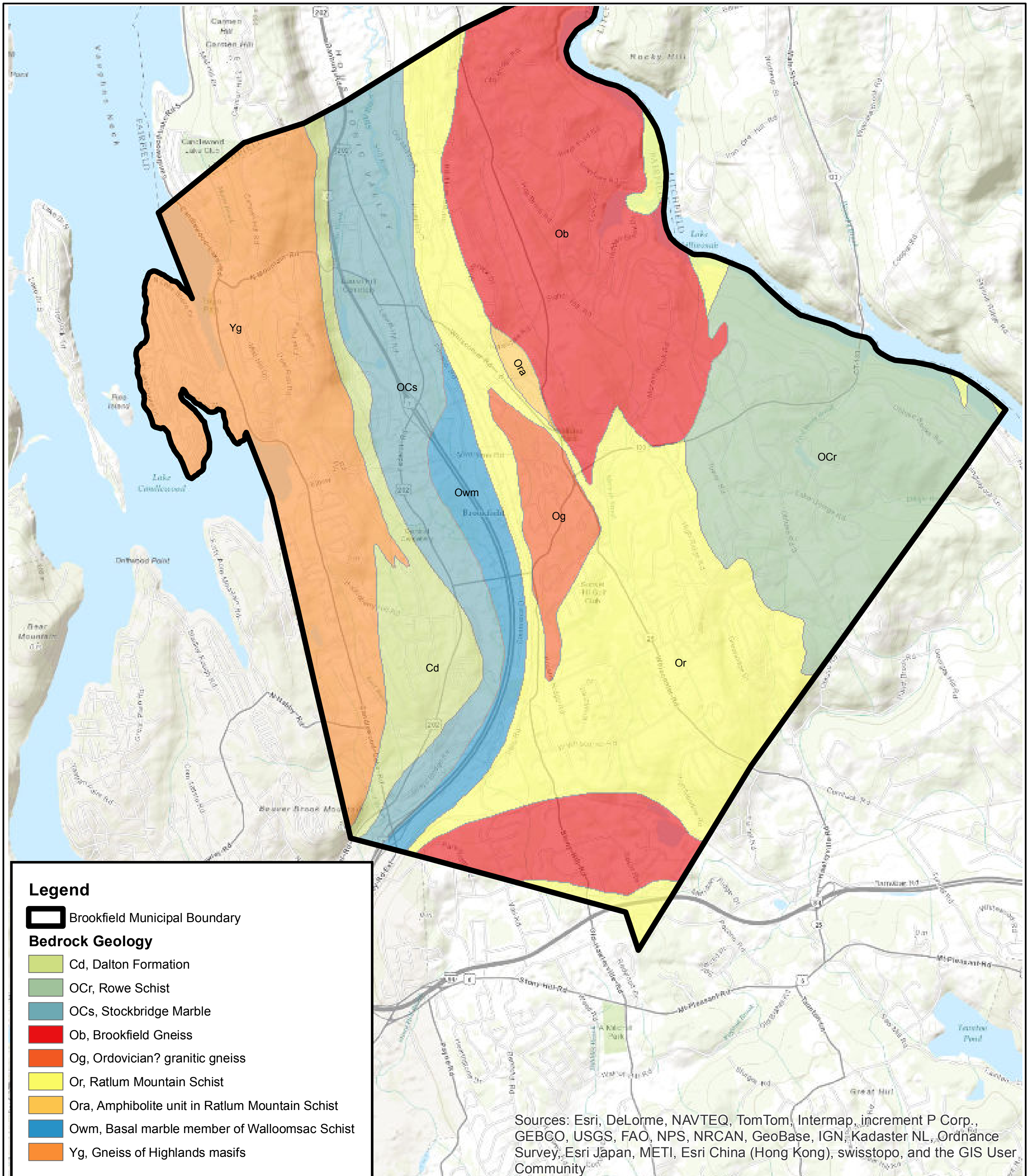
Continental ice sheets moved across Connecticut at least twice in the late Pleistocene era. As a result, Brookfield's surficial geology is characteristic of the depositional environments that occurred during glacial and postglacial periods. Refer to Figure 2-4 and Table 2-4 for a depiction of surficial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

Brookfield is covered primarily (nearly 77%) 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.

Table 2-4
Surficial Geology

Surficial Material	Area within Town (acres)	Percent of Town
Till	7,161	55%
Thick till	2,836	21.74%
Sand and gravel	614	4.71%
Sand	481	3.68%
Fines	452	3.46%
Water	429	3.29%
Sand overlying fines	304	2.33%
Alluvium overlying fines	232	1.77%
Sand and gravel overlying sand	120	0.92%
Sand and gravel overlying fines overlying sand and gravel	119	0.91%
Swamp	107	0.82%
Sand and gravel overlying fines	90	0.69%
Gravel	43	0.32%
Fines overlying sand	27	0.20%
Alluvium overlying sand and gravel	21	0.16%
Total	**13,036**	**100%**

Source: Connecticut Department of Energy & Environmental Protection GIS Data



SOURCE: CT DEEP

Figure 2-3: Bedrock Geology

LOCATION: **Brookfield, CT**

Town of Brookfield
Hazard Mitigation Plan

Map By: CPS
MMI#: 3101-14
MXD: P:\xxxx.mxd
Date: 11/15/2013
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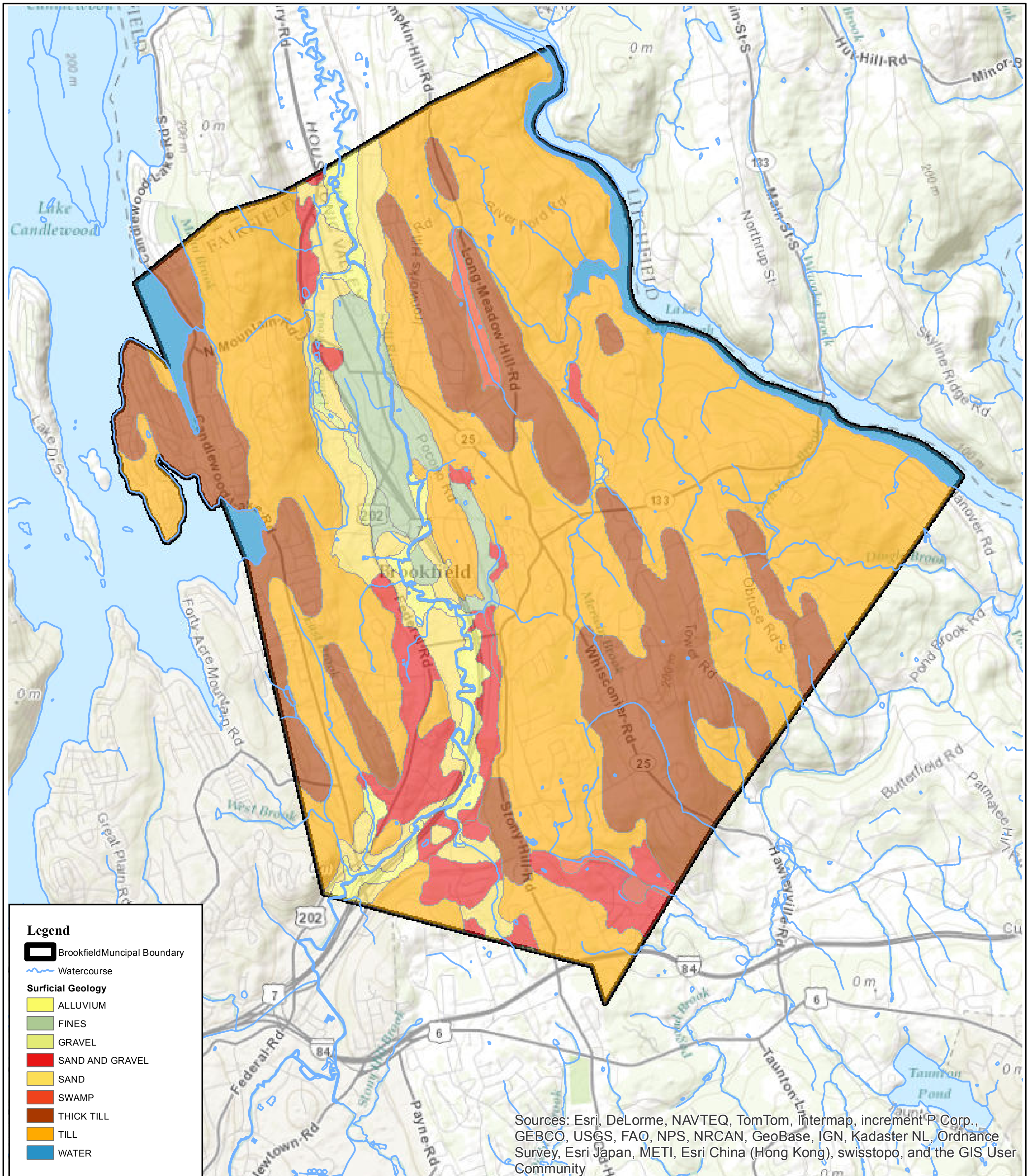

SOURCE:
CT DEEP

Figure 2-4: Surficial Geology

LOCATION:
Brookfield, CT

N

Town of Brookfield
Hazard Mitigation Plan

Map By: CPS
MMI#: 3101-14
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A review of the Still River corridor relative to Brookfield geology shows that the river valley is coincident with a narrow band of the Stockbridge Marble as well as Cameron's Line. The marble is less resistant to erosion as compared to the schist and gneiss bedrock found in the west and east sides of the town. This erodability contributed to the formation of the valley.

Stratified Glacial Fluvial Deposits – The amount of stratified glacial fluvial deposits present in the town 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 wetland areas that provide significant floodplain storage. However, the smaller glacial till watercourses throughout Brookfield can also cause flooding.

The amount of stratified glacial fluvial deposits also has bearing on the relative intensity of earthquakes and the likelihood of soil subsidence in areas of fill.

The stratified glacial fluvial deposits in the Still River valley were deposited by postglacial rivers that occupied this eroded section of the marble, and today these deposits and the overlying alluvium are located along the Still River.

Soil type affects the ability of rainwater to infiltrate, which in turn affects flooding. In terms of soil types, approximately 51% of Brookfield contains Woodbridge fine sandy loam, Hollis-Chatfield-Rock outcrop complex, Paxton and Montauk fine sandy loam and Charlton-Chatfield complex.

2.4 Climate

Brookfield has a climate characterized by moderate but distinct seasons. The mean annual temperature is 49.7 degrees Fahrenheit based on temperature data compiled by the National Climatic Data Center (NCDC) from the Danbury station between 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 43.6 inches per year. Mean annual precipitation is 51.8 inches, with at least four inches of precipitation occurring in each month with the exception of February.

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

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

2.5 Drainage Basins and Hydrology

Brookfield is divided among five sub-regional watersheds as shown on Figure 2-5 and in Table 2-5. The majority of the sub-regional basins drain into the Still River and then to the Housatonic River. All of the water that passes through Brookfield eventually empties into Long Island Sound.

Table 2-5
Sub-regional Drainage Basins

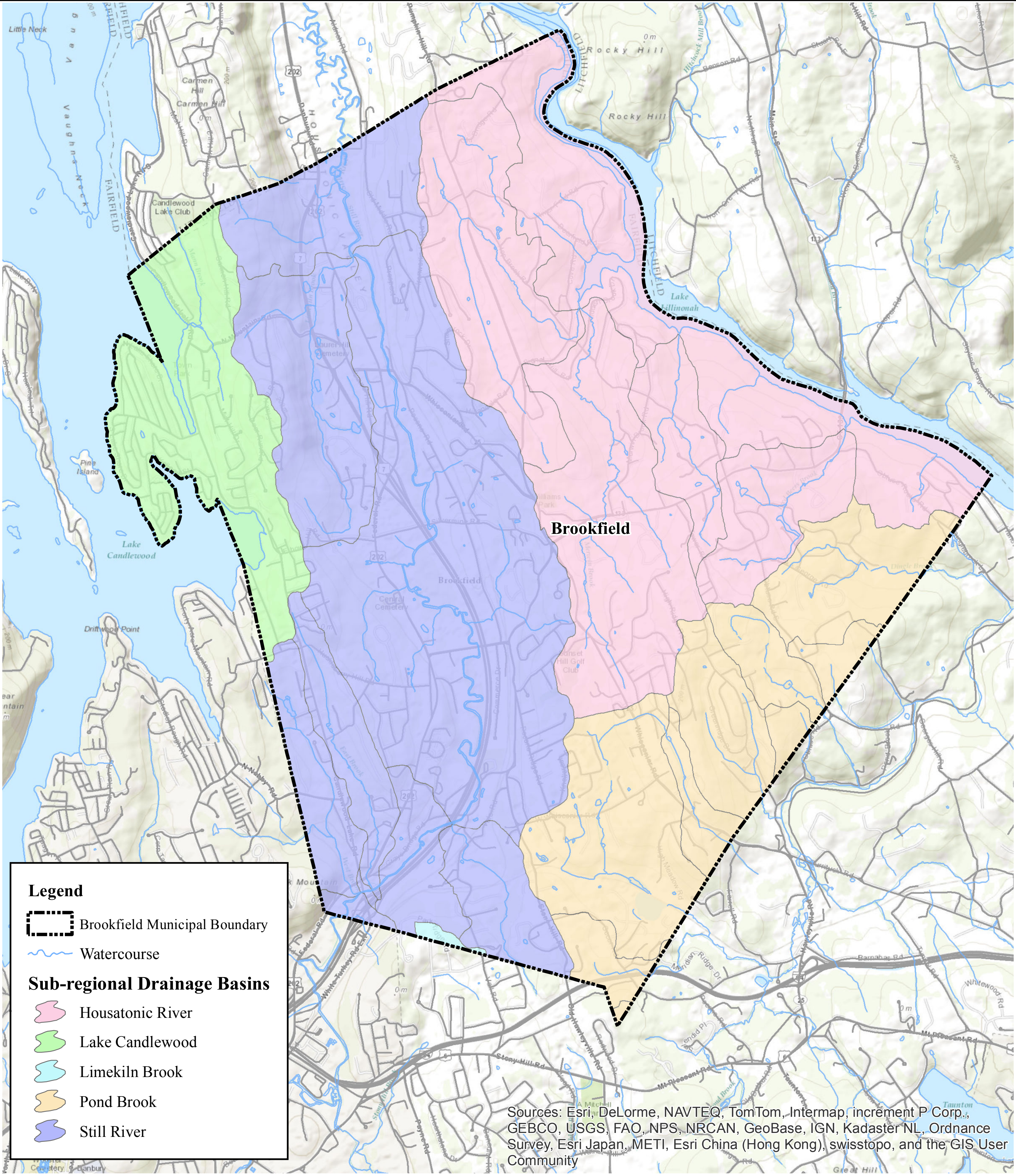
Drainage Basin	Overall Sub-regional Area (sq. mi)	Area within Town (sq. mi)	Area within Town (acres)	Percent of Town
Still River	63.44	8.17	5,230.94	40.12%
Housatonic River	623.53	6.70	4,291.40	32.91%
Pond Brook	13.90	3.58	2,293.19	17.59%
Candlewood Lake	27.68	1.87	1,200.08	9.20%
Limekiln Brook	8.76	0.03	21.08	0.16%
Total	**n/a**	**20.37**	**13,036**	**100.0%**

Source: Connecticut Department of Environmental Protection GIS Data

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.

Still River

The Still River is a 25.4 mile tributary to the Housatonic River. Its headwaters originate from Farringtons Pond at the New York border with Danbury. It meanders through Sanfords Pond and Lake Kenosia before entering a concrete aqueduct near downtown Danbury. It then turns north and becomes a more conventional river as it cuts through Brookfield and southern New Milford before joining the Housatonic river. In Brookfield, the Still River sub-regional basin area makes up about one third of the town's drainage.



SOURCE:
CT DEEP

Figure 2-5: Sub-regional Drainage Basins

LOCATION:
Brookfield, CT

N

Town of Brookfield
Hazard Mitigation Plan

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

Map By: CPS
MMI#: 3101-14

Date: 01/14/ 2014
Scale: 1 inch = 0.83 miles

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Housatonic River

The Housatonic River drains an area of 1,948 square miles from Pittsfield, Massachusetts to Milford, Connecticut where it flows into Long Island Sound. The river flows a total of 134 miles from its upper reach to the sound with 1,234 square mile of the total drainage area existing in Connecticut. After crossing into Connecticut, the river creates the border for several towns as it flows south through the northwestern part of the state. Once into the lower Housatonic Valley region, the river breaks to the southeast flowing through New Milford and cutting between Brookfield, Bridgewater, Southbury, Newtown and down to the sound. Many of the sub-regional drainages in these towns flow into the Housatonic River along with small tributaries that flow directly into the river, which make up the Housatonic sub-regional drainage basin. Approximately, 4,291 acres of Brookfield are within the Housatonic River sub-regional drainage basin that covers 33% of the town. The main channel of the Housatonic is lined with 1% annual chance storm floodplains that extend on either side of the river with areas that further extend making up the 0.2% annual chance floodplains.

Pond Brook

With a drainage basin area of around 14 square miles, much of the flow in the Pond Brook drainage basin is directed north from Newtown towards the Housatonic River. The headwaters begin south of Interstate 84 in Newtown beginning at Taunton Pond and surrounding tributaries also with several tributaries flowing south-southeast from Brookfield. Most of the input streams flow directly into the main channel of Pond Brook before it empties into a cove of Lake Lillinonah. Approximately, 2,293 acres of Brookfield are within the Pond Brook sub-regional drainage basin; this covers 17.5% of the town.

Candlewood Lake

Candlewood Lake is the country's first pump-storage reservoir and, at 5,400 acres, is the largest lake in Connecticut. The reservoir was constructed to support power generation at the Rocky River power station in New Milford. Since 1926, water has been diverted from the Housatonic River and pumped uphill into the Lake. During low-flow conditions on the Housatonic River, water is released from Lake Candlewood to run the generation turbines and, hence, this water is returned to the Housatonic River.

The Candlewood Lake watershed comprises 9.2% of the town’s land area. Large tributaries to the lake include Sawmill Brook and Glen Brook in Sherman and Ball Pond Brook in New Fairfield. The lake is impounded in Danbury by the Lake Candlewood Dam, a Class C dam near the Danbury Candlewood Park off Hayestown Road, and is impounded by several dams lying in other municipalities as well. There is a delineated 1% annual chance floodplain surrounding the lake without elevations defined.

Consisting of just less than 28 square miles of land area, the drainage for this region collects in Candlewood Lake. This sub-regional drainage basin is located between five towns including Brookfield, New Milford, Danbury, New Fairfield and Sherman with the majority of area in New Fairfield. The total area of the lake consists of eight and a half square miles and the surrounding land area actively draining several input tributaries that enter into various bays of Candlewood Lake.

Limekiln Brook

The Limekiln Brook's sub-regional drainage basin only inhabits 21 acres of southern Brookfield and stretches from northern Bethel to the south east edge and into Newtown (a total of just under nine square miles of drainage area). Tributaries enter from Newtown to the east and flow northwest towards the mouth at the Still River. This sub-regional drainage basin meets the Still River in Newtown just after it flows under Route 84. *This sub-regional drainage basin should not be confused with the similarly named stream associated with the Meadowbrook Manor neighborhood located in the Still River sub-regional drainage basin, Lime Kiln Brook.*

2.6 Population and Demographic Setting

According to the 2010 U.S. Census, Brookfield had a population of 16,452, with 810 persons per square mile. As noted in Table 2-6, Brookfield is the sixth most populated municipality in the HVCEO region. The Connecticut State Data Center predicts that population growth in Brookfield will increase over the next twelve years. The population in 2025 is projected to be 16,740.

Table 2-6
Population Density by Municipality, Region and State, 2010

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

Source: United States Census Bureau, 2013

2.7 Governmental Structure

The Town of Brookfield 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 Commission, Zoning Commission, Conservation Commission, Inland Wetlands Commission, the Building Official, the

Land Use Department, the Fire Department, Emergency Management, and the Public Works Department.

Drainage complaints are routed through the First Selectman's office and the Public Works Department. These complaints are usually received via phone, fax, 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

In the 1700s Brookfield was an area of farm lands, forests and streams. It was called Newbury, a name derived from the three towns from which its land was taken (New Milford, Newtown, and Danbury). The Town was incorporated in 1778. The name Newbury was changed to Brookfield in honor of the Reverend Thomas Brooks, who was a local minister. The first Town Meeting was held on June 9, 1788.

As early as 1732, there was industry along the Still River, and the area became known as the Iron Works District. Found here were the furnaces for making iron, the ever important grist mills, sawmills, comb shops, carding and cotton mills, a paper mill, knife factory, hat factories, and others. Still standing today is the grist mill, now the Brookfield Craft Center, and the remains of the Iron Works Aqueduct Company. This company was formed in 1837 to supply water from the mountain springs to the Iron Works District.

Electricity was first brought to Brookfield in 1915, when the Danbury and Bethel Gas and Electric Company hooked up the homes in Brookfield Center to their electric lines. By the late 1920s electricity was in more demand. The Connecticut Light and Power Company built the first hydroelectric plant in America at Rocky River, just north of New Milford. A reservoir for the water was needed, so land from Danbury, New Fairfield, Brookfield, and Sherman was taken. This land also included ponds named Neversink, Barses, and Squantz. By 1928, the plant was finished and Candlewood Lake was formed. It is the largest man-made lake in Connecticut. Brookfield Town Park is located on the Candlewood Lake Beachfront.

As noted in Section 2.2, Brookfield has been transforming from a colonial New England town to a local shopping and consumer goods destination with low-to-moderate commercial uses since the 1980s. The area surrounding Candlewood Lake has also seen increase in residential growth and volume of summer traffic. Today commercial and residential development is growing in Brookfield, as compared to other communities in Connecticut. The Federal Road (U.S. Route 202) corridor is the economic engine of Brookfield since it is the location of most existing commercial uses and the primary area for accommodating intensive development in the future, whereas the "Four Corners" area at the intersection on Federal Road and Route 25 is currently the pulse of development in Brookfield. The proximity of Brookfield to the Still River / Route 7 corridor and Interstate 84 has helped promote economic development.

According to town officials, there have not been many recent open space acquisitions, although some conservation easements have been secured in recent years, which included steep slopes. The town acquired the Erickson Farm for open space; however this area did not include any specific areas of hazard risk.

Future Development

The Four Corners in Brookfield is a well-known community landmark and so named primarily because it is the historic junction of State Routes 7 and 25. The name is also associated with the four gas stations occupying the four corners of this intersection today. When the highway portion of Route 7 in southwestern Connecticut ended at Exit 12 in Brookfield, just south of the Four Corners, all drivers exited there and passed through the area. Since an extension to highway Route 7 opened in 2010, as much as 70 percent of that traffic began to bypass the Four Corners. The Town has seized this change as an opportunity. They see this landmark place as ripe for renewal, to be reenergized, and with potential beyond being a place to buy gas. This Four Corners plan presents the culmination of a planning process which has developed a future revitalization scenario and associated implementation plan which lays out the steps to the plan's realization. The Four Corners study area is represented by the Town Center District – a zoning district that encompasses the Four Corners and adopted to manage land use in the area.

Moving forward, the Four Corners is expected to continue developing with commercial and residential land uses, and more than 250 units of multi-family housing is approved in this area. Most of the outlying parts of the town will remain at lower residential densities, and subdivisions are typically small.

2.9 Critical Facilities, Sheltering Capabilities, and Emergency Response

The Town considers its police, fire, governmental, and major transportation arteries to be its most important critical facilities since these are needed to ensure that emergencies are addressed while day-to-day management of Brookfield continues. The Town also considers various infrastructure and facilities (such as water and sewer pump stations) to be critical facilities, as well as companies and businesses storing hazardous materials. Table 2-7 identifies all of these critical facilities.

Table 2-7
Critical Facilities

Facility	Address or Location	Comment	Emergency Power?	Shelter?	In 1% Annual Chance Floodplain?
Brookfield Volunteer Fire Company	92 Pocono Road	Emergency Response	✓		
Brookfield Volunteer Fire Department, Candlewood Company	18 Bay View Drive	Emergency Response	✓		
Brookfield Ambulance Facility	4 Obtuse Hill Road (Route 133)	Emergency Response			
Brookfield Town Hall and Brookfield Senior Center	100 Pocono Road	Emergency Support and Response			
Brookfield Police Department	63 Silvermine Road	Emergency Operations Center (EOC)	✓		
Brookfield High School	45 Longmeadow Hill Road	Primary Shelter	✓	✓	

Huckleberry Hill Elementary School	100 Candlewood Lake Road	Proposed Secondary Shelter			
Brookfield YMCA	2 Huckleberry Hill Road	Emergency Assistance (Showers)			
Brookfield Public Works Garage	81 Gray's Bridge Road	Emergency Support	✓		✓
Sewer Pump Stations	Various Locations	Critical Facility			
Water Pump Stations	Various Locations	Critical Facility			
Water tank		Critical Facility			
Elderly Housing "Brooks Quarry"	3 Brooks Quarry Road	Elderly Housing			
Assisted Living	246 Federal Road	Assisted Living			
Brookfield School Age Program	100 Candlewood Lake Road	Day Care			
Christian Life Academy	133 Junction Road	Day Care			
Country Kid's Club	94 Old State Road	Day Care			
Country Kids Play Farm	107 Old State Road	Day Care			
Greenknoll Children's Center	60 Old New Milford Road	Day Care			
Greenknoll Children's Center	2 Huckleberry Hill Road	Day Care			
The Goddard School	1 Production Drive	Day Care			
Kid's Castle Learning Center	777 Federal Road	Day Care			
Montessori Community Center	21 West Whisconier	Day Care			
Prince of Peace	179 Junction Road	Day Care			
Brookfield Hills Condominium	Vail Road	Condominium/Apartments			
Cederbrook Condominium	Whisconier Road	Condominium/Apartments			
High Meadows Condominium	Route 133	Condominium/Apartments			
Lake Lillinonah Shores	Hearthstone Drive	Condominium/Apartments			
Ledgewood Condominium	Route 133	Condominium/Apartments			
Mill River Condominium	Federal Road	Condominium/Apartments			
Newbury Crossing	Silvermine Road	Condominium/Apartments			
Newbury Village	Federal Road	Condominium/Apartments			
Oak Meadows	Federal Road	Condominium/Apartments			
Orchard Place Apartments	Orchard Street	Condominium/Apartments			
Riverview Condominium	Federal Road	Condominium/Apartments			
Rollingwood Condominium	Federal Road	Condominium/Apartments			
Sandy Lane Village	Sandy lane	Condominium/Apartments			
Silvermine Manor	Silvermine Road	Condominium/Apartments			
Stony Hill Village	Stony Hill Road	Condominium/Apartments			
Town Brooke Commons	Nabby Road	Condominium/Apartments			
Whisconier Village	Whisconier Road	Condominium/Apartments			
Woodcreek Village	Prange Road	Condominium/Apartments			

Emergency shelters are an important subset of critical facilities as they are needed in many emergency situations. The primary identified shelter in the town that is also considered a critical facility is the Brookfield High School on Long Meadow Hill Road. This facility has a backup generator; however the town would like to increase the capacity of the generator.

The Brookfield YMCA is only used as a day shelter and provides showers in the event of power outages. While the YMCA is not considered a designated shelter, its importance during disasters makes it a critical facility and the town would like to obtain standby power for this facility.

The town would also like to have a shelter on the west side of town and have considered using the Huckleberry Hill School for this purpose. The town wishes to renovate the school, and the renovations may include elements that make it easier to be a shelter, but this has not been financed or approved yet. The town would also like to acquire standby power for the school.

Utilities

Several sewer pumping stations throughout Brookfield are considered to be critical facilities. The station that collects all sanitary wastewater and pumps it to Danbury is the most important. Some of these have access to standby power, and the sewer commission has a few portable generators. However, the town would like to obtain additional standby power for these facilities.

Water pumping stations and the water tank are also considered critical facilities.

Emergency Response Capabilities

The Police Department and Emergency Services coordinates emergency preparedness in the Town of Brookfield. The Town's Emergency Operations Center (EOC), including its Emergency Communications Center, is located the Brookfield Police Department. The EOC's goal is to provide citizens with the highest level of emergency preparedness before, during, and after disasters or emergencies. That Town coordinates with all departments internally to develop plans, protocols, and procedures that assure the safety of Brookfield's citizens. It also provides technical assistance to state and local emergency response agencies and public officials.

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

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

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

Communications

The Town's EOP guides its response to emergencies arising from both natural and anthropogenic hazards. The Town utilizes a program known as "CT Alert" to direct geographically specific emergency notification telephone calls into affected areas. The local radio station, WLAD is also utilized for notifications purposes and the town utilizes the services of Charter Communications to post emergency information on cable channel 21. Finally, the Board of Education maintains an email blast system for notifications that may include natural hazards.

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 exists across Brookfield, 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 Brookfield 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 inland flooding:

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

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

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

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

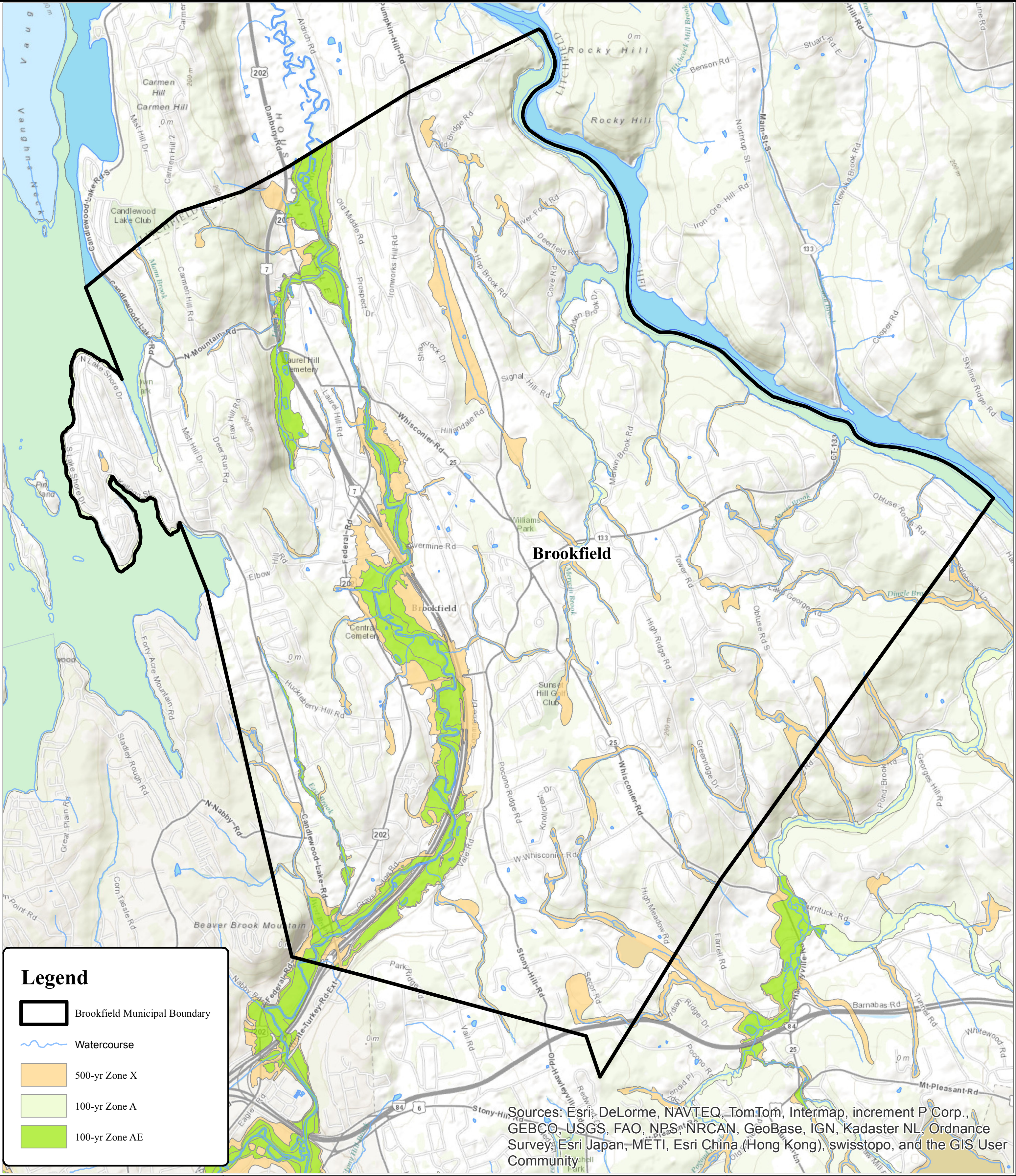
Furthermore, damp conditions trigger the growth of mold and mildew in flooded buildings, contributing to allergies, asthma, and respiratory infections. Snakes and rodents are forced out of their natural habitat and into closer contact with people, and ponded water following a flood presents a breeding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

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

In order to provide a national standard without regional discrimination, the 1% annual chance flood has been adopted by FEMA as the base flood for purposes of floodplain management and to determine the need for insurance. The risk of having a flood of this magnitude or greater increases when periods longer than one year are considered. For example, FEMA notes that a structure located within a 1% annual chance flood zone has a 26% 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 September 30, 1982 and intends to continue participation in the NFIP. SFHAs in Brookfield are delineated on a Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS). The FIRM delineates areas within Brookfield that are vulnerable to flooding and was most recently published on June 18, 2010 as part of the Fairfield County FIS. The hydrologic and hydraulic analyses from the FIS report dated December 1978 were performed by Harris-Toups Associates for the Federal Insurance Administration (FIA), under Contract No. H-3987. That work, which was completed in October 1977, covered all significant flooding sources affecting the Town of Brookfield. The original FIS and FIRMs for flooding sources in the town were originally published in December 1978 and were revised in 2010.

A regulatory floodplain with AE designation has been mapped along the Still River and the Housatonic River. 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. Portions of the Housatonic River and its tributaries distribute these traits. Floodplain and floodway designations have also been established along the Still River. Refer to Figure 3-1 for the areas of Brookfield susceptible to flooding based on FEMA flood zones. Table 3-1 describes the various zones depicted on the FIRM panel for Brookfield.



SOURCE(S):
2013 Fairfield County DFIRM
(c)2009 Microsoft Corporation

Figure 3-1: FEMA | Special Flood Hazard Areas (SFHA)

LOCATION:
Brookfield, CT

N

Town of Brookfield
Hazard Mitigation Plan

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

Map By: CPS
MMI#: 3101-14
Original: 01/14/2014
Revision: 3/25/2014
Scale: 1 inch = 0.79 miles

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www.miloneandmacbroom.com

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 pre-storm storage is available.

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

3.3 Historic Record

The Town of Brookfield 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.

According to the revised October 2013 FEMA FIS, at least 26 major storms occurred in the Housatonic River basin since 1693. The notable historical floods in the early 20th century occurred in March 1936, September 1938, January 1949, August 1955, October 1955, and September 1960. In terms of damage to Brookfield, the most severe of these was damage associated with the flood of October 1955, which had a return period of 80 years. This flood was the result of high intensity rainfall falling on saturated ground.

The Still River has experienced floods during all seasons as a result of either intense rainfall during the coastal storm and hurricane season from June to October or because of rain combined with melting snow, which caused the flood of 1936. The most notable storms in the Still River basin occurred in March 1936, September 1938, December 1948, August and October 1955, and September 1960. Of these, only the March 1936 and December 1948 storms were not associated with tropical activity.

The 1955 flood is the greatest Still River flood event on record, having a recurrence interval estimated at approximately 80 years. No record of damage is available. For two months previous to the October flood, the area had been deluged with an inordinate amount of precipitation, leaving lakes and ponds swollen to capacity. When the October storm arrived, no natural storage was available for these new rains resulting in the almost instantaneous dumping of surging floodwaters from lakes and ponds into streams which were rising rapidly. The Still River and its tributaries quickly overflowed, inundating dozens of residential and commercial properties. The greatest flood damage occurred along the flat floodplains of the Still River where many industrial and commercial concerns in the vicinity of White Turkey Road, Station Road, and along U.S. Highway 7 were inundated by three or more foot flood depths. Two tributaries, Limekiln Brook and East Brook, have experienced minor flooding chiefly in the vicinity of their confluences with the Still River.

In general, potential present-day flooding problems in Brookfield are concentrated along the Still River. The highest risk areas along the Still River include Lower Federal Road, Dean Road and Sand Cut Road. Town officials have noted that washouts of railroad tracks have occurred at Vail Road, near Sunset Hill Road. Minor flooding problems are widespread throughout Brookfield. However, periodic extreme events along defined floodplains often result in damage to insured structures. The most common damage is to infrastructure and occurs due to flash flooding.

According to the NCDC Storm Events Database, since 1996 there have been 22 flooding and 72 flash flooding events in Fairfield County. The following are descriptions of historic floods in the vicinity of the Town of Brookfield 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.

- March 9, 1998: This system produced widespread heavy rainfall including thunderstorms that caused widespread urban and small stream flooding as well as river flooding. Many low-lying and poor drainage areas, including streets were flooded throughout the area. The Still River in Danbury, southwest of Brookfield, overflowed its' banks. In Newtown, southeast of Brookfield, a dam split, causing the Pootatuck River to rise.

- January 15, 1999: A combination of heavy rain falling on frozen ground, snow and ice melting, and partially clogged storm drains, caused widespread flash flooding of low-lying and poor drainage areas across the region. Widespread and significant street flooding also occurred in in southwest of Brookfield, in Danbury.

- September 16, 1999: Torrential record rainfall, which caused serious widespread urban, small stream, and river flooding, preceded the remnants of Hurricane Floyd. Fairfield, Litchfield, and Hartford Counties were declared disaster areas. The initial cost estimates for damage to only the public sector included $1.3 million dollars for Fairfield County. These estimates do not account for damage in the private sector. Serious widespread flooding of low-lying and poor drainage areas resulted in the closure of many roads and basement flooding across Fairfield County. The greatest property damage occurred in Danbury and downstream into Brookfield along the Still River and its tributaries.

- July 15, 2000: Heavy rainfall caused serious and widespread flooding of low-lying and poor drainage areas, especially along streets in Newtown, southeast of Brookfield.

- September 8, 2004: The remnants of Hurricane Frances produced torrential rainfall across western Connecticut, with total rainfall amounts ranging from one to six inches. The rainfall produced flash flooding of many roads in Fairfield County.

- July 18, 2005: Thunderstorms developed in a very moist and unstable airmass. This allowed flash flooding and severe weather to occur across Fairfield County as the storms moved slowly. Flash flooding trapped several motorists in their cars as the water quickly rose. Metro North service was stopped due to high flood waters.

- June 6, 2005: A strong cold front moved into a very unstable airmass over Western Connecticut. A line of thunderstorms formed along the cold front, some of which produced wind damage over most of Fairfield County, many trees were reported down.

- October 2005: Although the consistent rainfall of October 7-15, 2005 caused flooding and dam failures in most of Connecticut (most severely in northern Connecticut), the precipitation intensity and duration was such that only moderate flooding occurred in Brookfield. Urban flooding of low-lying and poor drainage areas occurred throughout the region.

- April 15-27, 2007: A combination of storms caused widespread flooding across New York and Connecticut. The Metro North railroad line from Danbury to Norwalk suffered track washouts in three locations and was out of service for a day. Flooding along the Still River in Danbury and downstream into Brookfield was estimated as being between the 10-year and 50-year recurrence interval. Fairfield County was declared a disaster area, and statewide there were 1,450 registrations for aid totaling $1,489,916 for housing assistance and $62,874 for other needs assistance. According to the "Q-Alert" system, flooding was reported at the intersection of Old Brookfield Road and Federal Road, preventing the residents of the Lexington Mews, Lexington Court, and Good Shepard Hill Summit View condominiums from leaving or entering.

- July 29, 2007: Thunderstorms produced torrential rain that resulted in significant street flooding in Brookfield. Torrential rain caused flash flooding along portions of Candlewood Lake Road, Main Drive, Pocono Road and Dean Road in the town.

- March 30, 2010: A two-day storm ending March 30, 2010 produced 4.5 inches of rain resulting in a disaster declaration for Fairfield County. Statewide, there were 3,681 registrations for aid totaling $4,383,365 for housing assistance and $244,276 for other needs assistance, as well as 3,438 Small Business Administration loan applications with $2,659,200 in assistance approved. Repeated severe spring storms occurred through May 17, 2010.

- June 9, 2011: A pre-frontal trough and an approaching cold front caused a bout of widespread thunderstorms that produced severe weather and hail across most of Southern Connecticut. Around 100 trees were reported down throughout Brookfield.

- 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 Fairfield County totals ranged from 5 to 10 inches. Moderate flooding occurred in Brookfield. Numerous road closures were reported due to flooding, downed trees and power lines causing some evacuations and widespread, long duration power outages. 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. The wind and power outages were worse than the flooding.

3.4 Existing Capabilities

Ordinances, Regulations, and Plans

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

- ***Code of the Town of Brookfield***: the Town's Code of Ordinances was adopted by Town Council in 1980 for the sole purpose of codifying municipal laws and ordinances. The purpose of this chapter is to:

  > *promote the public health, safety and general welfare within the Town and to minimize public and private losses due to flood conditions in the floodway and flood-fringe areas in the Town and to protect the aquifer within said areas by provisions designed to: A. Protect human life and health; B. Minimize expenditures of public money for costly flood-control projects; C. Minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public; D. Minimize prolonged business interruptions; E. Minimize damage to public facilities and utilities, such as water and gas mains, electric, telephone and sewer lines, streets and bridges located in areas of special flood hazards; F. Help maintain a stable tax base by providing for the sound use and development of areas of special flood hazard so as to minimize future flood blight areas; G. Ensure that potential buyers are notified that property is in an area of special flood hazard; and H. Ensure that those who occupy the areas of special flood hazard assume responsibility for their actions.*

- ***Zoning Regulations***. Effective August 17, 1967, the Town of Brookfield Zoning Regulations, have been enacted to "to guide the future growth and development of the Town in accordance with a comprehensive plan designed to represent and promote the most beneficial and convenient relationships among the residential, commercial, industrial and public areas within the Town, considering the suitability of each area for such uses as indicated by existing conditions; trends in development and changing modes of living; and having due regard for the use of land, building development and economic activity, both within and adjacent to the Town.

- Section 242-503 of the Zoning Regulations outlines regulations for ***Floodplain Districts*** and is essential the local version of the NFIP regulations. The regulations were enacted to address floodplains, including establishing areas of special flood hazard, restrictions, development permit requirements, permitted uses, and standards for flood hazard reduction.

- Section 242-503(B)(1) states that a development permit shall be obtained before construction or development begins within any area of special flood hazard established in Subsection B.

- Sections 242-503 (c) and (d) outline uses that are permitted in floodways and floodplains.

- Section 242-503(h) outlines that provisions for flood hazard reduction and provides standards for all areas of special flood hazards such as, anchoring construction materials and methods and utilities.

- Section 242-503(h)(a)(1) states that new construction, including manufactured and mobile homes, and substantial improvements thereto shall be placed on a permanent foundation and shall have the lowest floor, including basement, elevated to or above the base flood elevation.

- Section 242-503(h)(a)(2) New construction and substantial improvements of any commercial, industrial or other nonresidential structure shall either have the lowest floor, including basement, elevated to a level one foot (1') above the base flood elevation or, together with attendant utility and sanitary facilities, shall

  (a) Be floodproofed from an elevation one foot (1') above the base flood elevation and below, so that the structure is water tight with walls and floors substantially impermeable to the passage of water;

  (b) Have structural components capable of resisting hydrostatic and hydrodynamic loads and effects on buoyancy; and

  (c) Be certified by a registered professional engineer or architect that the standards of this subsection are satisfied. Such certificates shall be provided to the official set forth in Subsection B(5)(b).

- ***Wetlands and Watercourse Regulations***. Effective with an ordinance adopted June 24, 1974 wetlands and watercourses regulations, Chapter 220 of the *Code of the Town of Brookfield* is to protect the quality of the inland wetlands and watercourses within the Town of Brookfield 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 220-3 *Definitions* – Regulated Activity means any operation within or use of a wetland or watercourse involving removal or deposition of materials, or any obstruction, construction, alteration or pollution, of the wetlands or watercourses, but shall not include the activities specified in Section 220-5 of these regulations. Furthermore, any operation that may disturb the natural and indigenous character of a wetlands or watercourse and any earth moving, filling, construction, or clear-cutting of trees within two hundred feet (200') of the mean waterline of Candlewood Lake, the Still River, or Lake Lillinonah, within one hundred feet (100') of such waterline of any other watercourse or within seventy-five feet (75') of any wetlands is a regulated activity. Furthermore, any clearing, grubbing, filling, grading, paving, excavating, construction, depositing or removal of material and discharging of storm water in the following areas is a regulated activity:

    - (1) on land within seventy-five feet (75') measured horizontally from the boundary of any wetland or one hundred feet (100') of any watercourse, provided
    - (2) if the slope of such land exceeds 5%, within the distance measured horizontally from the boundary of the wetland or watercourse equal to seventy-five (75') feet for a wetland and one hundred (100') feet for a watercourse plus an additional 5 feet for each 1% increase in slope greater than 5%, but not more than two hundred (200') feet;

    The Commission may rule that any other activity located within such upland review area or in any other non-wetland or non-watercourse area is likely to impact or affect wetlands or watercourses is a regulated activity.

- Section 220-5 *Permitted Uses as of Right and Non-Regulated Uses*

    - (A)(2)(b) states that no residential homes shall be permitted "as of right" in wetlands and watercourses after July 1, 1987.

- Section 220-7 *Regulated Activities to be Licensed*

    - (A) No person shall conduct or maintain a regulated activity without first obtaining a permit for such activity from the Inland Wetland Commission of the Town of Brookfield.
    - (B) Any person found to be conducting or maintaining a regulated activity without the prior authorization of the Town of Brookfield Inland Wetland Commission, or violating any other provision of these regulations, shall be subject to the enforcement proceedings and penalties prescribed in Section 220-15 of these regulations and any other remedies as provided by law.

- ***Subdivision Regulations.*** The 2007 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.

    - All subdivision proposals shall be consistent with the need to minimize flood damage.
    - All subdivision proposals shall have public utilities and facilities such as sewer, gas, electrical and water systems located and constructed to minimize flood damage.

- All subdivision proposals shall provide adequate drainage to reduce exposure to flood hazards
- Base flood elevation data shall be provided for all subdivision proposals and other proposed development in Zone A which are greater than five acres or fifty lots
- All subdivision proposals serviced by public utilities and facilities including sewer, gas, electrical and water systems, shall have such facilities located and constructed to minimize flood damage.

- ***Plan of Conservation and Development.*** This 2002 document is the Town's vision statement for future development. It is typically updated every 10 years.

  - Support the Conservation Commission in their role as the lead agency for coordinating the overall conservation and preservation of natural resources in Brookfield.
  - Continue to protect watercourses, waterbodies, wetlands, floodplains, vernal pools, groundwater, and other important water resources.
  - Continue to protect water quality and water resources in Brookfield by:
    - regularly reviewing the aquifer protection zone regulations to ensure adequate protection for aquifer areas.
    - requiring the replacement of underground residential fuel storage tanks that are more than 20 years old before sale of a property.
    - maintaining upland review areas adjacent to wetlands and watercourses that will help to preserve them in their natural state or buffer them from adjacent activities.
    - Consider ways to limit development impacts in sensitive watershed areas (such as Candlewood Lake).
    - Continue efforts to reduce pollution from septic systems, salt storage areas, storm drainage systems, soil erosion, and other diffuse (non-point) sources, including examining the amount of impervious surfaces allowed in all zones and areas.
    - Require periodic cleaning of storm basins that drain to Candlewood Lake, Lake Lillinonah, wetlands, watercourses, and other areas where water pollution may be prevented.

<u>Floodplain Management, NFIP and CRS</u>

Mr. Ralph Tedesco, P.E., Director of Public Works 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 meets the minimum reasonable for regulatory purposes under the NFIP. The Town is not enrolled in the Community Rating System (CRS) program. Freeboard is not required in Brookfield.

The Town's Planning and Zoning Commission uses the 1% annual chance flood lines from the FIRM delineated by FEMA to determine floodplain areas. Site plan standards require that all proposals be consistent with the need to minimize flood damage, that public facilities and utilities be located and constructed to minimize flood damage, and that adequate drainage is provided.

<u>Drainage and Street Flooding</u>

The Town Department of Public Works (DPW) is in charge of the maintenance of the town's drainage systems and performs clearing of bridges and culverts and other maintenance as needed. Brookfield maintains a paving program with catch basin and drainage replacements, but up-sizing is not automatically done. The town does not have a catch basin cleanout program, but owns the equipment. The current approach is to address cleanouts as they are needed. However, the town desires a more proactive approach.

There are areas of street flooding throughout the town, and these are addressed by the Public Works Department as necessary. Drainage complaints are routed to the DPW. The Town uses these reports to identify potential problems and plan for maintenance and upgrades.

Public Information

The Town receives regular weather updates through Division of Emergency Management and Homeland Security (DEMHS) Region 5 email alerts as well as watches and warnings through the National Weather Service. A flood gauge on the Still River in Brookfield helps town officials watch for flooding conditions and respond accordingly.

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.

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

Dam Operations

In general, major flooding problems associated with Candlewood Lake are seldom reported. If necessary, flooding resulting from Candlewood Lake can be controlled by lowering its elevation at the power station. However, this option would require the town to enter into an agreement with First Light and Power, the owner of the dam. It should be noted that lowering the elevation has not been done during major floods because this would further raise the water-surface elevation on the Housatonic River (Upper Reach).

Summary

The Town is aggressively pursuing flood mitigation through its most at-risk areas along the Still River. The reconstruction of U.S. Highway 7, running parallel to the Still River from White Turkey Hill Road to Silvermine Road, may improve the flood-carrying capacity of the Still River. Many bridges have been replaced or raised and sections of the river have been changed to trapezoidal channels. These measures, in conjunction with the high overbank created by the new U.S. Highway 7, lower flood elevations and help reduce damage along the Still River.

In addition to the Still River improvement plans, the Town through its land use regulations works to reduce future increases in flow associated with development. 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.

3.5 Vulnerabilities and Risk Assessment

This section discusses specific areas at risk to flooding within the Town. As shown in the historic record, flooding can impact a variety of river corridors and cause severe damages in the Town of Brookfield but most often occurs in the Still 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, three repetitive loss properties (RLPs) are located in the Town of Brookfield. Of the three, two of the properties are residential, and one is commercial as indicated in Table 3-2. Each of the repetitive loss properties is located along the Still River.

Table 3-2
Repetitive Loss Properties

Type	Flooding Source	Mapped Floodplain
Commercial	Still River	1% Annual Chance
Residential (1)	Still River	1% Annual Chance
Residential (2)	Still River	1% Annual Chance

As damage to the three structures is repaired over time, the town believes that substantial improvement thresholds will result in improvements such as elevations and floodproofing that will minimize future flood damage.

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. The Public Works Garage, located on Gray's Bridge Road was found to lie within the 1% annual chance floodplains. While this building is not known to have experienced serious flooding damage in recent years, its proximity to the Still River makes it at risk to flooding and the town would eventually like to relocate the facility to an area with lower flood risk. Potential measures for mitigating future flooding damage at this critical facility is discussed in Section 3.6.2.

3.5.3 Vulnerability Analysis of Areas Along Watercourses

The primary waterways in the town are the Still River and the Housatonic River. Candlewood Lake, Lake Lillinonah and a variety of smaller lakes and ponds are significant recreational resources. 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 in the town have issues with flooding. Specific areas susceptible to flooding are identifiable by the FEMA defined special flood hazard areas.

Most of the flood problems in Brookfield are well-understood. As noted above, a flood gauge in Brookfield helps town officials watch for flooding conditions and respond accordingly. However, the Public Works Department's greatest problem in Brookfield is reportedly flood response and mitigation.

Still River

The most frequently flooded areas in town are adjacent to the Still River (Figure 3-2). The existing economic hub of Brookfield located on Federal Road (Route 202) where the Town Center is located in the area of most concern. Because the Still River cuts through the center of town, possible flooding could impair east-west accessibility. Bridges in Brookfield could be compromised. The town does have a few north-south routes but these are minor arterial roads that do not have a large carrying capacity for the town's traffic volume.

Three areas of the Still River corridor experience the worst flooding: Lower Federal Road, Sand Cut Road, and Dean Road. The Dean Road area, shown on Figure 3-3, includes commercial and residential buildings that are subject to flooding.

Tree blockages are also believed to be a problem along the Still River corridor. The Still River greenway project can help address this problem. As people become more connected to the river, cleanups can be coordinated. However, the central part of the town will still remain in the flood risk zone along the river.

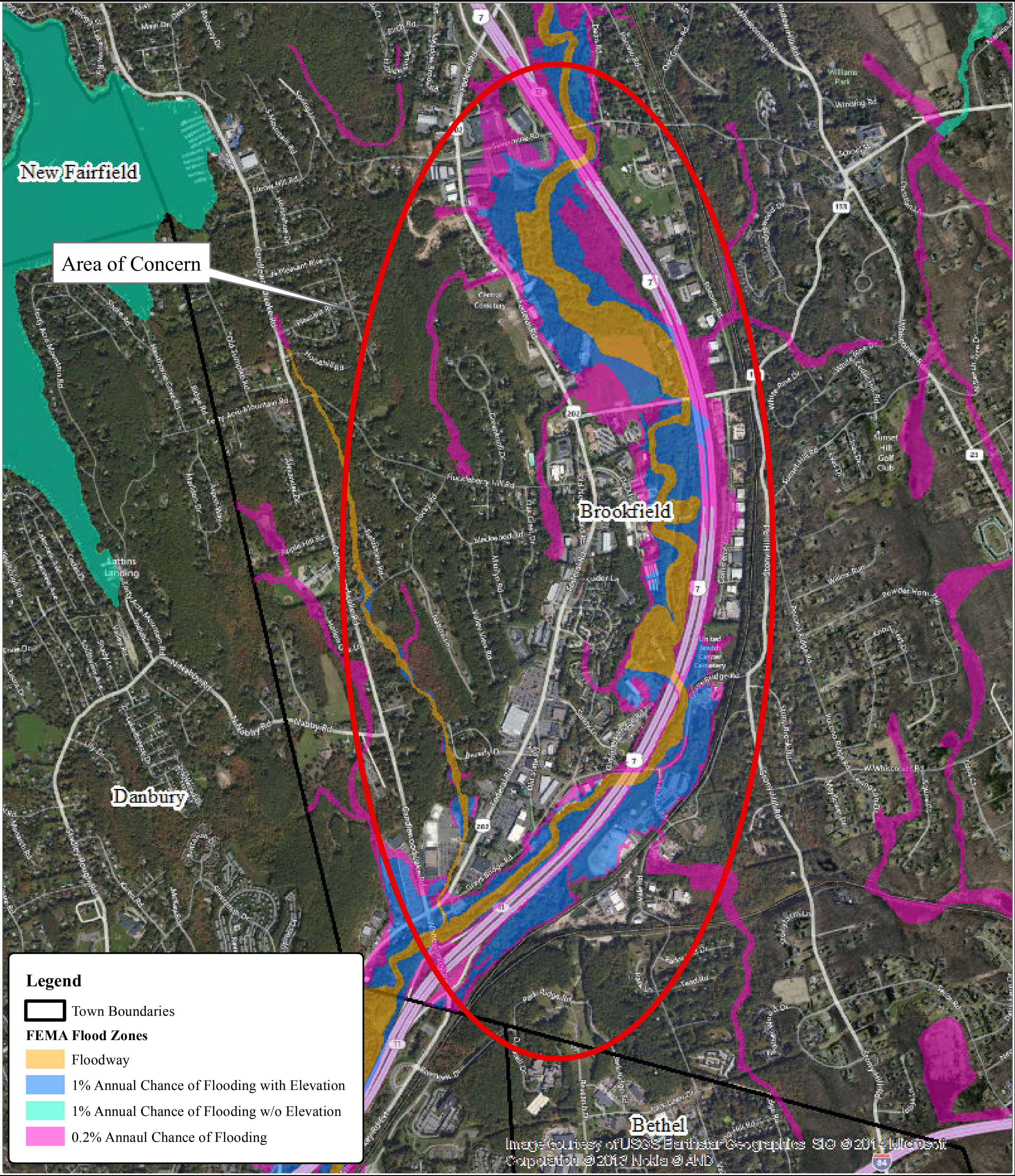
West Brook and East Brook

The Candlewood Plaza off of Federal Road suffers repeated flooding due to its proximity to West Brook. Based on a review of historic topographic maps, West Brook was relocated and channelized many years ago to make space for the plaza. The brook runs along the west sides of the buildings in the plaza. Figure 3-4. In addition, East Brook is located in close proximity to the east side of the plaza.

Flooding also occurred along Hollow Oak Lane about 15 years ago (possibly during Tropical Storm Floyd). The associated watercourse is a tributary of West Brook. More recent flooding has not been noted in this area.

Lime Kiln Brook

Meadowbrook Manor, shown in Figure 3-5, is a key area of flood concern in Brookfield. A substantial number of homeowners have suffered flood damage in this neighborhood. A review of historic topographic maps shows that portions of Lime Kiln Brook were likely re-routed long ago to construct the streets and homes in the neighborhood. During this process, drainage systems were also installed. At the present time, drainage systems and watercourse conveyances are believed undersized. The town would like to implement a conveyance and drainage improvement project to increase capacities and reduce flooding.



SOURCE(S):
2013 Fairfield County DFIRM
(c)2009 Microsoft Corporation

Figure 3-2: Still River Corridor Flood Risk Areas

LOCATION:
Brookfield, CT

N

Town of Brookfield
Hazard Mitigation Plan

MXD: P:\3101-14\Design\GIS\Fairfield County\Brookfield\Maps\Figure 3-2 Brookfield Still River Improvement Areas.mxd

Map By: CPS
MMI#: 3101-14
Original: 4/3/2014
Revision: 5/5/2014
Scale: 1 inch = 2,000 feet

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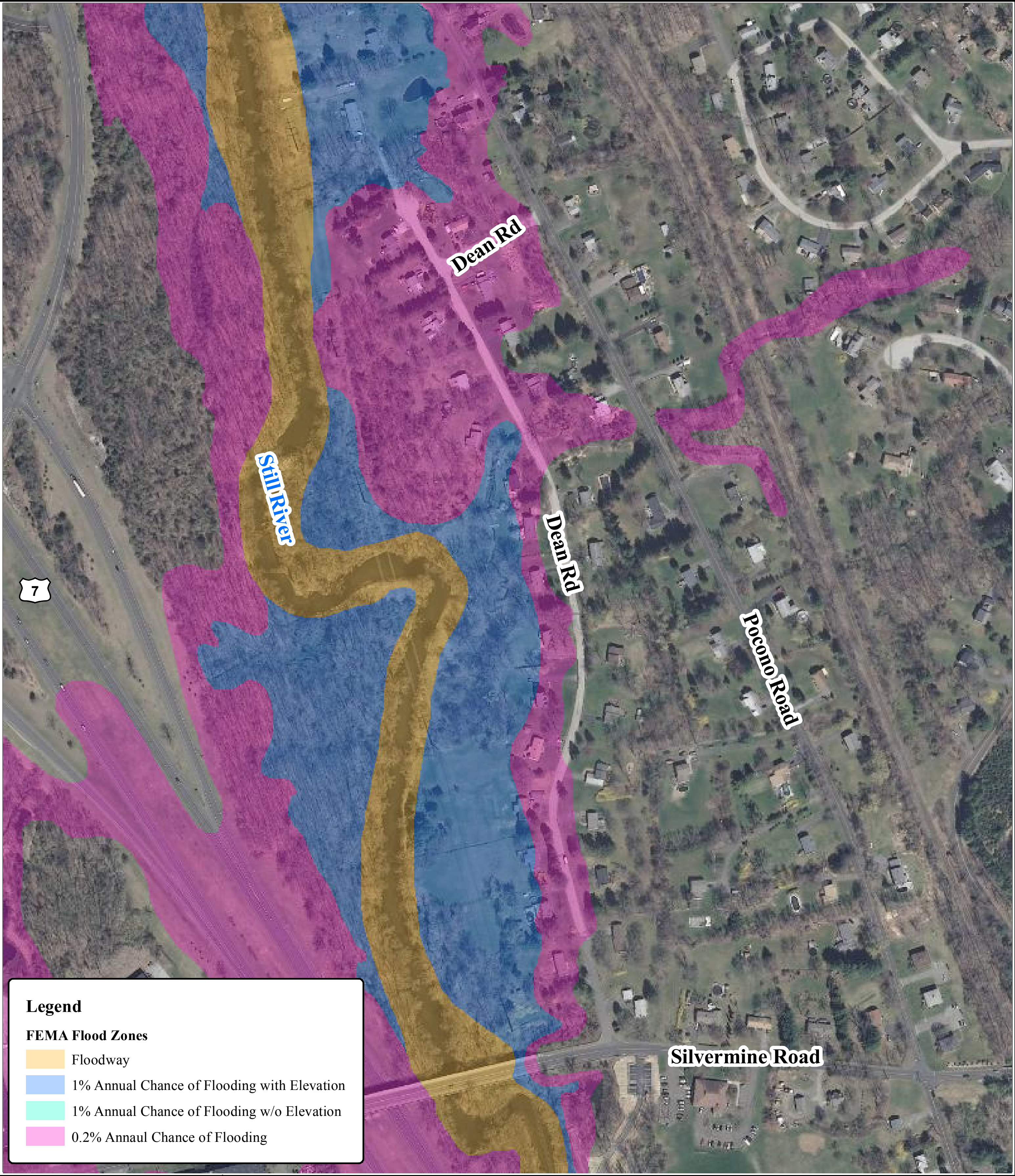

SOURCE(S):
2013 Fairfield County DFIRM
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Figure 3-3: Dean Road Flood Risk Area

LOCATION:
Brookfield, CT

N

Town of Brookfield
Hazard Mitigation Plan

MXD: P:\3101-14\Design\GIS\Fairfield County\Brookfield\Maps\Figure 3-3 Brookfield Still River Improvement Areas.mxd

Map By: CPS
MMI#: 3101-14
Original: 4/3/2014
Revision: 5/5/2014
Scale: 1 inch = 350 feet

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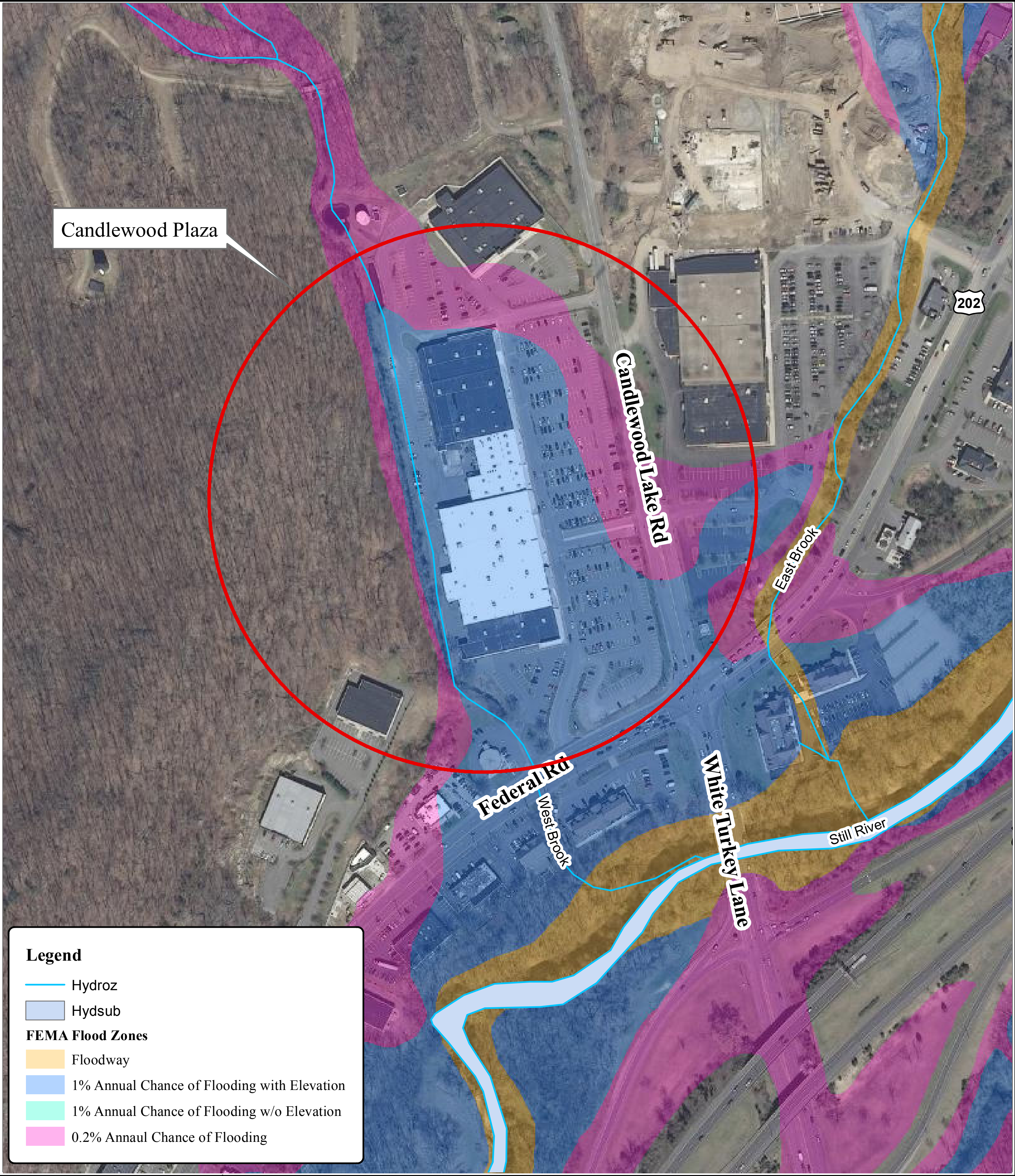

SOURCE(S):
2013 Fairfield County DFIRM
(c)2009 Microsoft Corporation

Figure 3-4: Candlewood Plaza Flood Risk Area

LOCATION:
Brookfield, CT

N

Town of Brookfield
Hazard Mitigation Plan

MXD: P:\3101-14\Design\GIS\Fairfield County\Brookfield\Maps\Figure 3-4 Brookfield Candlewood Plaza.mxd

Map By: CPS
MMI#: 3101-14
Original: 4/3/2014
Revision: 5/5/2014
Scale: 1 inch = 300 feet

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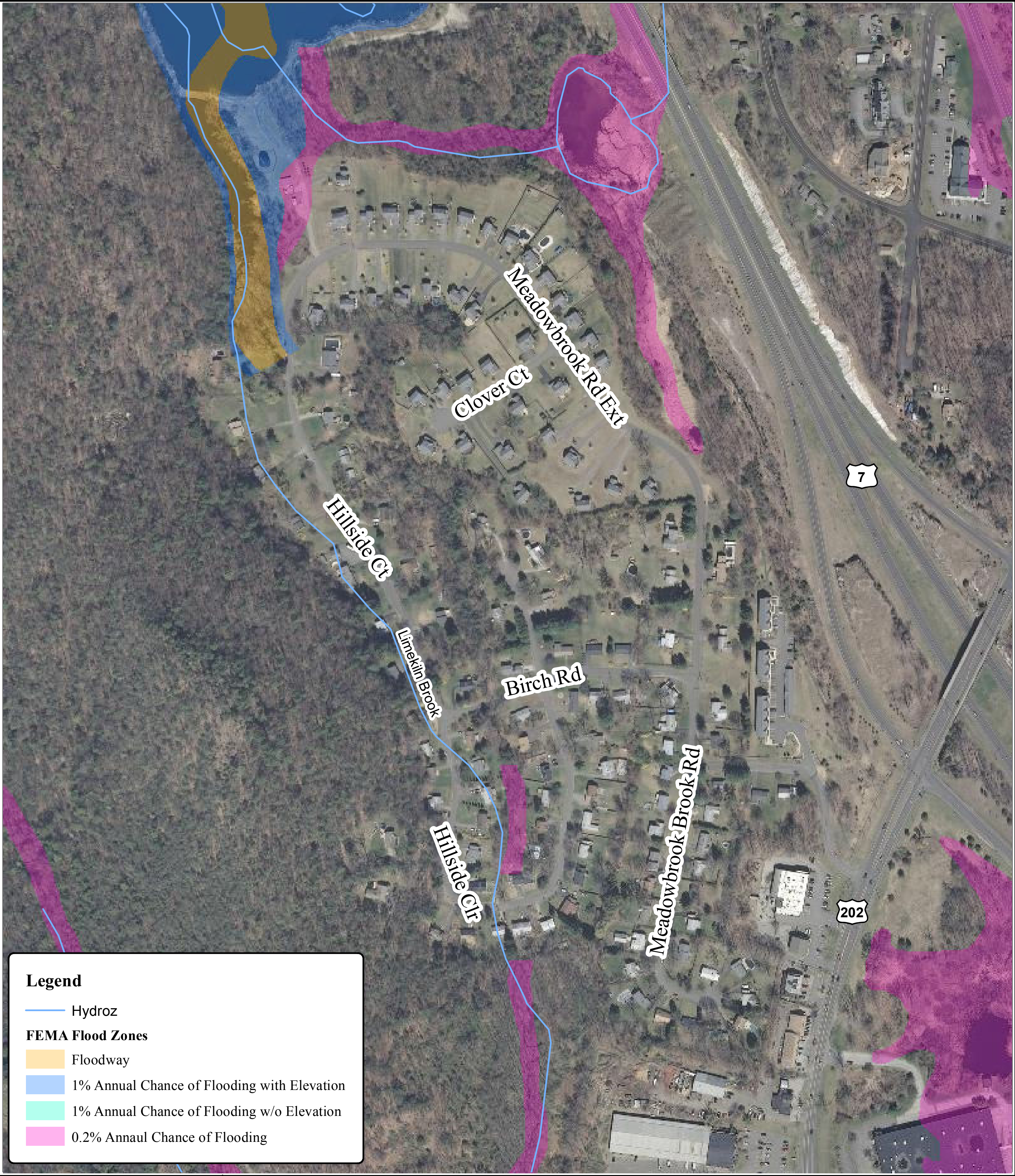

SOURCE(S):
2013 Fairfield County DFIRM
(c)2009 Microsoft Corporation

Figure 3-5: Meadowbrook Manor Neighborhood

LOCATION:
Brookfield, CT

N

Town of Brookfield
Hazard Mitigation Plan

MXD: P:\3101-14\Design\GIS\Fairfield County\Brookfield\Maps\Figure 3-5 Brookfield Meadowbrook.mxd

Map By: CPS
MMI#: 3101-14
Original: 4/3/2014
Revision: 5/5/2014
Scale: 1 inch = 400 feet

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Town officials have indicated that there are roughly four phases or steps that the Town is taking to remedy flooding related issues: review and approval of a water diversion permit application, adoption of the Hazard Mitigation Plan, the application for hazard mitigation grants, and design of the drainage project. In addition, a future referendum will have to take place for the residents of Brookfield to approve or reject the Town implementing the project for Meadowbrook Manor. The estimated construction cost is $2 million.

An October 7, 2011 article in the Danbury News-Times provides documentation of the town's initial discussions with residents about the flooding in Meadowbrook Manor. A February 4, 2014 article in the Danbury News-Times stated that the town's application for federal funding (under HMGP) to assist with the costs associated with the necessary drainage improvements was under review. To date, the funds have not been granted to the town. Finally, an article in the April 15, 2014 issue of the News-Times provides a summary of the history of flooding and a status report on funding. Copies of all articles are included in Appendix B.

Merwin Brook

In the past, flooding has also occurred along Merwin Brook. Specifically, town officials noted that a pond near Merwin Brook Road (tributary to Merwin Brook) may have caused some flooding in the past, but this may have been resolved.

3.5.4 *HAZUS-MH* Vulnerability Analysis and Loss Estimates

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

The FEMA default values were used for each of the town's census blocks in the HAZUS simulation. Approximately $1.7 billion of total building replacement value were estimated to exist within Brookfield. Of that total, the HAZUS 1% annual chance riverine flood event estimates a total building-related loss of $55.29 million. A summary of potential damage estimates is shown in Table 3-3.

Table 3-3
***HAZUS-MH* Flood Scenario – Potential Damage Estimates**

Occupancy	Dollar Exposure (2006 USD)
Residential	$ 1,200,050,000
Commercial	$ 337,007,000
Other	$ 205,682,000
Total	**$ 1,742,739,000**

The *HAZUS-MH* simulation estimates that during a 1% annual chance flood event, 30 buildings will be at least moderately damaged in the town from flooding. A total of seven of these buildings will be substantially damaged and uninhabitable. Table 3-5 presents the expected damages based on building type.

Table 3-4
***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	1	8	11	7
Commercial	0	0	0	0	0	0
Other	0	3	0	0	0	0
Total	**0**	**3**	**1**	**8**	**11**	**7**

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

The *HAZUS-MH* simulation estimated that a total of 1,016 tons of debris would be generated by flood damage for the 1% annual chance flood scenario. It is estimated that 41truckloads (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 689 tons.
- Structural material (wood, brick, etc.) comprise 191 tons.
- Foundation material (concrete slab, concrete block, rebar, etc.) comprise 136 tons.

HAZUS-MH calculated the potential sheltering requirement for the 1% annual chance flood event. The model estimates that 80 households will be displaced due to flooding. Displacement includes households evacuated from within or very near to the inundated areas. Of these households, 180 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 $55.29 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 $8.26 million, commercial losses totaled $24.3 million, and other (municipal and industrial) losses totaled $22.73 million.

- Building-related economic losses of $55.54 million are predicted if $0.25 million in business interruption losses are included.

Given the known flood risks in Brookfield, the *HAZUS-MH* results may slightly undercount or under-predict flood losses. Based on the historic record and the location of the SFHAs and other areas vulnerable to flooding damages, floods are one of the most significant natural hazards affecting Brookfield.

3.6 Potential Mitigation Strategies and Actions

A number of measures can be taken to reduce the impacts of a local 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

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

Open Space Creation and Preservation: More than 10 percent of all the land in Brookfield has already been preserved as open space. This includes open space owned by the Town of Brookfield, the Brookfield Open Space Legacy, Inc., the Weatinogue Land Conservation Trust, and other smaller entities. Dedicated open space in Brookfield includes 780 acres owned by the Town and 340 acres by Land Trusts. In some instances, the Town has identified specific properties that will be preserved for flood mitigation. These include Lillinonah Woods, the Greenway Trail along the bank of the Still River and Birch Rocks. Other tracts of land are considered as options when they become available.

Planning and Zoning: Zoning regulations in Brookfield 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 criteria for stormwater management planning, including mandating the predevelopment and postdevelopment runoff rates be equal.

Floodplain Development Regulations: The Town's floodplain regulations require engineering review of all development applications in the floodplain. Site plan and new subdivision regulations include the following:

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

Adherence to the State Building Code requires that the foundation of structures will withstand flood forces and that all portions of the building subject to damage are above or otherwise protected from flooding.

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 Brookfield 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: Development and redevelopment policies to address the prevention of flood damage must include effective stormwater management policies. Developers are typically required to build detention and retention facilities where appropriate. 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 of 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.

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

3.6.2 Property Protection

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

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

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

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

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

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

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

  - ***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 Brookfield residents to prevent damage from inland and nuisance flooding. The Building Official should be prepared to provide outreach and education in these areas where appropriate.

3.6.3 Emergency Services

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

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

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

3.6.4 Public Education and Awareness

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

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

3.6.5 Natural Resource Protection

> **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**

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.

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

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

- Pursue additional open space properties in floodplains by purchasing RLPs and other floodprone structures and converting the parcels to open space.
- Pursue the acquisition of additional municipal open space properties as discussed in the *Plan of Conservation and Development*.
- Selectively pursue conservation objectives listed in the Plan of Conservation and Development and/or more recent planning studies and documents.
- Continue to regulate development in protected and sensitive areas, including steep slopes, wetlands, and floodplains.

3.6.6 Structural Projects

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

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

- Individuals can protect private property by raising structures and constructing walls and levees around structures.

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

Given the many culverts and bridges in a typical community and the increasing rainfall rates in Connecticut described in Section 2.4, reevaluation of the drainage computations on culverts and bridges is recommended.

3.7 Summary of Specific Strategies and Actions

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

Prevention

- Consider requiring new buildings constructed in floodprone areas to be protected to the highest recorded flood level regardless of being within a defined SFHA.
- 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.
- Develop a town wide catch basin cleanout program to reduce flood impacts due to drainage issues.

Property Protection

- Encourage property owners to purchase flood insurance under the NFIP and to report claims when flooding damage occurs.
- Evaluate floodprone properties along the Still River Corridor, specifically in the vicinity of Dean Road, Federal Road and Sand Cut Road to determine potential flood damage reduction methods.
- Consider flood mitigation methods at the Public Works Garage, such as berm construction and/or floodproofing to reduce flood risk; or
- Consider relocating the Public Works Garage to eliminate flood risk.
- Provide technical assistance to the Candlewood Plaza occupants to pursue floodproofing that will make the tenants more resilient and able to open soon after flooding.

Public Education

- Consider enrolling in the Community Rating System (CRS).
- 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.
- Provide outreach regarding home elevation and relocation, flood barriers, dry floodproofing, wet floodproofing, and other home improvement techniques (Section 3.6.2) to private homeowners and businesses with flooding problems.

- ❑ Hold workshops involving all Town departments to provide training for dealing with widespread flooding damage.

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.
- ❑ Selectively pursue conservation recommendations listed in the Plan of Conservation and Development and other studies and documents.
- ❑ Continue to regulate development in protected and sensitive areas, including steep slopes, wetlands, and floodplains.

Structural Projects

- ❑ Conduct drainage improvements within the Meadow Brook Manor neighborhood.
- ❑ Develop a plan to selectively remove debris from the Still River to prevent obstructions of bridges and culverts.
- ❑ Review culvert conveyances based on existing hydrology and Northeast Regional Climate Center guidance.

Emergency Services

- ❑ Ensure adequate barricades are available to block flooded areas in floodprone areas of the town.

In addition, mitigation strategies important to all hazards are included in Sect2010ion 10.1.

4.0 HURRICANES

4.1 Setting

Several types of hazards may be associated with tropical storms and hurricanes including heavy or tornado winds, heavy rains, and flooding. While only some of the areas of Brookfield 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 Brookfield. A hurricane striking Brookfield 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), two Category Three Hurricanes, seven Category Two Hurricanes, seven Category One Hurricanes, and 39 tropical storms have tracked within a 150-nautical-mile radius of Brookfield. The representative storm strengths were measured as the peak intensities for each individual storm passing within the 150-mile radius. The 16 hurricanes noted above occurred in August through October as noted in Table 4-1.

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

Category	July	August	September	October
Tropical Storm[1]	6	13	12	5
One	0	2	3	2
Two	0	3	3	1

Three	0	0	2	0
Total	**6**	**18**	**20**	**8**

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

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

- An unnamed hurricane in 1858 was a Category One Hurricane when its center made landfall in southeastern Connecticut.

- An unnamed hurricane in 1869 was a Category Three Hurricane when its center made landfall in Rhode Island.

- An unnamed hurricane in 1878 was a Category One Hurricane when its center passed over eastern Pennsylvania toward Albany, New York.

- An unnamed hurricane in 1879 was a Category One Hurricane when its center made landfall in East Falmouth, Massachusetts.

- An unnamed hurricane in 1893 was a Category One Hurricane when its center made landfall near New York Town and traveled north over western Connecticut.

- An unnamed hurricane in 1894 was a Category One Hurricane when its center made landfall near Clinton, Connecticut.

- An unnamed hurricane in 1903 was a Category One Hurricane when its center made landfall in southern New Jersey.

- An unnamed hurricane in 1916 was a Category One Hurricane when its center passed near Block Island, Rhode Island.

- An unnamed hurricane in 1936 was a Category Two Hurricane when its center passed southeast of Long Island.

- 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.

- 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 2007 edition of 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 in the Danbury/Brookfield area. 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. In Brookfield, wind damage was significant from this storm. Approximately 49,000 cubic feet of brush was generated and power outages lasted up to eight days, with some areas approaching two weeks. The public assistance reimbursement for Brookfield was $1.2 million.

- 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. Brookfield fared relatively well during Hurricane Sandy. However, the storm did cause wind damage and debris generation. The public assistance reimbursement was $88,250.

4.4 Existing Capabilities

Flooding

Existing capabilities and 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 2009 and adopted with an effective date of August 1, 2009. 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 Brookfield is 100 miles per hour. Brookfield has adopted the Connecticut Building Code as its building code.

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

Parts of tall and older trees may fall during heavy wind events, potentially damaging structures, utility lines, and vehicles. Therefore, Brookfield maintains an aggressive tree and tree limb trimming program. The annual budget is $75,000. The town owns two chippers and contracts the bucket trucks. The tree warden reports to the Public Works Director. Utilities must be placed underground in new developments; this capability is considered proactive to prevent damage from wind and falling trees.

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. Town officials do not feel that CL&P conducts more than routine trimming and would like to work with a CL&P liaison to ensure a more proactive approach in Brookfield.

During emergencies, the Town currently has two designated emergency shelters available for residents as discussed in Section 2.9.

During Tropical Storm Irene, the Town used the CT Alert system to notify all residents in the SFHA that they may evacuate and use one of the shelters. The Board of Education used its notification system to notify people on its list of emergency procedures. Prior to severe storm events, the Town ensures that warning/notification systems and communication equipment are working properly and prepares for the possible evacuation of impacted areas.

4.5 Vulnerabilities and Risk Assessment

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

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

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

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

Category	New York Town (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 Fairfield County to be 39 years and 68 years, respectively. The last major hurricane to impact Connecticut was Hurricane Bob in 1991. Category One Hurricane Earl in 2010 and Tropical Storm Irene in 2011 were reminders that hurricanes do track close to Connecticut.

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

<u>Tropical Cyclone Vulnerability</u>

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

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

The Town of Brookfield 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, Brookfield 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 Brookfield is estimated to increase by approximately 288 people 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 Brookfield while areas susceptible to flooding are more vulnerable yet more limited. 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.

Brookfield'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.

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

As the Town of Brookfield 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.

<u>HAZUS-MH Simulation and Loss Estimates</u>

In order to quantify potential hurricane damage, HAZUS-MH simulations were run for historical and probabilistic storms that could theoretically affect Brookfield. 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 <u>wind effects alone</u> and not damages due to flooding or other non-wind effects. Thus, the damage and displacement estimates presented below are likely lower than would occur during a hurricane associated with severe rainfall. Results are presented in Appendix E and summarized below.

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

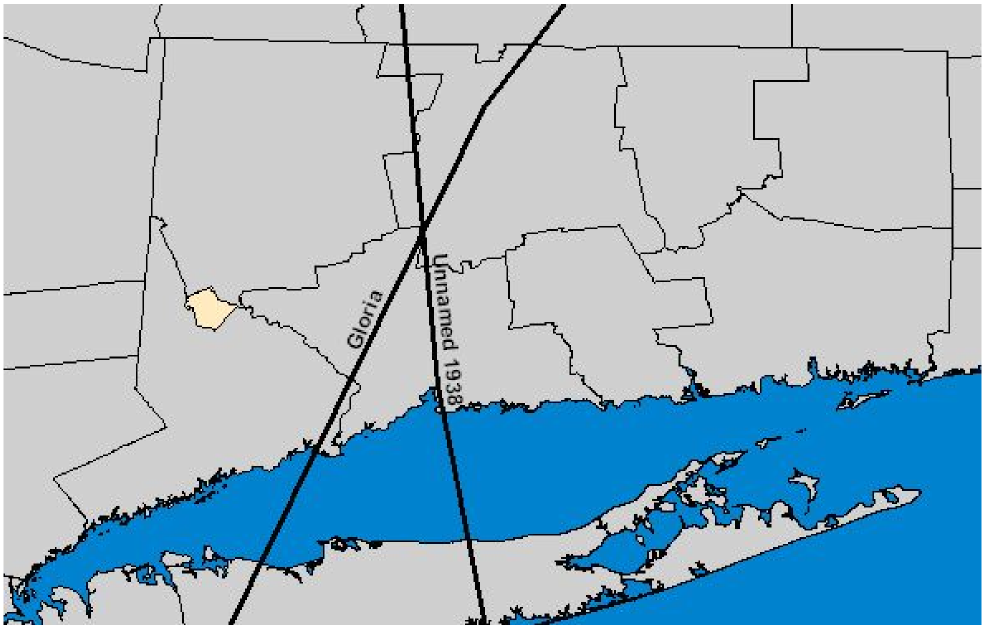


Figure 4-1: Historical Hurricane Storm Tracks

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 Brookfield. 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 71 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	39-40	None	None	None	None	None
20-Years	53-54	None	None	None	None	None
Gloria (1985)	61	1	None	None	None	1
50-Years	71	11	None	None	None	11
100-Years	83	100	5	None	None	105
200-Years	93-94	392	31	None	None	423
Unnamed (1938)	95	439	37	None	None	476
500-Years	105-106	1,118	180	9	6	1,313
1000-years	114-115	1,728	438	48	32	2,246

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)	3	None	None	None	3
50-Years	14	None	None	None	14
100-Years	110	6	None	None	116
200-Years	424	35	1	None	460
Unnamed (1938)	475	42	1	None	518
500-Years	1,218	207	14	6	1,445
1000-Years	1,891	513	64	32	2,500

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

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

Return Period or Storm	Fire Stations (1)	Police Stations (1)	Schools (7)
10-Years	None or Minor	None or Minor	None or Minor
20-Years	None or Minor	None or Minor	None or Minor
Gloria (1985)	None or Minor	None or Minor	None or Minor
50-Years	None or Minor	None or Minor	None or Minor
100-Years	None or Minor	None or Minor	None or Minor
200-Years	None or Minor	None or Minor	None or Minor
Unnamed (1938)	None or Minor	None or Minor	None or Minor
500-Years	None or Minor	None or Minor	Minor damage with loss of use to all schools
1000-Years	None or Minor	None or Minor	Minor damage with loss of use to all schools

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

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

Return Period or Storm	Brick / Wood	Reinforced Concrete / Steel	Eligible Tree Debris	Other Tree Debris	Total
10-Years	None	None	None	None	None
20-Years	None	None	None	None	None
Gloria (1985)	2	None	None	None	2
50-Years	None	None	None	55	55
100-Years	350	None	1,129	1,798	3,277
200-Years	1,007	None	2,569	4,064	7,640
Unnamed (1938)	1,124	None	2,707	4,257	8,088
500-Years	3,217	None	4,907	7,718	15,842
1000-Years	6,798	None	10,480	16,621	33,899

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

Table 4-7
HAZUS Hurricane Scenarios – Shelter Requirements

Return Period or Storm	Number of Displaced Households	Short Term Sheltering Need (Number of People)
10-Years	None	None
20-Years	None	None
Gloria (1985)	None	None
50-Years	None	None
100-Years	None	None
200-Years	1	None
Unnamed (1938)	1	None
500-Years	16	4
1000-Years	61	12

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

Table 4-8
HAZUS Hurricane Scenarios – Economic Losses

Return Period or Storm	Residential Property Damage Losses	Total Property Damage Losses	Business Interruption (Income) Losses	Total Losses
10-Years	None	None	None	None
20-Years	None	None	None	None
Gloria (1985)	$9,990	$9,990	$60	$10,050
50-Years	$790,130	$843,950	$3,400	$847,340
100-Years	$3,277,960	$3,547,780	$201,420	$3,749,210
200-Years	$7,845,550	$8,831,670	$731,290	$9,562,960
Unnamed (1938)	$8,550,630	$9,666,110	$789,490	$10,455,600
500-Years	$24,016,850	$28,634,720	$3,430,870	$32,065,590
1000-Years	$56,699,460	$69,420,270	$9,001,030	$78,421,300

Losses are minimal for storms with return periods of less than 20-years (54 mph) but increase rapidly as larger storms are considered. For example, a reenactment of the 1938 hurricane would cause approximately $10.5 million in wind damages to Brookfield. 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 Brookfield. 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.

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. Brookfield 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.

- <u>Shutter mitigation</u> 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.
- <u>Load path</u> 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.
- <u>Roof projects</u> 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.
- <u>Code plus</u> 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 Brookfield, 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 Brookfield are listed below.

- ❑ Continue to provide town wide tree limb inspection and maintenance programs to ensure that the potential for downed power lines is diminished. Continue to encourage property owners to trim branches located over structures and power lines.
- ❑ Work with the CL&P liaison to ensure a more pro-active approach to tree trimming in Brookfield
- ❑ Work with CL&P to determine the feasibility of placing non-conducting steel cables above power lines to protect them from falling branches and trees.
- ❑ Continue requiring the location of utilities underground in new developments or during redevelopment whenever possible. Pursue funding to place them underground in existing developed areas.
- ❑ 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 Brookfield. 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 Brookfield 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 Brookfield 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 Fairfield County each year that could cause significant damage to a small area.

5.2 Hazard Assessment

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

<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.

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

- ❑ A gustnado is a whirl of dust or debris at or near the ground with no condensation tunnel that forms along the gust front of a storm.
- ❑ A landspout is a narrow, ropelike condensation funnel that forms when the thunderstorm cloud is still growing and there is no rotating updraft. Thus, the spinning motion originates near the ground. Waterspouts are similar to landspouts but occur over water.

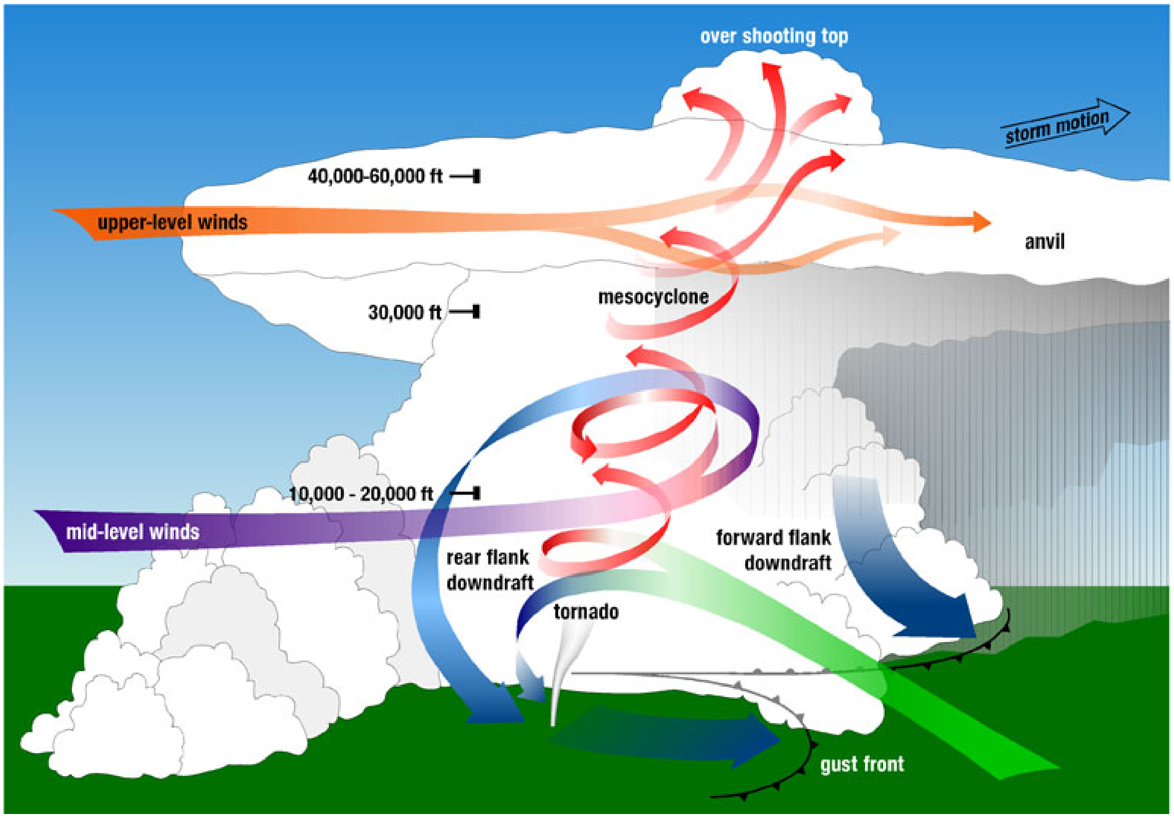
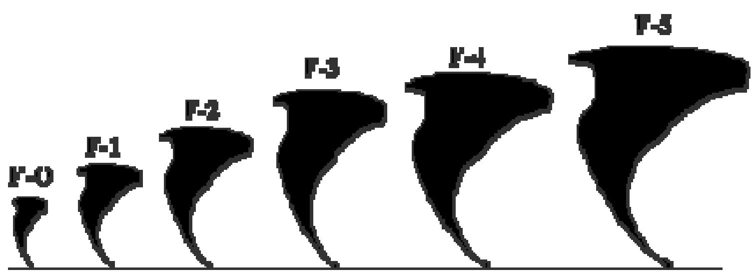


Figure 5-1: Anatomy of a Tornado. Image from NOAA National Severe Storms Laboratory.



Fujita Tornado Scale. Image courtesy of FEMA.

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

Table 5-1
Fujita Scale

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

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

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

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

Table 5-2
Enhanced Fujita (EF) Scale

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

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

Lightning

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

Image courtesy of NOAA.

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

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

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

Downbursts

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

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

Downbursts fall into two categories:

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

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

Hail

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

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

5.3 Historic Record

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

An extensively researched list of tornado activity in Connecticut is available on Wikipedia. This list extends back to 1648 although it is noted that the historical data prior to 1950 is incomplete due to lack of official records and gaps in populated areas. Based on available information through July 2013, Fairfield County has experienced a total of 21 tornado events with reported damages totaling tens of millions of dollars. Table 5-3 summarizes the tornado events near Brookfield through July 2013 based on the Wikipedia list.

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

Date	Location	Fujita Tornado Scale	Property Damage	Injuries / Deaths
October 8, 1797	North Salem, NY to Ridgefield, CT, and additionally to possibly Branford, CT	-	NR	6 injured
September 27, 1899	Norwalk, CT to Ridgefield, CT	-	50- to 300-foot wide path of damaged buildings	NR
July 14, 1950	Ridgefield, CT	F2	Roof of high school torn off, tree damage	3 injured
August 9, 1968	Near Danbury, CT	F1	$0	NR
June 29, 1990	Danbury, CT	F0	$2,500	7 injured from flying glass
July 5, 1992	Near New Fairfield, CT	F0	$0	NR
May 31, 2002	Brookfield, CT	F1	$0	NR
May 16, 2007	Bethel, CT to Newtown, CT	EF1	$0, although widespread wind damage affected other parts of the state	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 Brookfield (below). A limited selection of summer storm damage in and around Brookfield, taken from the NCDC Storm Events database, is listed below:

- July 5, 1992 – An F0 tornado struck near neighboring New Fairfield.
- July 27, 1995 – Thunderstorm winds downed several trees and powerlines from Danbury to Brookfield. A house was significantly damaged after being struck by lightning.
- July 9, 1996 – Hail one-inch in diameter was reported in Danbury, southwest of Brookfield.
- June 29, 1999 – A severe thunderstorm produced high winds (50 mph) and heavy rain that downed trees and power lines in Danbury. More than 600 Danbury residents lost power.
- June 2, 2000 – Lines of severe thunderstorms caused high winds that downed many trees and power lines throughout the region. A downburst was observed in Danbury along with a 60 mph wind gust. Police reported roofs ripped off houses along Jackson Drive, Starr Road, and

near the Danbury Town Park on Lake Candlewood. Many three- to 3.5-foot diameter trees were snapped off in the Cornell Road area.

- August 2, 2002 – A spotter and newspaper reported penny-sized hail in Danbury. A total of 21 city streets were affected by downed trees and power lines caused by 50 mph winds.
- May 23, 2004 – Two severe thunderstorms each produced penny-sized hail in Danbury.
- June 1, 2006 – A man was struck by lightning in New Fairfield, causing minor injuries.
- May 16, 2007 – Thunderstorms produced 55 mph winds that knocked trees down on Carriage House Drive and Newtown Road. The storms also produced an EF1 tornado in Bethel, to the south of Brookfield.
- June 1, 2007 – Severe thunderstorms produced 50 mph winds and hail across southwestern Connecticut. Trees were downed along Route 7 south of Interstate 84 in Danbury.
- May 12, 2008 – High winds (50 mph) downed trees and power lines on Madison Avenue and Starr Street in Danbury and across Route 37 in New Fairfield.
- June 14, 2008 – Isolated severe thunderstorms produced 52 mph winds that downed wires on Durant Street, Housman Street, and Tarrywile Lake Road in Danbury.
- Town officials indicated that a straight-line wind event in May 2011 caused three to four days without power. This storm affected a section of the town, but not surrounding towns.
- June 9, 2011: A pre-frontal trough and an approaching cold front caused a bout of widespread thunderstorms that produced severe weather and hail across most of Southern Connecticut. Around 100 trees were reported down throughout Brookfield.
- July 26, 2011 – A pre-frontal trough and an approaching cold front triggered severe thunderstorms across Southern Connecticut producing damaging wind gusts across the region. Multiple trees were reported down throughout Ridgefield, southwest of Brookfield.
- August 1, 2011 – A passing cold front and mid level shortwave combined to produce severe thunderstorms across Southwest Connecticut, with several reports of large hail and wind damage. Multiple large branches were reported down on Saxon Road in neighboring Bethel.
- July 26, 2012 – A passing warm front triggered multiple severe thunderstorms across Fairfield County.
- September 8, 2012 – An approaching coldfront produced a few severe storms in southwest Connecticut. A wire was reported down across King Lane in Ridgefield and caught fire.

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 Brookfield as explained in Section 4.0, such as the placement of utilities below ground in new developments. In addition, the Connecticut State Building Code includes guidelines for the proper grounding of buildings and electrical boxes.

A <u>severe thunderstorm watch</u> 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 <u>severe thunderstorm warning</u> 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

5.5 Vulnerabilities and Risk Assessment

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

Although tornadoes pose a threat to all areas of the state, their occurrence is not considered frequent enough to justify the construction of tornado shelters or safe rooms. 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 Brookfield 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 Brookfield 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 Brookfield 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 Brookfield is believed to be low for any given year, although it was only recently (2011) that straight line winds caused a significant power outage in Brookfield. All areas of the town are susceptible to damage from high winds although more building damage is expected in the town center while more tree damage is expected in the less densely populated areas.

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

Town personnel note that strong thunderstorms will cause power lines to fall all over the town. Most downed power lines in Brookfield 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.

Wind risks are higher along Long Meadow Hill Road and Mist Hill Drive, because the elevations are higher. Wind shear can be a problem in these areas. A tornado was believed confirmed a few years ago.

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 Brookfield reports that the typical cost for the town to respond to downed branches and wires from a localized severe thunderstorm can approach $100,000. This is based on labor costs of approximately $30,000, equipment costs of $30,000 to $35,000, debris management (chipping, log removal) of $25,000, and police costs of $10,000 or more.

The 2014 Connecticut Natural Hazard Mitigation Plan provides annual estimated losses on a countywide basis for several hazards. Based on the population of Brookfield relative to Fairfield County, the annual estimated loss is $3,524 for thunderstorms and $2,337 for tornadoes. The figure for tornadoes is influenced by their infrequent occurrence.

Summary – In summary, the entire Town of Brookfield is at relatively equal risk for experiencing damage from summer storms and tornadoes. Based on the historic record, a few summer storms and tornadoes have resulted in costly damages to the town. Most 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. However, the strong wind storm of May 2011 that struck Brookfield has raised awareness regarding the damage that such storms can cause.

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

5.7 Summary of Specific Strategies and Actions

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

- ❑ Continue to provide town wide tree limb inspection and maintenance programs to ensure that the potential for downed power lines is diminished. Continue to encourage property owners to trim branches located over structures and power lines.
- ❑ Work with the CL&P liaison to ensure a more pro-active approach to tree trimming in Brookfield
- ❑ Work with CL&P to determine the feasibility of placing non-conducting steel cables above the power lines to protect them from falling branches and trees.
- ❑ Continue requiring the location of utilities underground in new developments or during redevelopment whenever possible. Pursue funding to place them underground in existing developed areas.
- ❑ 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 Brookfield. However, unlike summer storms, winter events and the hazards that result (wind, snow, and ice) have more widespread geographic extent. The entire Town of Brookfield is susceptible to winter storms and, due to its variable elevation, can have higher amounts of snow in the outskirts of the town than in the town center. In general, winter storms are considered highly likely to occur each year (although major storms are less frequent), and the hazards that result (nor'easter winds, snow, and blizzard conditions) can potentially have a significant effect over a large area of the town.

6.2 Hazard Assessment

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

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

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

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

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

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

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

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

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

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

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

Table 6-1
RSI Categories

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

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

6.3 Historic Record

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

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

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

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

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

However, the most damaging winter storms are not always nor'easters. Additional examples of recent winter weather events to affect the Brookfield 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.

- January 15, 1998 – An ice storm caused widespread icing across northern Fairfield County, northern New Haven County, and northern Middlesex County. At least one-half inch of ice accumulated on power lines and trees. Power outages were reported throughout much of Connecticut.

- 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.

- March 16, 2007 – A winter storm beginning during the Friday afternoon rush hour produced six to 12 inches of snow across New Haven and Fairfield Counties. The storm caused treacherous travel conditions that resulted in many accidents. This storm is ranked 69th overall by RSI and is regarded as a "Category 2 – Significant" storm.

- January 6, 2009 – An ice storm produced up to 0.4 inches of ice across Fairfield County. The storm caused one death and injured three. Power lines and large tree limbs were reported down across the Brookfield area.

- 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 southern Connecticut during the second week in February. A significant amount of snow removal was conducted throughout Brookfield, including the schools.

- 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. Brookfield experienced a power outage of more than a week. 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. Brookfield opened its shelter for the first time in many years as a result of Winter Storm Alfred. The overall storm impacts and damages resulted in another Presidential Disaster Declaration for Connecticut.

- 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. Eighteen inches of snow was recorded in Brookfield during Nemo.

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.

TABLE 6-2
Reported Roof Collapse Damage, 2011

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

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

The overall storm impacts and damages of the winter 2010-2011 storms resulted in Presidential Disaster Declaration 1958-DR for Connecticut. A significant amount of snow removal was conducted throughout Brookfield, including the schools. Reportedly, three or four barns collapsed. As a result of this disaster, the town is more conscious of snow build-up and the damage it can cause.

6.4 Existing Capabilities

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

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

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

CTDOT plows all State roads and Interstates. The town utilizes a dozen trucks to plows 100 miles of local roads. Town plowing is typically ahead of CT DOT plowing. Priority is given to plowing egresses to critical facilities. Homeowners, private associations, and businesses are responsible for plowing their own driveways and roads. The MgCl/salt mixture is used for deicing.

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

6.5 Vulnerabilities and Risk Assessment

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

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

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

Elbow Hill Road and North Mountain Road are steep and have many turns. Snow accident risks are greater on these roads. North Obtuse and Obtuse Road have similar risks. Icing also causes difficult driving conditions throughout the hillier sections of the town. However, the Town's standard of presalting has been helpful in controlling ice in these problem areas.

The structures and utilities in Brookfield 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.

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.

<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 Brookfield relative to Fairfield County, the annual estimated loss is $0 for severe winter storms. The low figure is likely influenced by the difficulty in separating typical winter storm costs from those associated with extreme events. Nevertheless, the Town’s public assistance reimbursements for the last three winter storm disasters were significant:

- January/February 2011: the public assistance reimbursement was $66,442.
- Winter Storm Alfred, October 2011: the public assistance reimbursement was $1.2 million.
- Winter Storm Nemo, February 2013: $85,250.00 (total cost), $63,937 (reimbursement)

Recall that a few barns collapsed in Brookfield in January and February 2014. The loss figures are not available because the properties are privately owned, but the town has estimated costs were at least $20,000 per structure. The Public Works Department notes that roof damage to a school would cost $100,000 to repair, whereas similar damage to the town hall would cost $500,000 to repair.

Summary – The entire Town of Brookfield 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. The public assistance reimbursement from Winter Storm Alfred was $1.2 million, proving that winter storms can be very costly. However, many damages are relatively site specific and occur to private property (and therefore are paid for by private insurance) while repairs for power outages are often widespread and difficult to quantify to any one municipality.

For municipal property, the Town budget 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.

6.6 Potential Mitigation Strategies and Actions

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

6.6.1 Prevention

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

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

6.6.2 Property Protection

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

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

6.6.3 Emergency Services

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

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. It is recognized that plowing critical facilities may not be a priority to all residents as people typically expect their own roads to be cleared as soon as possible.

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

6.6.4 Public Education and Awareness

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

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

6.6.5 Structural Projects

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

6.7 Summary of Mitigation Strategies and Actions

Most of the recommendations in Section 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 Brookfield 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.
- ❑ 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.
- ❑ Develop a plan to reduce accident risks along steep roads such as Elbow Hill Road, North Mountain Road, North Obtuse Road and Obtuse Road. Snow fencing and certain vegetation buffers may be helpful to reduce drifting and drainage improvements may reduce icing.

7.0 EARTHQUAKES

7.1 Setting

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

7.2 Hazard Assessment

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

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

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

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

Table 7-1
Comparison of Earthquake Magnitude and Intensity

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

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

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

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

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.

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 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.
- 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 the magnitude 5.8 earthquake which occurred 38 miles from Richmond, Virginia on August 23, 2011. The quake was felt from Georgia to Maine and reportedly as far west as Chicago. Many residents of Connecticut experienced the swaying and shaking of buildings and furniture during the earthquake although widespread damage was constrained to an area from central Virginia to southern Maryland. According to Cornell University, the August 23 quake was the largest event to occur in the east central United States since instrumental recordings have been available to seismologists.

7.4 Existing Capabilities

The Connecticut Building Codes include design criteria for buildings specific to each municipality as adopted by the Building Officials and Code Administrators (BOCA). These include the seismic coefficients for building design in the Town of Brookfield. 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 2007 regulations do not explicitly address the issue of construction on steep slopes. However, the regulations do encourage the conservation of existing undeveloped land, by preserving water bodies, wetlands, watercourses, major stands of trees, steep slopes, ridge lines, significant geological features and other areas of environmental value.
  - The regulations also require that soil erosion and sediment control plans be developed for proposed projects.

- **Plan of Conservation and Development:**
  - The 2002 Plan of Conservation and development recommends the protection of resources by continuing to discourage building and road development on steep slopes.

In addition, the town has a height restriction of 42 feet, which may help reduce earthquake damage risks along with adherence to the state building code. The critical facilities are believed to be resilient.

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 Brookfield are underlain by sand and gravel, particularly within the Still River and Housatonic River sub-regional basins, and in the vicinity of Lime Kiln Brook. 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 Brookfield, 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 Brookfield. Results are presented in Table 7-2 below.

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

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

Based on the historic record and the probability maps generated from the USGS database, the state of Connecticut possesses areas of seismic activity. It is likely that Connecticut will continue to experience minor earthquakes (magnitude less than 3.0) in the future. While the risk of an earthquake affecting Brookfield 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 Brookfield.

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 Brookfield. 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 Brookfield. 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	143	23	2	None	168
Portland – 5.7	173	29	3	None	205
Stamford – 5.7	581	135	14	1	731
East Haddam – 6.4	491	107	11	None	609

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	168	31	3	None	202
Portland – 5.7	201	38	3	None	242
Stamford – 5.7	673	184	22	2	881
East Haddam – 6.4	567	143	16	1	727

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

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

Epicenter Location and Magnitude	Fire Stations (1)	Police Stations (1)	Schools (7)
Haddam – 5.7	Minor damage (87% functionality)	Minor damage (86% functionality)	Minor damage (86% functionality)
Portland – 5.7	Minor damage (86% functionality)	Minor damage (85% functionality)	Minor damage (85% functionality)
Stamford – 5.7	Minor damage (66% functionality)	Minor damage (67% functionality)	Minor damage (67% functionality)
East Haddam – 6.4	Minor damage (71% functionality)	Minor damage (71% functionality)	Minor damage (71% functionality)

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

- Highway: 20 major bridges and 10 major segments;
- Railway 1 major bridge, 3 major segments;
- Bus: 1 facility;
- A potable water system consisting of 194 total kilometers of pipelines;
- A waste water system consisting of 116 total kilometers of pipelines;
- A total of 78kilometers of natural gas lines, and;
- Communication: 2 facilities

As shown in Table 7-6, highway bridges and the bus facility are impacted under every scenario in Brookfield. Sewer, and gas lines are expected to have leaks and breaks, but 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 ($0.05 million to bridges and $0.02 million to bus facilities)	1 leak in potable water system ($0.01 million) and 1 leak in waste water system (<$0.01 million). No loss of service expected. Total damage: Approximately $0.02 million.	Fire damage will displace no people.
Portland – 5.7	Minor damage to transportation infrastructure ($0.07 million to bridges and $0.02 million to bus facilities)	2 leaks in potable water system ($0.01 million) and 1 leak in waste water system (<$0.01 million). No loss of service expected. Total damage: Approximately $0.02 million.	Fire damage will displace no people.
Stamford – 5.7	Minor damage to transportation infrastructure ($1.22 million to bridges and $0.10 million to bus facilities)	6 leaks and 2 major breaks in potable water system ($0.03 million), 3 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 $0.05 million.	Fire damage will displace no people.
East Haddam – 6.4	Minor damage to transportation infrastructure ($1.84 million to bridges and $0.06 million to bus facilities)	9 leaks and 2 major breaks in potable water system ($0.04 million), 4 leaks and 1 major break in waste water system ($0.02 million) and 2 leaks in natural gas system ($0.01 million). No loss of service expected. Total damage: Approximately $0.07 million.	Fire damage will displace no people.

Table 7-7 presents the estimated tonnage of debris that would be generated by earthquake damage during each HAZUS-MH scenario. As shown in Table 7-7, the most debris is expected for the Stamford Scenario.

Table 7-7
HAZUS-MH Earthquake Scenarios – Debris Generation (Tons)

Epicenter Location and Magnitude	Brick / Wood	Reinforced Concrete / Steel	Total	Estimated Cleanup Truckloads (25 Tons / Truck)
Haddam – 5.7	730	270	1,000	40
Portland – 5.7	720	280	1,000	40
Stamford – 5.7	2,900	2,100	5,000	200
East Haddam – 6.4	2,520	1,480	4,000	160

Table 7-8 presents the potential sheltering requirements based on the various earthquake events simulated by HAZUS-MH. There is predicted sheltering requirements for both the Stamford and East Haddam scenario due to displaced households for earthquake damage (not including fire damage in Table 7-6). 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.

Table 7-8
HAZUS-MH Earthquake Scenarios – Shelter Requirements

Epicenter Location and Magnitude	Number of Displaced Households	Short Term Sheltering Need (Number of People)
Haddam – 5.7	None	None
Portland – 5.7	None	None
Stamford – 5.7	5	2
East Haddam – 6.4	3	1

Table 7-9 presents the casualty estimates generated by HAZUS-MH for the various earthquake scenarios. Casualties are broken down into four severity levels that describe the extent of injuries. The levels are as follows:

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

Table 7-9
HAZUS-MH Earthquake Scenarios – Casualty Estimates

Epicenter Location - Magnitude	2 AM Earthquake	2 PM Earthquake	5 PM Earthquake
Haddam – 5.7	None	1 (Level 1)	1 (Level 1)
Portland – 5.7	1 (Level 1)	1 (Level 1)	1 (Level 1)
Stamford – 5.7	3 (Level 1) 0 (Level 2)	5 (Level 1) 1 (Level 2)	4 (Level 1) 1 (Level 2)
East Haddam – 6.4	2 (Level 1) 0(Level 2)	4 (Level 1) 1 (Level 2)	3 (Level 1) 1 (Level 2)

All earthquake scenarios cause only minor injuries or no injury at all.

Table 7-10 presents the total estimated losses and direct economic impact that may result from the four earthquake scenarios created for Brookfield as estimated by the HAZUS-MH software. Capital damage loss estimates include the subcategories of building, contents, and inventory damages. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building or its contents. Business interruption loss estimates include the subcategories of lost income, relocation expenses, and lost wages. The business interruption losses are associated with the inability to operate a business due to the damage sustained during an earthquake, and also include temporary living expenses for those people displaced from their home because of the storm. Note that these damages do not include transportation, utility, or fire damage in Table 7-6.

Table 7-10
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	$2,660,000	$780,000	$3,440,000
Portland – 5.7	$3,490,000	$950,000	$4,440,000
Stamford – 5.7	$21,040,000	$5,360,000	$26,400,000
East Haddam – 6.4	$13,780,000	$3,800,000	$17,580,000

The maximum simulated damage considering direct losses and infrastructure losses is approximately $26.4 million for the Stamford scenario. Note that the losses are presented in 2006 dollars, which implies that they will be greater in the future due to inflation. It is also believed that the next plan update will be able to utilize 2010 census data within HAZUS-MH, providing a more recent dataset for analysis.

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

7.6 Potential Mitigation Strategies and Actions

As earthquakes are relatively infrequent, difficult to predict, and can affect the entire Town of Brookfield, 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, Brookfield will activate its Emergency Operations Plan and initiate emergency response procedures as necessary.

7.7 Summary of Mitigation Strategies and Actions

The following potential mitigation measures have been identified:

- ❑ Consider preventing new residential development in areas prone to collapse.
- ❑ Ensure that municipal departments have adequate backup facilities in case earthquake damage occurs to municipal buildings.
- ❑ 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. The DEEP inventory documents 18 dams within Town limits. Additionally, high hazard dams located in surrounding municipalities have the potential to affect the Town of Brookfield 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.

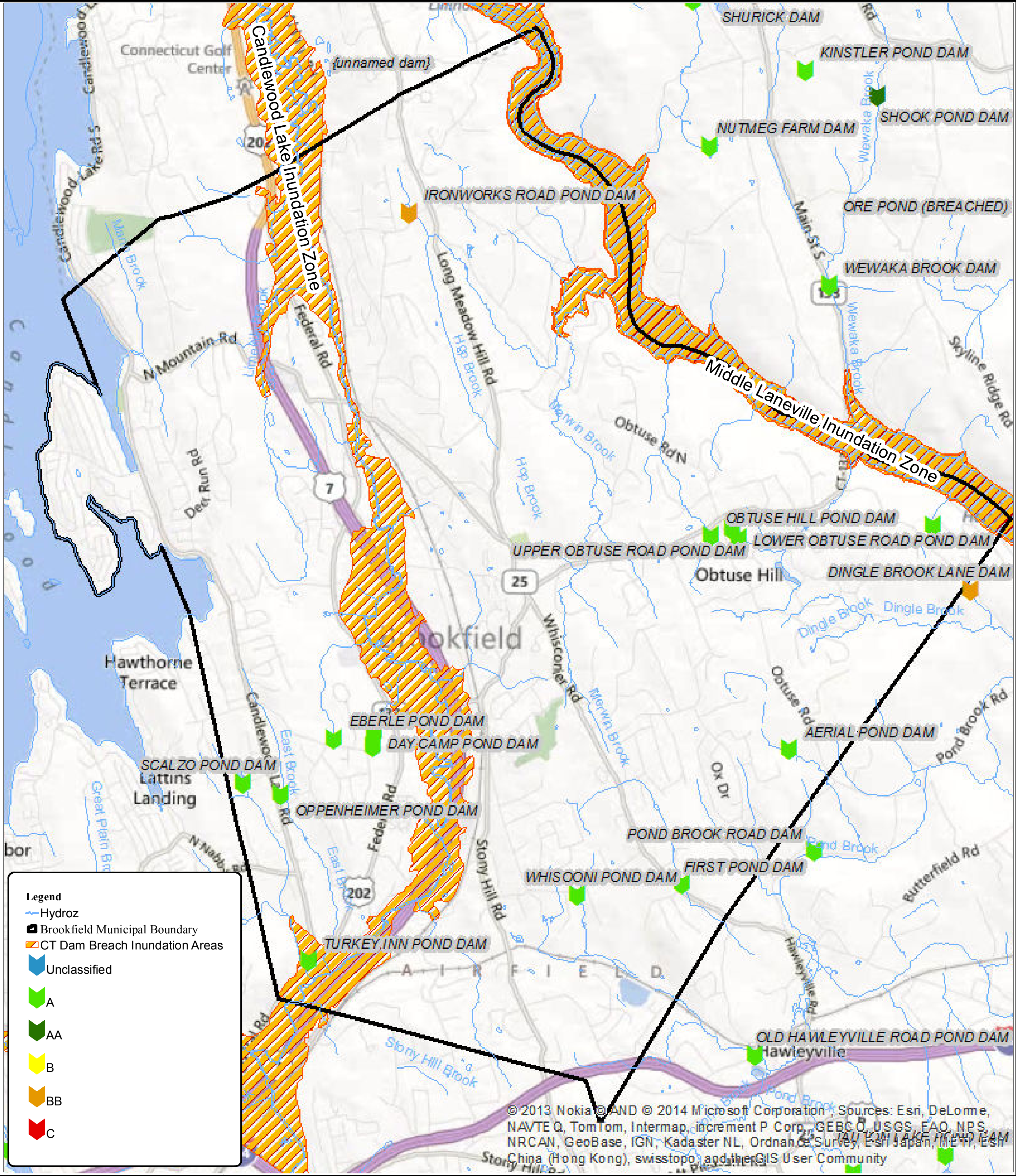
8.2 Hazard Assessment

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.

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

As of 2013, there were 18 DEEP-inventoried dams within the Town of Brookfield. These dams are shown in Figure 8-1. None of these dams are considered high or significant hazard (Class B or C). As shown in Table 8-1, the high hazard dams located on Candlewood Lake in New Milford and Danbury present the highest potential for damage in Brookfield should failure occur because portions of Brookfield are downstream of these dams.



SOURCE(S): 2013 CT DEEP Dam Inventory

Figure 8-1: Dam Location and Hazard Classification

LOCATION: Brookfield, CT

N

Town of Brookfield
Hazard Mitigation Plan

MXD: P:\3101-14\Design\GIS\Fairfield County\Brookfield\Maps\Figure 8-1 Brookfield Dam Locations and Hazard Classification.mxd

Map By: CPS
MMI#: 3101-14
Original: 01/14/2014
Revision: 01/14/2014
Scale: 1 inch = 0.76 miles

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

#	Name	Location	Class	Owner
3404	Candlewood Lake South Dam	Candlewood Lake, Danbury	C	First Light Power Resources
9602	Candlewood Lake Dam #2	Candlewood Lake, Rocky River, New Milford	B	First Light Power Resources
9639	North Lanesville Dike	Candlewood Lake, New Milford	C	First Light Power Resources
9640	Middle Lanesville Dike	Candlewood Lake, New Milford	C	First Light Power Resources

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	Town of Meriden
-----	ABB Pond Dam	Bloomfield	--	Minor Damage	Private
4905	Springborn Dam	Enfield	BB	Minor Damage	DEEP
13904	Cains Pond Dam	Suffield	A	Full Breach	Private
13906	Schwartz Pond Dam	Suffield	BB	Partial Breach	Private
14519	Sessions Meadow Dam	Union	BB	Minor Damage	DEEP

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

8.4 Existing Capabilities

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

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

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

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

Dam inspection regulations require that nearly 700 dams in Connecticut be inspected annually. The 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 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.

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 of the 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*. 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.

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

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

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

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

Inundation mapping developed in conjunction with the Dam Breach Analysis indicates the limits of dam failure impacts extending into Brookfield. Failure of the New Milford dams and dikes would result in a flood wave that would enter Brookfield from the north. Floodwaters would increase water surface elevations in Lake Lillinoah and the Housatonic River. The primary affected roadways would be the Route 133 crossing of the Housatonic River.

Failure of the Danbury dam would result in a flood wave that would enter Brookfield from the southwest. Floodwaters would cause Still River to jump its banks and inundate portions of roadways that are adjacent to the water course. These roadways include Route 7, White Turkey Road, Candlewood Lake Road, Route 202, Gray's Bridge Road and Old Gray's Bridge Road, Commerce Drive, Del Mar Drive, Route 133, Silvermine Road, Dean Road, Pocono Road, and Station Road.

The EAP specifies that representatives of the Rocky River Project are responsible for notifying Brookfield government officials in the event of an emergency.

Loss Estimates – *HAZUS-MH* was utilized to determine the effect of dam failure for the Danbury Dike located upstream of the Still River in Danbury. The Emergency Operations Plan for the Danbury Dike was obtained for this 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 following paragraphs discuss the results of the *HAZUS-MH* analysis.

The *HAZUS-MH* simulation estimates that approximately four buildings will be at least moderately damaged and approximately 100 buildings are expected to be substantially damaged or completely destroyed in Brookfield. One school is expected to experience substantial damage, although the remaining schools, the fire station, and the police station are not expected to experience moderate or higher damage.

The *HAZUS-MH* simulation estimated the following tons of debris would be generated by flood damage from the dam failure scenario. The simulation also estimates the number of truckloads (at approximately 25 tons per truck) that will be required to remove the debris. The breakdown of debris generation is as follows:

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

Stream	Finishes	Structural	Foundations	Total	Truckloads
Failure of Danbury Dike	2,819	16,283	12,219	31,321	1,253

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

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

Stream	Displaced Households	Population Using Public Shelters
Failure of Danbury Dike	144	381

HAZUS-MH also calculated the predicted economic losses due the dam failure scenario. Economic losses are categorized between building-related losses and business interruption losses. The total loss for a worst-case scenario dam failure event is estimated by *HAZUS-MH* to be approximately $206.3 million.

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

Stream	Residential	Commercial	Industrial	Others	Total
Failure of Danbury Dike	$31,240,000	$88,950,000	$30,980,000	$54,040,000	$205,220,000

Table 8-6
***HAZUS-MH* Flood Scenario – Business Interruption Estimates**

Stream	Residential	Commercial	Industrial	Others	Total
Failure of Danbury Dike	$20,000	$570,000	$10,000	$420,000	$1,020,000

The *HAZUS-MH* results do not provide casualty estimates. However, it is assumed that casualties would occur under this 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 located downstream from high and significant hazard dams or containing these dams should maximize their emergency preparedness for a potential dam failure. This can be done by having copies of the EOP/EAP for each dam on file with the local emergency manager and the local engineering department as well as by including potential inundation areas in an emergency notification database. It is important to maintain up to date dam failure inundation mapping in order to properly direct notifications into potentially affected areas. Dam failure inundation areas should be mapped for all community-owned significant and high hazard dams. For dams without a mapped failure inundation area, the 100-year and 500-year floodplains described in Section 3 could be utilized to provide approximate failure inundation areas for the notification database.

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

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

8.7 Summary of Specific Strategies and Actions

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

- ❑ Include dam failure inundation areas in the CT Alert emergency contact database.
- ❑ Provide technical assistance to private dam owners regarding effective maintenance strategies.
- ❑ File EOPs/EAPs with town departments and emergency personnel in Brookfield.

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

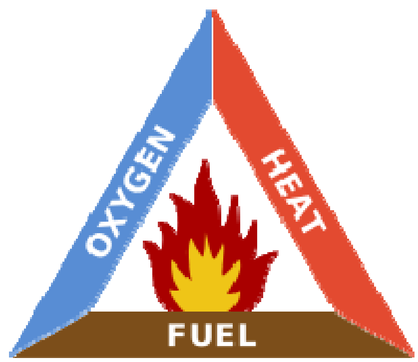
9.1 Setting

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

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



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

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

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

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

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

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

Connecticut has a particular vulnerability to fire hazards where 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 2,792 acres of land burned in Connecticut from 2002 through 2010 due to 1,934 nonprescribed wildfires, an average of 1.4 acres per fire and 215 acres per year (Table 9-1). The Connecticut DEEP Forestry Division estimates the wildland fires burn approximately 1,300 acres per year.

Table 9-1
Wildland Fire Statistics for Connecticut

Year	Number of Wildland Fires	Acres Burned	Number of Prescribed Burns	Acres Burned	Total Acres Burned
2010	69	267	6	52	319
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	**1,934**	**2,792**	**74**	**829**	**3,621**

Source: National Interagency Fire Center

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

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

Minor brush fires have occurred in Brookfield but nothing significant has occurred in a very long time. Small fires along the railroad tracks are started by the trains, but these are addressed quickly.

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.

Regulations regarding fire protection in Brookfield are outlined in the *Subdivision Regulations:*

- ❑ Section 234-01 states that a copy of the subdivision plans must be submitted to the Fire Department Water Source Committee for review of fire tank(s) and emergency access.

- ❑ Section 234-402(2) includes language that must be included in fire tank easements and deeds.

- ❑ Section 234-402(9) states that all multi-family dwellings shall be protected by pressurized fire hydrants, as approved by the Water Source Committee of the Brookfield Fire Department. Whenever possible, for all single family housing subdivisions of four lots, to ten lots will be required that the property owner/subdivider shall install a 30,000 gallon in ground, nonmetallic fire suppression tank. For subdivisions of eleven lots or more, one additional 30,000 gallon tank shall be required for every ten lots, or part thereof.

- ❑ Section 234-505(b) states that dead end streets with cul-de-sacs shall not exceed 1,500 feet in length, unless an alternate means of access for emergency vehicles is provided which is acceptable to the Planning Commission and the Water Source Committee.

- ❑ Section 234-601 requires the installation of fire tanks before a building permit is issued.

Town officials have noted that the public water system along Federal Road is almost complete and the corridor will have fire protection. Outlying areas are served by almost 50 dry hydrants, some with fire ponds. As stated above, regulations currently require any development with more than three houses to include a 30,000 gallon cistern for fire protection.

The town's Fire Department has mutual aid agreements and two vehicles that can fight fires off-road. They also have a pumper boat on Candlewood Lake and other watercraft-based equipment for additional support.

Unlike the west coast of the United States where the fires are allowed to burn toward development and then stopped, the Brookfield Fire Department goes to the fires whenever possible. This proactive approach is believed to be effective for controlling wildfires. Finally, the DEEP Forestry Division uses rainfall data from a variety of sources to compile forest fire probability forecasts. This allows the DEEP and the Town to monitor the drier areas of the state to be prepared for forest fire conditions.

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.

9.5 Vulnerabilities and Risk Assessment

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

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

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

According to the Connecticut DEEP, the overall forest fire risk in Connecticut is low due to several factors. First, the overall incidence of forest fires is very low (an average of 215 fires per year occurred in Connecticut from 2002 to 2010, which is a rate slightly higher than one per municipality per year). Secondly, as the wildfire/forest fire prone areas become fragmented due to development, the local fire departments have increased access to those neighborhoods for firefighting equipment. Third, the problematic interface areas such as driveways too narrow to permit emergency vehicles are site specific. Finally, trained firefighters at the local and state level are readily available to fight fires in the state, and inter-municipal cooperation on such instances is common. However, local risk is not necessarily the same as the overall statewide risk.

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.

In Brookfield, town officials have indicated that the two high pressure natural gas lines in town are a concern, due to the potential for fires if the pipe is damaged. The Iroquois line includes a compression station and a meter station. The Algonquin line includes a meter station. Both lines include 24 inch pipes but they will reportedly be upgraded to 50 inch pipes.

Loss Estimates – According to the Town of Brookfield, the total cost to fight wildfires in any given year is $10,000 to $15,000 (equipment and labor) depending on the size and scope of the event. The 2014 Connecticut Natural Hazard Mitigation Plan provides annual estimated losses on a countywide basis for several hazards. Based on the population of Brookfield relative to Fairfield County, the annual estimated loss is $1,006 for wildfires. This figure is low compared to those provided by the Town, and it may not represent the true risks in Brookfield.

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.

9.7 Summary of Mitigation Strategies and Actions

The following recommendations could be implemented to mitigate fire risk:

- Support the expansion of public water service (provided by Aquarion Water Company) in Brookfield.
- The Town should continue to require the installation of fire protection water in new developments where municipal water service is unavailable, and sprinkler systems where access is limited for fire apparatus.
- The Fire Departments should coordinate with the Water Department to identify areas where fire-fighting capacity may be limited due to lack of water pressure or storage. Deficiencies should be addressed as they are identified and funding allows.
- Provide outreach programs on how to properly manage burning and campfires on private property.
- Patrol Town-owned open space and parks to prevent unauthorized campfires.
- Coordinate with the local natural gas company to ensure that procedures are in place to address fires associated with potential pipeline failures.
- 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

Due to the importance of critical facilities during storm events, provision of standby power is a priority strategy of this plan:

- ❑ As noted in Section 2.9, the primary identified shelter in the town that is also considered a critical facility is the Brookfield High School on Long Meadow Hill Road. This facility has a backup generator; however the town would like to increase the capacity of the generator.
- ❑ The town would like to have a shelter on the west side of town and have considered using the Huckleberry Hill School for this purpose. The town wishes to renovate the school, and the renovations may include elements that make it easier to be a shelter, but this has not been financed or approved yet. The town would also like to acquire standby power for the school.
- ❑ While the YMCA is not considered a designated shelter, its importance during disasters makes it a critical facility and the town would like to obtain standby power for this facility.
- ❑ Standby power is desired for sewer pumping stations.

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

10.2 Summary of Proposed Strategies and Actions

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

<u>All Hazards</u>

- ❑ Pursue funding to obtain backup generators for the YMCA, Huckleberry Hill School and the sewer pumping stations.

- Pursue funding to increase the capacity of the generator at the high school.
- Develop a plan to designate a shelter on the west side of town; determine the feasibility of renovating the Huckleberry Hill School in order to designate it as a shelter.
- Disseminate informational pamphlets regarding natural hazards to public locations.
- Add pages to the Town website (www.brookfieldct.gov) dedicated to citizen education and preparation for hazard events.
- Review potential evacuation routes to ensure timely migration of people seeking shelter in all areas of the town. Post a list of Town sheltering facilities in the Town Hall and on the Town's website so residents can best plan how to access critical facilities during a hazard event.
- When possible, advertise the location of emergency shelters on the Town website, in local municipal buildings and supermarkets, on local radio and television stations, and in the local newspapers in advance of hazard events.
- Utilize the existing CT Alert emergency notification software to its fullest capabilities.
- Encourage residents to purchase and use NOAA weather radios with alarm features.

<u>Flooding</u>

<u>Prevention</u>

- Consider requiring new buildings constructed in floodprone areas to be protected to the highest recorded flood level regardless of being within a defined SFHA.
- 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.
- Develop a town wide catch basin cleanout program to reduce flood impacts due to drainage issues.

<u>Property Protection</u>

- Encourage property owners to purchase flood insurance under the NFIP and to report claims when flooding damage occurs.
- Evaluate floodprone properties along the Still River Corridor, specifically in the vicinity of Dean Road, Federal Road and Sand Cut Road to determine potential flood damage reduction methods.
- Consider flood mitigation methods at the Public Works Garage, such as berm construction and/or floodproofing to reduce flood risk; or
- Consider relocating the Public Works Garage to eliminate flood risk.
- Provide technical assistance to the Candlewood Plaza occupants to pursue floodproofing that will make the tenants more resilient and able to open soon after flooding.

<u>Public Education</u>

- Consider enrolling in the Community Rating System (CRS).
- 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.

- ❑ Provide outreach regarding home elevation and relocation, flood barriers, dry floodproofing, wet floodproofing, and other home improvement techniques (Section 3.6.2) to private homeowners and businesses with flooding problems.
- ❑ Hold workshops involving all Town departments to provide training for dealing with widespread flooding damage.

<u>Natural Resource Protection</u>

- ❑ Pursue the acquisition of additional municipal open space inside SFHAs and set it aside as greenways, parks, or other nonresidential, noncommercial, or nonindustrial use.
- ❑ Selectively pursue conservation recommendations listed in the Plan of Conservation and Development and other studies and documents.
- ❑ Continue to regulate development in protected and sensitive areas, including steep slopes, wetlands, and floodplains.

<u>Structural Projects</u>

- ❑ Conduct drainage improvements within the Meadow Brook Manor neighborhood.
- ❑ Develop a plan to selectively remove debris from the Still River to prevent obstructions of bridges and culverts.
- ❑ Review culvert conveyances based on existing hydrology and Northeast Regional Climate Center guidance.

<u>Emergency Services</u>

- ❑ Ensure adequate barricades are available to block flooded areas in floodprone areas of the town.

<u>Wind Damage Related to Hurricanes, Summer Storms, and Winter Storms</u>

- ❑ Continue to provide town wide tree limb inspection and maintenance programs to ensure that the potential for downed power lines is diminished. Continue to encourage property owners to trim branches located over structures and power lines.
- ❑ Work with the CL&P liaison to ensure a more pro-active approach to tree trimming in Brookfield
- ❑ Work with CL&P to determine the feasibility of placing non-conducting steel cables above power lines to protect them from falling branches and trees.
- ❑ Continue requiring the location of utilities underground in new developments or during redevelopment whenever possible. Pursue funding to place them underground in existing developed areas.
- ❑ 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.
- 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.
- Develop a plan to reduce accident risks along steep roads such as Elbow Hill Road, North Mountain Road, North Obtuse Road and Obtuse Road. Snow fencing and certain vegetation buffers may be helpful to reduce drifting and drainage improvements may reduce icing.

Earthquakes

- Consider preventing new residential development in areas prone to collapse.
- Ensure that municipal departments have adequate backup facilities in case earthquake damage occurs to municipal buildings.
- The town may consider bracing systems and assets inside critical facilities. This could help protect IT systems, important records and files.

Dam Failure

- Include dam failure inundation areas in the CT Alert emergency contact database.
- Provide technical assistance to private dam owners regarding effective maintenance strategies.
- File EOPs/EAPs with town departments and emergency personnel in Brookfield.

Wildfires

- Support the expansion of public water service (provided by Aquarion Water Company) in Brookfield.
- The Town should continue to require the installation of fire protection water in new developments where municipal water service is unavailable, and sprinkler systems where access is limited for fire apparatus.
- The Fire Departments should coordinate with the Water Department to identify areas where fire-fighting capacity may be limited due to lack of water pressure or storage. Deficiencies should be addressed as they are identified and funding allows.
- Provide outreach programs on how to properly manage burning and campfires on private property.
- Patrol Town-owned open space and parks to prevent unauthorized campfires.
- Coordinate with the local natural gas company to ensure that procedures are in place to address fires associated with potential pipeline failures.
- Revise and enhance the town’s website concerning the local regulatory requirements concerning Open Burning.

10.3 Priority Projects and Procedures

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

1. Pursue funding to acquire backup generators for the YMCA, Huckleberry Hill School and sewer pumping stations.
2. Pursue funding to increase the capacity of the generator at the High School.
3. Develop a town-wide catch basin cleanout program to reduce flood impacts due to drainage issues.
4. Conduct drainage improvements within the Meadowbrook Manor neighborhood.
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.

The strategies and actions were separated into two categories:

- The first category includes those strategies and actions that are meant to be implemented within the five-year timeframe of this hazard mitigation plan (2015-2019).

- The second category includes two actions that may not be implemented within the timeframe of this hazard mitigation plan because specific properties have not been identified, but that should be incorporated into the next Plan of Conservation and Development. It is important to maintain this list of longer term strategies and actions because their absence from this HMP would likely contribute to them not appearing in future updates to this HMP and the next Plan of Conservation and Development. The second category also contains two actions that require close coordination with Aquarion Water Company and incorporation into Aquarion Water Company's Water Supply Plan. Because Aquarion Water Company's service in Brookfield is relatively new, time is needed for these actions to be implemented.

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 DEMHS.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

U.S. Fire Administration

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

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

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

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

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

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

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

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

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

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

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

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

The POCD and the Emergency Operations Plan are the two documents most likely to benefit from the adoption of this Hazard Mitigation Plan. In particular, the town is in the process of updating the 2002 POCD. The POCD update will include policies from this Hazard Mitigation Plan.

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 the 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.

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

11.2 Progress Monitoring and Public Participation

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

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

The local coordinator will be responsible for obtaining a current list of repetitive loss properties (RLPs) in the community each year. 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.

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

<u>Post-Disaster Reporting and Metering</u> – 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.

<u>Continued Public Involvement</u> – 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.

11.3 <u>Updating the Plan</u>

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

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

update is being developed; the assistance of the regional planning organization may be solicited from time to time for this purpose.

Table 11-1 presents a schedule to guide the preparation for the plan update and then the actual update of the plan. The schedule assumes that the current version of this plan was adopted in November 2014 and will therefore expire in November 2019.

Table 11-1
Schedule for Hazard Mitigation Plan Update

Month and Year	Tasks
November 2015	Annual meeting to review plan content and progress
November 2016	Annual meeting to review plan content and progress
November 2017	Annual meeting to review plan content and progress
June 2018	Ensure that funding for the plan update is included in the fiscal year 2018-2019 budget
November 2018	Annual meeting to review plan content and progress
	Secure consultant to begin updating the plan, or begin updating in-house
June 2019	Forward draft updated plan to DEMHS for review
July 2019 – September 2019	Process edits from DEMHS and FEMA and obtain the Approval Pending Adoption (APA)
November 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 Housatonic Valley Council of Elected Officials (HVCEO)
- City of Danbury
- Town of Bridgewater
- Town of Bethel
- Town of Newtown
- Town of New Fairfield
- Town of New Milford

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.

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

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

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

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

SBA has the authority to "declare" disaster areas following disasters that affect a significant number of homes and businesses, but that would not need additional assistance through FEMA. (SBA is triggered by a FEMA declaration, however.) SBA can provide additional low-interest funds (up to 20% above what an eligible applicant would "normally" qualify for) to install mitigation measures. They can also loan the cost of bringing a damaged property up to state or local code requirements. These loans can be used in combination with the new "mitigation insurance" under the NFIP, or in lieu of that coverage.

Environmental Protection Agency
Region I
1 Congress Street, Suite 1100
Boston, MA 02114-2023
(888) 372-7341

Provides grants for restoration and repair, and educational activities, including:

- *Capitalization Grants for Clean Water State Revolving Funds*: Low interest loans to governments to repair, replace, or relocate wastewater treatment plans damaged in floods. Does not apply to drinking water or other utilities.

- *Clean Water Act Section 319 Grants*: Cost-share grants to state agencies that can be used for funding watershed resource restoration activities, including wetlands and other aquatic habitat (riparian zones). Only those activities that control non-point pollution are eligible. Grants are administered through the CT DEEP.

U.S. Department of Housing and Urban Development
20 Church Street, 19th Floor
Hartford, CT 06103-3220
(860) 240-4800
http://www.hud.gov/

The U.S. Department of Housing and Urban Development offers *Community Development Block Grants (CDBG)* to communities with populations greater than 50,000, who may contact HUD directly regarding CDGB. One program objective is to improve housing conditions for low and moderate income families. Projects can include acquiring floodprone homes or protecting them from flood damage. Funding is a 100% grant; can be used as a source of local matching funds for other funding programs such as FEMA's "404" Hazard Mitigation Grant Program. Funds can also be applied toward "blighted" conditions, which is often the post-flood condition. A separate set of funds exists for conditions that create an "imminent threat." The funds have been used in the past to replace (and redesign) bridges where flood damage eliminates police and fire access to the other side of the waterway. Funds are also available for smaller municipalities through the state-administered CDBG program participated in by the State of Connecticut.

U.S. Army Corps of Engineers
Institute for Water Resources
7701 Telegraph Road
Alexandria, VA 22315
(703) 428-8015
http://www.iwr.usace.army.mil/

The Corps provides 100% funding for floodplain management planning and technical assistance to states and local governments under several flood control acts and the Floodplain Management Services Program (FPMS). Specific programs used by the Corps for mitigation are listed below.

- *Section 205 – Small Flood Damage Reduction Projects*: This section of the 1948 Flood Control Act authorizes the Corps to study, design, and construct small flood control projects in partnership with non-Federal government agencies. Feasibility studies are 100 percent federally-funded up to $100,000, with additional costs shared equally. Costs for preparation of plans and construction are funded 65 percent with a 35 percent non-federal match. In certain cases, the non-Federal share for construction could be as high as 50 percent. The maximum federal expenditure for any project is $7 million.

- *Section 14 – Emergency Streambank and Shoreline Protection:* This section of the 1946 Flood Control Act authorizes the Corps to construct emergency shoreline and streambank protection works to protect public facilities such as bridges, roads, public buildings, sewage treatment plants, water wells, and non-profit public facilities such as churches, hospitals, and schools. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $1.5 million.

- *Section 103 – Hurricane and Storm Damage Reduction Projects:* This section of the 1962 River and Harbor Act authorizes the Corps to study, design, and construct small coastal storm damage reduction projects in partnership with non-Federal government agencies. Beach nourishment (structural) and floodproofing (non-structural) are examples of storm damage reduction projects constructed under this authority. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $5 million.

- *Section 208 – Clearing and Snagging Projects:* This section of the 1954 Flood Control Act authorizes the Corps to perform channel clearing and excavation with limited embankment construction to reduce nuisance flood damages caused by debris and minor shoaling of rivers. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $500,000.

- *Section 206 – Floodplain Management Services:* This section of the 1960 Flood Control Act, as amended, authorizes the Corps to provide a full range of technical services and planning guidance necessary to support effective floodplain management. General technical assistance efforts include determining the following: site-specific data on obstructions to flood flows, flood formation, and timing; flood depths, stages, or floodwater velocities; the extent, duration, and frequency of flooding; information on natural and cultural floodplain resources; and flood loss potentials before and after the use of floodplain management measures. Types of studies conducted under FPMS include floodplain delineation, dam failure, hurricane evacuation, flood warning, floodway, flood damage reduction, stormwater management, floodproofing, and inventories of floodprone structures. When funding is available, this work is 100 percent federally funded.

In addition, the Corps also provides emergency flood assistance (under Public Law 84-99) after local and state funding has been used. This assistance can be used for both flood response and post-flood response. Corps assistance is limited to the preservation of life and improved property; direct assistance to individual homeowners or businesses is not permitted. In addition, the Corps can loan or issue supplies and equipment once local sources are exhausted during emergencies.

U.S. Department of Commerce
National Weather Service
Northeast River Forecast Center
445 Myles Standish Blvd.
Taunton, MA 02780
(508) 824-5116
http://www.nws.noaa.gov/

The National Weather Service prepares and issues flood, severe weather, and coastal storm warnings. Staff hydrologists can work with communities on flood warning issues and can give technical assistance in preparing flood warning plans.

U.S. Department of the Interior
National Park Service
Steve Golden, Program Leader
Rivers, Trails, & Conservation Assistance
15 State Street
Boston, MA 02109
(617) 223-5123
http://www.nps.gov/rtca/

The National Park Service provides technical assistance to community groups and local, state, and federal government agencies to conserve rivers, preserve open space, and develop trails and greenways as well as identify nonstructural options for floodplain development.

U.S. Fish and Wildlife Service
New England Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5087
(603) 223-2541
http://www.fws.gov/

The U.S. Fish and Wildlife Service provides technical and financial assistance to restore wetlands and riparian habitats through the North American Wetland Conservation Fund and Partners for Wildlife programs. It also administers the *North American Wetlands Conservation Act Grants Program*, which provides matching grants to organizations and individuals who have developed partnerships to carry out wetlands projects in the United States, Canada, and Mexico. Funds are available for projects focusing on protecting, restoring, and/or enhancing critical habitat.

U.S. Department of Agriculture
Natural Resources Conservation Service
Connecticut Office
344 Merrow Road, Suite A
Tolland, CT 06084-3917
(860) 871-4011

The Natural Resources Conservation Service provides technical assistance to individual landowners, groups of landowners, communities, and soil and water conservation districts on land use and conservation planning, resource development, stormwater management, flood prevention, erosion control and sediment reduction, detailed soil surveys, watershed/river basin planning and recreation, and fish and wildlife management. Financial assistance is available to reduce flood damage in small watersheds and to improve water quality. Financial assistance is available under the Emergency Watershed Protection Program, the Cooperative River Basin Program, and the Small Watershed Protection Program.

Regional Resources

Northeast States Emergency Consortium
1 West Water Street, Suite 205
Wakefield, MA 01880
(781) 224-9876
http://www.serve.com/NESEC/

The Northeast States Emergency Consortium (NESEC) develops, promotes, and coordinates "all-hazards" emergency management activities throughout the northeast. NESEC works in partnership with public and private organizations to reduce losses of life and property. They provide support in areas including interstate coordination and public awareness and education, along with reinforcing interactions between all levels of government, academia, nonprofit organizations, and the private sector.

State Resources

Connecticut Department of Administrative Services, Division of Construction Services
165 Capitol Avenue
Hartford, CT 06106
(860) 713-5850
http://www.ct.gov/dcs/site/default.asp

Office of the State Building Inspector - The Office of the State Building Inspector is responsible for administering and enforcing the Connecticut State Building Code and is also responsible for the municipal Building Inspector Training Program.

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/

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.

Connecticut Office of Policy and Management
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.

<u>The National Association of Flood & Stormwater Management Agencies (NAFSMA)</u>
1301 K Street, NW, Suite 800 East
Washington, DC 20005
(202) 218-4122
http://www.nafsma.org

NAFSMA is an organization of public agencies who strive to protect lives, property, and economic activity from the adverse impacts of stormwater by advocating public policy, encouraging technology, and conducting educational programs. NAFSMA is a voice in national politics on water resources management issues concerning stormwater management, disaster assistance, flood insurance, and federal flood management policy.

<u>National Emergency Management Association (NEMA)</u>
P.O. Box 11910
Lexington, KY 40578
(859)-244-8000
http://www.nemaweb.org/

A national association of state emergency management directors and other emergency management officials, the NEMA Mitigation Committee is a strong voice to FEMA in shaping all-hazard mitigation policy in the nation. NEMA is also an excellent source of technical assistance.

<u>Natural Hazards Center</u>
University of Colorado at Boulder
482 UCB
Boulder, CO 80309-0482
(303) 492-6818
http://www.colorado.edu/hazards/

The Natural Hazards Center includes the Floodplain Management Resource Center, a free library and referral service of the ASFPM for floodplain management publications. The Natural Hazards Center is located at the University of Colorado in Boulder. Staff can use keywords to identify useful publications from the more than 900 documents in the library.

***Volunteer Organizations* -** Volunteer organizations including the American Red Cross, the Salvation Army, Habitat for Humanity, and the Mennonite Disaster Service are often available to help after disasters. Service Organizations such as the Lions Club, Elks Club, and the Veterans of Foreign Wars are also available. Habitat for Humanity and the Mennonite Disaster Service provide skilled labor to help rebuild damaged buildings while incorporating mitigation or floodproofing concepts. The office of individual organizations can be contacted directly or the FEMA Regional Office may be able to assist.

***Flood Relief Funds* -** After a disaster, local businesses, residents, and out-of-town groups often donate money to local relief funds. They may be managed by the local government, one or more local churches, or an ad hoc committee. No government disaster declaration is needed. Local officials should recommend that the funds be held until an applicant exhausts all sources of public disaster assistance, allowing the funds to be used for mitigation and other projects that cannot be funded elsewhere.

***Americorps* -** Americorps is the National Community Service Organization. It is a network of local, state, and national service programs that connects volunteers with nonprofits, public agencies, and faith-based and community organizations to help meet our country's critical needs in education, public safety, health, and the environment. Through their service and the volunteers they mobilize, AmeriCorps members address critical needs in communities throughout America, including helping communities respond to disasters. Some states have trained Americorps members to help during flood-fight situations such as by filling and placing sandbags.

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APPENDIX A
STAPLEE MATRIX

#	Strategies and Actions for the Town of Brookfield	Schedule Year Provided or A. 2020-2025 B. 2026-2031	Cost Low = Minimal[2] Intermediate = <$100,000 High = >$100,000	Potential Funding Sources[3]	Weighted STAPLEE Criteria[4] – *Benefits*								*Costs*								Total STAPLEE Score
					Social	Technical (x2)	Administrative	Political	Legal	Economic (x2)	Environmental	**STAPLEE Subtotal**	Social	Technical (x2)	Administrative	Political	Legal	Economic (x2)	Environmental	**STAPLEE Subtotal**	
	Strategies and Actions for Implementation During the Timeframe of this Hazard Mitigation Plan (2015-2019)																				
	ALL HAZARDS																				
1	Pursue funding to acquire backup generators for the YMCA, Huckleberry Hill School and sewer pumping station	2015	Intermediate	HMA*	1	1	1	1	0.5	1	0	**7.5**	0	0	0	0	0	-0.5	0	**-1.0**	**6.5**
2	Pursue funding to increase the capacity of the generator at the high schoo	2015	Intermediate	HMA*	1	1	1	1	0.5	1	0	**7.5**	0	0	0	0	0	-0.5	0	**-1.0**	**6.5**
3	Ensure that emergency information is available through several different media, such as newspaper, radio, internet and phone	2015	Low	Municipal	1	1	0.5	1	0	0	0	**4.5**	0	0	-0.5	0	0	0	0	**-0.5**	**4.0**
4	Utilize the CT Alert emergency notification system to its fullest capabilitie	2015	Low	Municipal	1	1	1	1	0	0	0	**5.0**	0	0	-0.5	0	0	0	0	**-0.5**	**4.5**
5	Encourage residents to purchase and use NOAA weather radios with alarm feature	2016	Low	Municipal	1	1	0.5	1	0	0	0	**4.5**	0	0	0	0	0	0	0	**0.0**	**4.5**
6	Disseminate informational pamphlets regarding natural hazards to public location	2016	Low	Municipal	1	1	0.5	1	0	0	0	**4.5**	0	0	-0.5	0	0	0	0	**-0.5**	**4.0**
7	Review potential evacuation routes to ensure timely migration of people seeking shelter in all areas of town	2016	Low	Municipal	1	1	0.5	1	0	0	0	**4.5**	0	0	-0.5	0	0	0	0	**-0.5**	**4.0**
8	Add pages to the town website dedictaed to citizen education and preparation for hazard event	2016	Low	Municipal	1	1	0.5	1	0	0	0	**4.5**	0	0	-0.5	0	0	0	0	**-0.5**	**4.0**
9	Develop a plan to designate a shelter on the west side of town. Determine the feasibility of renovating the Huckleberry Hill School for this us	2018	Intermediate	Municipal, STEAP	1	0	1	1	1	0	0	**4.0**	0	-0.5	0	0	0	0	0	**-1.0**	**3.0**
	FLOODING - Prevention																				
10	Consider requiring new buildings constructed in floodprone areas to be protected to the highest recorded flood level regardless of being within a defined SFH/	2016	Low	Municipal	1	0.5	1	1	0	0	0.5	**4.5**	0	0	0	0	-0.5	0	0	**-0.5**	**4.0**
11	Develop a town-wide catch basin cleanout program to reduce flood impacts due to draiange issues	2019	inermediate	Municipal, STEAP	1	1	1	0.5	0.5	1	1	**8.0**	0	0	0	0	0	-0.5	0	**-1.0**	**7.0**
12	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.	2016	Low	Municipal	1	1	1	0	0	0	0.5	**4.5**	0	0	-0.5	0	0	0	0	**-0.5**	**4.0**
	FLOODING - Property Protection																				
13	Evaluate floodprone properties along the Still River Corridor, specifically in the vicinity of Dean Road, Federal Road and Sand Cut Road to determine potential flood damage reduction methods.	2016	High	Municipal, STEAP	1	1	1	1	1	0	1	**7.0**	0	0	-0.5	0	0	-0.5	0	**-1.5**	**5.5**
14	Encourage property owners to purchase flood insurance under the NFIP.	2016	Low	Municipal	1	1	1	1	1	0	0	**6.0**	0	0	0	0	0	0	0	**0.0**	**6.0**
15	Provide technical assistance to the Candlewood Plaza occupants to pursue floodproofing that will make them more resilient.	2016	Low	Municipal																	
16	Consider flood mitigation methods at the Public Works Garage, such as berm construction and/or floodproofing to reduce flood risk	2017	High	Municipal, STEAP	1	1	1	1	1	0.5	0	**7.0**	0	0	0	0	0	-0.5	0	**-1.0**	**6.0**
17	Consider relocating the Public Works Garage to eliminate flood risk	2017	High	Municipal	1	1	1	1	1	0.5	1	**8.0**	0	0	0	0	0	-1	0	**-2.0**	**6.0**
	FLOODING - Public Education																				
18	Ensure that the appropriate municipal personnel are trained in flood damage prevention methods.	2015	Low	Municipal, EMI	1	1	1	1	1	0	0	**6.0**	0	0	-0.5	0	0	0	0	**-0.5**	**5.5**
19	Consider enrolling in the Community Rating System	2015	High	Municipal	1	0	0	1	1	1	0	**5.0**	0	0	-1	0	0	0	0	**-1.0**	**4.0**
20	Provide outreach regarding home elevation and relocation, flood barriers, dry floodproofing, wet floodproofing, and other techniques (Section 3.6.2) to private homeowners and businesses with flooding problems.	2015	Low	Municipal	1	1	1	1	1	0	0	**6.0**	0	0	-0.5	0	0	0	0	**-0.5**	**5.5**
21	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.	2016	Low	Municipal	1	1	1	1	1	0	0	**6.0**	0	0	-0.5	0	0	0	0	**-0.5**	**5.5**
	FLOODING - Natural Resource Protection																				
22	Continue to regulate development in protected and sensitive areas, including steep slopes, wetlands, and floodplains	2015	Low	HMA, private funds	1	1	1	1	0	0	1	**6.0**	0	0	0	0	0	0	0	**0.0**	**6.0**
	FLOODING - Structural Projects																				
23	Develop a plan to selectively remove debris from the Still River to prevent obstructions of bridges and culverts	2016	Intermediate	Municipal, STEAP	1	1	1	1	1	0	0.5	**6.5**	0	0	0	0	0	-0.5	0	**-1.0**	**5.5**
24	Conduct drainage improvements within the Meadow Brook Manor neighborhood	2016	High	Municipal, HMA, STEAP	1	1	1	1	1	1	0.5	**8.5**	0	0	0	0	0	-1	0	**-2.0**	**6.5**
25	Review culvert conveyances based on existing hydrology and Northeast Regional Climate Center guidance.	2017	Intermediate	Municipal	1	1	1	1	1	0	0	**6.0**	0	0	0	0	0	0	0	**0.0**	**6.0**
	FLOODING - Emergency Services																				
26	Ensure adequate barricades are available to block flooded streets in floodprone area	2015	Intermediate	Municipal	1	1	1	1	1	0	0	**6.0**	0	0	0	0	0	-0.5	0	**-1.0**	**5.0**
	WIND DAMAGE RELATED TO HURRICANES/SUMMER STORMS/WINTER STORMS																				
27	The Building Department should provide literature regarding appropriate design standards for wind	2015	Low	Municipal	1	1	1	1	1	0	0	**6.0**	0	-0.5	0	0	0	0	0	**-1.0**	**5.0**
28	Continue requiring the location of utilities underground in new developments or during redevelopment whenever possible.	2015	Low	Municipal, CL&P	1	1	1	1	1	0	0	**6.0**	0	0	0	0	0	0	0	**0.0**	**6.0**
29	Work with the CL&P liaison to ensure a more pro-active approach to tree trimming in Brookfield	2015	Low	Municipal and CL&P	1	1	1	1	1	0	0	**6.0**	0	-0.5	0	0	0	0	0	**-1.0**	**5.0**
30	Provide town wide tree limb inspection and maintenance programs to ensure that the potential for downed power lines is diminished.	2016	Low	Municipal	1	1	1	1	1	0	0	**6.0**	0	-0.5	0	0	0	0	0	**-1.0**	**5.0**
31	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	2016	Low	Municipal	1	1	1	1	1	0	0	**6.0**	0	0	0	0	0	0	0	**0.0**	**6.0**
32	Work with CL&P to determine the feasibility of placing non-conducting steel cables above power lines to protect them from falling branches and trees	2017	High	Municipal and CL&P	1	1	1	1	1	0	0	**6.0**	0	-0.5	0	0	0	0	0	**-1.0**	**5.0**
	WINTER STORMS																				
33	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.	2015	Low	Municipal	1	1	1	1	1	0	0	**6.0**	0	0	-0.5	0	0	0	0	**-0.5**	**5.5**
34	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.	2016	Low	Municipal	1	1	1	1	0.5	0.5	0	**6.5**	0	0	0	0	0	0	0	**0.0**	**6.5**

#	Strategies and Actions for the Town of Brookfield	Schedule Year Provided or A. 2020-2025 B. 2026-2031	Cost Low = Minimal[2] Intermediate = <$100,000 High = >$100,000	Potential Funding Sources[3]	Weighted STAPLEE Criteria[4]																Total STAPLEE Score
					Benefits								*Costs*								
					Social	Technical (x2)	Administrative	Political	Legal	Economic (x2)	Environmental	**STAPLEE Subtotal**	Social	Technical (x2)	Administrative	Political	Legal	Economic (x2)	Environmental	**STAPLEE Subtotal**	
35	Consider posting the snow plowing routes in Town buildings each winter to increase public awareness	2016	Low	Municipal	1	1	1	1	1	0	0	**6.0**	0	0	0	0	0	0	0	**0.0**	**6.0**
36	Emergency personnel should continue to identify areas that are difficult to access during winter storm events and devise contingency plans to access such areas durin emergencies.	2017	Low	Municipal	1	1	1	1	1	0	0	**6.0**	0	0	0	0	0	0	0	**0.0**	**6.0**
37	Develop a plan to reduce accident risks along steep roads such as Elbow Hill Road, North Mountain Road, North Obtuse Road and Obtuse Road. Consider the use of snow fencing or vegetative buffers.	2018	Intermediate	Municipal																	
	EARTHQUAKES																				
38	Consider preventing new residential development in areas prone to collapse	2017	Low	Municipal																	
39	Ensure that municipal departments have adequate backup facilities in case earthquake damage occurs to municipal buildings	2018	Intermediate	Municipal, EOC, STEAP	1	1	1	1	1	0.5	0	**7.0**	0	0	0	0	0	-0.5	0	**-1.0**	**6.0**
40	Consider bracing systems and assets inside critical facilities. This could help protect IT systems, important records and files	2019	High	Municipal, EOC, STEAP	1	1	1	1	1	0.5	0	**7.0**	0	0	0	0	0	-0.5	0	**-1.0**	**6.0**
	DAM FAILURE																				
41	File EOP's/EAP's with town departments and emergency personnel	2016	Low	Municipal	1	1	1	1	1	0	0	**6.0**	0	0	0	0	0	0	0	**0.0**	**6.0**
42	Include dam failure innundation areas in the CT Alert emergency notification system contact database	2017	Low	Municipal	1	1	1	1	1	0	0	**6.0**	0	0	0	0	0	0	0	**0.0**	**6.0**
43	Provide technical assistance to private dam owners regarding effective maintenance strategies	2018	Low	Municipal	1	1	1	1	1	0	0	**6.0**	0	0	-0.5	0	0	0	0	**-0.5**	**5.5**
	WILDFIRES																				
44	Continue to require the installation of fire protection water in new developments where municipal water service is unavailable, and sprinkler systems where access i limited for fire apparatus.	2015	Low	Municipal	1	1	1	1	1	0	0.5	**6.5**	0	0	-0.5	0	0	0	0	**-0.5**	**6.0**
45	Coordinate with the local natural gas company to ensure that procedures are in place to address fires associated with potential pipeline failures.	2016	Low	Municipal	1	1	1	1	1	0	1	**7.0**	0	-0.5	0	-0.5	0	0	0	**-1.5**	**5.5**
46	Provide outreach programs on how to properly manage burning and campfires on private property	2016	Low	Municipal	1	1	1	1	1	0	0	**6.0**	0	0	-0.5	0	0	0	0	**-0.5**	**5.5**
47	Revise and enhance the town's website concerning local regulatory requirements concerning Open Burining.	2015	Low	Municipal																	
48	Patrol Town-owned open space and parks to prevent unauthorized campfires	2015	Low	Municipal	1	1	1	1	1	0	0	**6.0**	0	0	0	0	0	0	0	**0.0**	**6.0**
	Strategies and Actions for Implementation After the Timeframe of this Hazard Mitigation Plan but to be incorporated into CIPs, the POCD, and the Aquarion Water Company Water Supply Plan																				
	FLOODING - Natural Resource Protection																				
49	Pursue acquisition of additional municipal open space in SHFAs and set it aside for greenways, parks, etc	A	High	HMA, private funds	1	1	1	1	1	0	1	**7.0**	0	0	0	0	0	-1	0	**-2.0**	**5.0**
50	Selectively pursue conservation recommendations listed in the Plan of Conservation and Development and other studies and documents	B	High	HMA, private funds	1	1	1	1	1	0	1	**7.0**	0	0	0	0	0	-1	0	**-2.0**	**5.0**
	WILDFIRES																				
51	Support the expansion of public water service (provided by Aquarion Water Company) in Brookfield.	A	Low	Municipal and Aquarion	1	1	1	0	1	0	0.5	**5.5**	0	0	0	0	0	0	0	**0.0**	**5.5**
52	Fire Department should coordinate with the Water Company to identify areas where fire-fighting capacity may be limited due to lack of water pressure or storage. Deficiencies should be addressed as they are identified and funding allows.	A	Low	Municipal	1	1	1	1	1	0	0	**6.0**	0	0	-0.5	0	0	0	0	**-0.5**	**5.5**

NOTES

1. Departments:
   - EMS = Emergency Management Services
   - 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)
   - CL&P = Connecticut Light and Power
   - Private = Brookfield Open Space Legacy and Weantinoge Heritage Land Trust, Inc
4. 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
DOCUMENTATION OF PLAN DEVELOPMENT

APPENDIX B
PREFACE

An extensive data collection, evaluation, and outreach program was undertaken to compile information about existing hazards and mitigation in the Town of Brookfield 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.

Meeting Agenda
HAZARD MITIGATION PLAN FOR TOWN OF BROOKFIELD
October 30, 2013

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1. Purpose and Need for Hazard Mitigation Plan
2. Natural Hazards and Hazard Mitigation
3. Update on Hazard Mitigation Grant Programs (PDM, HMGP)
4. Hazards to Include in Plan
5. Hazard Mitigation Planning Process
6. Project Scope and Schedule
7. Data Collection and Review of Hazards and Events from 2007-2013
8. Hazard Mitigation Strategies
9. Outreach and Public Involvement
10. Next Steps

TOWN OF BROOKFIELD HAZARD MITIGATION PLAN
ADVISORY COMMITTEE MEETING
OCTOBER 30, 2013

A meeting was held on October 30, 2013 to begin the hazard mitigation planning process. A brief power point presentation was used to provide structure for the meeting. A copy is attached.

The meeting attendees included:

- Bill Davidson, First Selectman
- George Walker, Selectman
- Howard Lasser, Selectman
- Ralph Tedesco, Director of Public Works
- Wayne Gravius, Fire Marshal
- Katherine Daniel, Land Use
- James Purcell, Police/EMD
- David Hannon, HVCEO
- David Murphy, P.E., CFM, Milone & MacBroom, Inc.

The following were discussion points:

- Critical facilities:
  - The EOC is the Police Station.
  - The Public Works garage is in the flood risk zone. The town would eventually like to relocate the facility to an area with lower flood risk.
  - The town has two fire houses and one ambulance facility.
  - Brookfield High School is the main shelter and can accommodate overnight guests.
  - The YMCA is used for showers but it is not a formal shelter. However, given its importance during disasters, this is a critical facility. Standby power is desired.
  - The town would like a shelter on the west side, and have targeted Huckleberry Hill School for this purpose. The town wishes to renovate the school, and the renovations may include elements that make it easier to be a shelter, but this has not been financed or approved yet.
  - Several sewer pumping stations are critical facilities. The station that collects all sanitary wastewater and pumps it to Danbury is the most important. Some of these have access to standby power, and the sewer commission has a few portable generators. Additional standby power is desired for these.
  - Water pumping stations and the water tank are also critical facilities.
  - The town hall is a critical facility although the town's IT system is backed up at the PD.
  - Assisted living at 246 Federal Road
  - Elderly housing at "Brooks Quarry"
  - The town uses CT Alert.
  - The Board of Education has its own email blast system.
  - Two substations are located in Brookfield, plus the high tension lines. However these are not to be considered critical facilities.

- Because the Still River cuts through town, attendees are concerned about impaired east-west access during floods. Bridges in Brookfield could be compromised. The town does have a few north-south routes.

- During the snow load disaster in January 2011, lots of snow removal was done throughout Brookfield, including the schools. Three or four barns collapsed. As a result of this disaster, the town is more conscious of snow build-up.

- T.S. Irene caused moderate flooding in Brookfield. The wind and power outage were worse than the flooding. Approximately 49,000 cubic feet of brush was generated. The power outage lasted up to eight days, with some areas approaching two weeks.

- A straight-line wind event of May 2011 caused three to four days without power. This storm affected a section of the town, but not surrounding towns.

- Winter Storm Alfred caused more than a week without power. The shelter was opened for the first time in many years to accommodate overnight guests.

- Sandy caused damage in Brookfield, but not as much as Irene and Alfred.

- Winter Storm Nemo caused 18 inches of snow, so it wasn't too bad in Brookfield.

- Brookfield maintains an aggressive tree and tree limb trimming program. The annual budget is $75,000. The town owns two chippers and contracts the bucket trucks. The tree warden reports to the Public Works director. Attendees do not believe that CL&P conducts more than routine trimming in Brookfield. The utility's efforts do not seem overly proactive.

- Development trends were discussed:

    - The existing economic hub of Brookfield (businesses along Federal Road) is along the Still River, and many businesses have flood risk.
    - The town hopes to create a dense mixed-use village type area around Four Corners. Most of the development in the coming years will be located there. Approximately 250 to 300 units of multi-family housing are approved.
    - No subdivisions are currently pending or approved for construction in Brookfield.
    - The Inland Wetland Commission is believed to be relatively strict in its reviews.
    - In general, residentially-zoned areas are not coincident with FEMA flood zones. However, some non-residential zoning is coincident with FEMA flood zones.
    - There haven't been any recent open space acquisitions, although some conservation easements have been secured in recent years. Some of these easements have included steep slopes.
    - The Erickson Farm open space acquisition did not include any specific areas of hazard risk.
    - Utilities must be underground in new developments.

- Drainage and flooding complaints typically come to the Public Works office, and they are addressed as needed. Complaints directed to the Police and Fire Departments are assigned a tracking number.

- Most of the flood problems in Brookfield are well-understood. Three areas of the Still River corridor experience the worst flooding: Lower Federal Road, Sand Cut Road, and Dean Road. The Dean Road area includes commercial and residential buildings. A flood gauge in Brookfield helps town officials watch for flooding conditions and respond accordingly. However, the Public Works Department's greatest problem in Brookfield is flood response and mitigation.

- Attendees believe that vegetative debris in the Still River has contributed to flooding. Mr. Hannon noted that the construction of the Route 7 expressway has also occupied land that used to serve as the floodplain.

- Meadowbrook Manor is a key area of concern, as several homeowners have suffered flood damage in this neighborhood. Drainage systems and watercourse conveyances are believed undersized, and the town would like to increase capacities.

- A pond near Merwin Brook Road (tributary to Merwin Brook) may have caused some nuisance flooding in the past, but this may have been resolved.

- The Raymour and Flanagan shopping center suffers from repeated flooding. The Webster Bank and Sounds Incredible stores are believed to be damaged as well. This is near West Brook.

- Hollow Oak Lane flooded about 15 years ago [this may be T.S. Floyd]. The road is located along a stream that is a tributary to West Brook.

- Washouts of the railroad tracks (beneath the tracks) occurred in the past at Vail Road and near Sunset Hill Road. An old Sears building was partially collapsed.

- Brookfield maintains a paving program with catch basin and drainage replacements, but up-sizing is not automatically done. The town does not have a catch basin cleanout program, but owns the equipment. The current approach is to address cleanouts as they are needed. A more proactive approach is desired.

- Wind risks are higher along Long Meadow Hill Road and Mist Hill Drive, because the elevations are higher. Wind shear can be a problem in these areas. A tornado was confirmed a few years ago.

- Elbow Hill Road and North Mountain Road are steep and have many turns. Snow/accident risks are greater on these roads. North Obtuse Road and Obtuse Road have similar risks.

- The town plows 100 miles of roads. The MgCl/salt mixture is used for deicing. The town owns a dozen plow trucks. Town plowing is typically ahead of CT DOT plowing.

- Dams are not a concern in Brookfield.

- Minor brush fires have occurred, but nothing significant has occurred in a very long time. Small fires along the railroad tracks are started by the trains, but these are addressed quickly.

- The public water system along Federal Road is almost complete. This corridor will have fire protection. Outlying areas are served by almost 50 dry hydrants, some with fire ponds. Regulations currently require any development with more than three houses to include a 30,000 gallon cistern for fire protection.

- Two high pressure gas lines in Brookfield are a concern. The Iroquois line includes a compression station and a meter station. The Algonquin line includes a meter station. Both are 24-inch pipes, but they will reportedly be upgraded to 50-inch pipes.

- The town's Fire Department has mutual aid agreements. They have two vehicles that can fight fires off-road. They also have a pumper boat on Candlewood Lake and other watercraft-based equipment.

- The town has a height restriction of 42 feet, which may help reduce earthquake damage risks along with adherence to the state building code. Critical facilities are believed to be resilient.

- Mr. Murphy asked attendees to brainstorm a few mitigation ideas:

    - The most important mitigation action is the Meadowbrook Manor drainage project.
    - Generators for the YMCA and Huckleberry Hill School are desired. The high school needs increased capacity of its standby power. The sewer pumping stations could use additional generators.
    - Relocation of the Public Works building from the flood hazard area is a long-term goal.
    - Flood mitigation at the Raymour and Flanagan/Webster Bank plaza is desired.
    - The town is not interested in home acquisitions.
    - Power transmission is a critical issue in Brookfield, and mitigation ideas to prevent outages are desired.

- The Still River corridor was discussed in the context of mitigation. Tree blockages are believed to be a problem. The Still River greenway project can help address this problem. As people become more connected to the river, cleanups can be coordinated. However, the central part of the town will still remain in the flood risk zone along the river. The attendees do not have a strong opinion about whether the town should be involved in assisting property owners with reducing flood risk, or whether the free market and insurance industries should lead to solutions for these property owners.

Development of Hazard Mitigation Plan for the Town of Brookfield

Presented by:
David Murphy, P.E., CFM
Milone & MacBroom, Inc.

October 30, 2013

PRE-DISASTER MITIGATION

HMGP HAZARD MITIGATION GRANT PROGRAM

MILONE & MACBROOM

Purpose and Need for a Hazard Mitigation Plan

- Authority
  - Disaster Mitigation Act of 2000 (amendments to Stafford Act of 1988)
- Goal of Disaster Mitigation Act
  - Encourage disaster preparedness
  - Encourage hazard mitigation measures to reduce losses of life and property
- Status of Plans in Connecticut
  - Most initial plans developed 2005-2010
  - A few areas of the State remain
  - The State hazard mitigation plan is updated every three years; local plans are updated every five years

MILONE & MACBROOM

What is a Natural Hazard?

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



MILONE & MACBROOM

What is Hazard Mitigation?

- Actions that reduce or eliminate long-term risk to people, property, and resources from natural hazards and their effects


MILONE & MACBROOM

Long-Term Goals of Hazard Mitigation

- Reduce loss of life and damage to property and infrastructure
- Reduce the costs to residents and businesses (taxes, insurance, repair costs, etc.)
- Educate residents and policy-makers about natural hazard risk and vulnerability
- Connect hazard mitigation planning to other community planning efforts
- Enhance and preserve natural resource systems in the community

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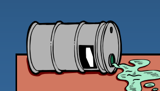
What a Hazard Mitigation Plan Does Not Address

- Terrorism and Sabotage
- Disaster Response and Recovery

- Human Induced Emergencies (some fires, hazardous spills and contamination, disease, etc.)



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Update on Hazard Mitigation Grant Programs

- Local communities must have a FEMA-approved Hazard Mitigation Plan in place to receive Federal Grant Funds for Hazard Mitigation Projects
  - PDM (Pre-Disaster Mitigation)
  - HMGP (Hazard Mitigation Grant Program)
  - FMA (Flood Mitigation Assistance)
- Connecticut has >$20M to distribute under HMGP

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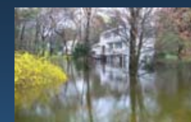
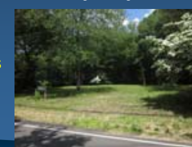
Update on Hazard Mitigation Grant Programs

- 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



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Update on Hazard Mitigation Grant Programs

Culvert Replacement to be funded by HMGP

Floyd 1999

Irene 2011

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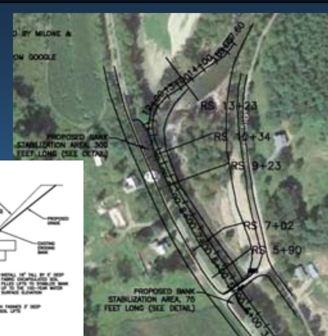
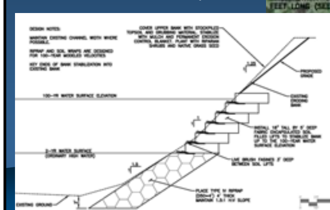
Update on Hazard Mitigation Grant Programs

Riverbank Stabilization to be funded by HMGP





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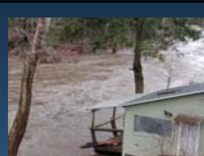
Proposed Hazards to Include in the Plan

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



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Hazards Proposed to Include in the Plan

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

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Components of Hazard Mitigation Plan Process

- Review natural hazards that could occur in Brookfield
- Review the vulnerability of structures and populations and identify critical facilities and areas of concern
- Incorporate effects of federally declared disasters that have occurred in the last few years:
  - ✓ March 2010 floods
  - ✓ Winter snow loads/collapsing roofs in January 2011
  - ✓ Tropical Storm Irene in August 2011 (and T.S. Lee afterward)
  - ✓ Winter Storm Alfred in October 2011
  - ✓ Hurricane Sandy in October 2012
  - ✓ Winter Storm Nemo in February 2013

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Components of Hazard Mitigation Plan Process

- Assess adequacy of mitigation measures currently in place such as regulations and drainage projects
- Develop mitigation goals, strategies, and actions
- Outreach to stakeholders and neighboring towns
- HAZUS vulnerability/risk analysis
- Public participation
- Develop plan document
- State and FEMA approvals
- Local adoption

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Scope of Services and Schedule

- Task 1 – Project Initiation and Data Collection: October-November 2013
- Task 2 – Risk and Vulnerability Assessment: November 2013
- Task 3 – Strategy and Plan Development: December 2013
- Task 4 – DEMHS and FEMA Review and Plan Adoption: January 2014 and continuing as needed

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Data Collection and Discussion

- What are Brookfield’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?
- Repetitive loss properties

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Data Collection and Discussion

- Have any bridges, culverts, or stormwater systems been replaced or upgraded recently?
- Areas prone to wind damage or increased wind damage risk
- Tree maintenance and tree warden budget
- Snow and ice removal routes and capabilities
- Areas prone to icing or drifts in winter
- Dams and effects of dam failure
- Areas without fire protection and use of dry hydrants and cisterns
- Areas prone to wildfires, fire department capabilities, coordination with nearby municipalities

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Hazard Mitigation Strategies

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Examples of 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 Brookfield

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

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Next Steps

- Outreach and public involvement
  - Coordination with other HVCEO municipalities
  - Public information meeting
- Materials needed or resulting from this meeting
  - POCD, Regulations, and zoning map are on town web site
  - Are any specific ordinances related to hazard mitigation?
  - Is flood damage prevention included in the municipal code?

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Brookfield Hazard Mitigation Plan

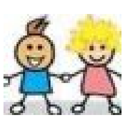
Posted by David Murphy , November 12, 2013 at 11:06 AM

Tropical Storm Irene, October snowstorm Alfred, and Superstorm Sandy are recent events that caused severe damage and resulted in Federal disaster declarations. Flooding, heavy snow, wind, and downed power lines cause damage to property, disrupt our daily routines, close our schools and businesses, and jeopardize the health and safety of the citizens of Brookfield.

What can be done to minimize our vulnerabilities to natural hazards? The Town of Brookfield is developing a hazard mitigation plan to identify activities that can be undertaken before natural hazards occur in order to minimize property damage, risk of life, and the costs that are shared by all. The plan will discuss the occurrence and consequences of floods, winter storms, tornadoes, hurricanes and tropical storms, wildfires, earthquakes, and dam failure. The plan will outline the steps that Brookfield can take to mitigate for future natural hazards.

In order to gain input to the hazard mitigation planning process, the Town will be hosting an informational meeting on Tuesday, November 19 at 7 PM in the Town Hall. For more information, please contact the office of the Brookfield First Selectman at (203) 775-7301.

Related Stories



The Mom Connection

Prince of Peace Youth Group hosts a Fall fundraiser dinner f...

Bye Bye Rocco's - we'll miss you like Pasta Garden

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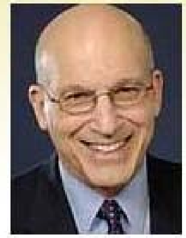
CONNECTICUT INTELLIGENCE CENTER

If You See Something, Say Something

Welcome to Brookfield, CT



We encourage residents to check this website frequently to learn about government activities and meetings, to find answers to questions, to utilize Town Hall services and to access municipal information electronically. You can learn about upcoming events by using "News & Announcements" on the HOME page, download a wide-variety of documents and forms from various departments, navigate to specific web pages of Town Hall departments, boards and commissions, and subscribe to the Town Hall Newsletters.

Please feel free to use the "Contact Us" button (left column of HOME page) to submit your comments or suggestions about our website or about Brookfield Matters. We are eager to maintain and improve the website as an effective and informative tool for our residents and others.

Brookfield is the home of 16,500 residents who have the good fortune to live in the beautiful rolling hills of western Connecticut. The two largest lakes in Connecticut border the Town, Candlewood Lake to the west and Lake Lillinonah to the east. Our citizens enjoy outstanding recreational facilities and spectacular scenery. The Town has a wide variety of home styles and values, excellent schools and a vibrant commercial district. This website is planned to help you discover Brookfield and the many Town services that are available to our residents.

Bill Davidson
First Selectman

News & Announcements

Brookfield Hazard Mitigation Plan Meeting on 11/19 at 7p.m. Room 133
Posted 11/8/13

November 2013 edition of Brookfield Matters is now available
Posted 11/7/13

Veterans Information and Contact Person for the community
Posted 10/29/13

Another Brookfield Success: Our Financial Rating Just Upgraded to "AAA" by S&P

Town Calendar

November 2013

Sun	Mon	Tue	Wed	Thu	Fri	Sat
27	28	29	30	31	01	02
03	04	05	06	07	08	09
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
01	02	03	04	05	06	07

Tue November 19

All Day
Auditors - Room booked AM & PM
Room 133

7:00 PM
Economic Development Commission
Room 209

7:00 PM
FEMA Hazard Mitigation Plan Meeting
Room 133

7:00 PM
Municipal Building Committee
Room 129

7:00 PM
Brookfield Soccer
Room 119

7:30 PM
Republican Town Committee
Room 135

MORE

ldct.gov/Pages/BrookfieldCT_News/01C025CA-000F8513... Internet

TOWN OF Brookfield CONNECTICUT

Search

FEMA Hazard Mitigation Plan Meeting

Tuesday, November 19, 2013 at 7:00 PM
Room 133

Printer-Friendly Version

CT Alert
WE CAN'T ALERT YOU...

Town of Brookfield
First Selectman's Office
Contact Info:
203-775-7301
firstselectman@brookfieldct.gov

FOR IMMEDIATE RELEASE

November 8, 2013

PUBLIC INVITED TO PARTICIPATE IN THE DEVELOPMENT OF THE

BROOKFIELD HAZARD MITIGATION PLAN

Tropical Storm Irene, October snowstorm Alfred and Superstorm Sandy are recent events that caused severe damage and resulted in Federal disaster declarations. Flooding, heavy snow, wind, and downed power lines cause damage to property, disrupt our daily routines, close our schools and businesses and jeopardize the health and safety of the citizens of Brookfield.

What can be done to minimize our vulnerabilities to natural hazards? The Town of Brookfield is developing a hazard mitigation plan to identify activities that can be undertaken before natural hazards occur in order to minimize property damage, risk of life and the costs that are shared by all. The plan will discuss the occurrence and consequences of floods, winter storms, tornadoes, hurricanes and tropical storms, wildfires, earthquakes, and dam failure. The plan will outline the steps that Brookfield can take to mitigate for future natural hazards.

In order to gain input to the hazard mitigation planning process, the Town will be hosting an informational meeting on **Tuesday, November 19 at 7 PM in the Town Hall, Room 133**. For residents and business owners who are unable to attend the meeting, comments can be sent to the Housatonic Valley Council of Elected Officials, 162 Whisconier Road, Brookfield, CT 06804. For more information, please contact the office of the Brookfield First Selectman at (203) 775-7301.

Natural Hazard Mitigation Plan
Town of Brookfield

Presented by:
David Murphy, P.E. CFM
Milone & MacBroom, Inc.

November 19, 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

MILONE & MACBROOM

What is Hazard Mitigation?

- Actions that reduce or eliminate long-term risk to people, property, and resources from natural hazards and their effects

MILONE & MACBROOM

Long-Term Goals of Hazard Mitigation

- Reduce loss of life and damage to property and infrastructure
- Reduce the cost to residents, businesses, and taxpayers
- Educate residents and policy-makers about natural hazard risk and vulnerability
- Connect hazard mitigation planning to other community planning efforts
- Enhance and preserve natural resource systems in the community

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How Can the 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

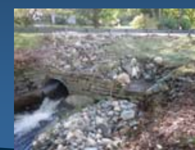
This home in Trumbull was acquired and demolished using a FEMA grant

MILONE & MACBROOM

How Can the Plans be Used?

Culvert Replacement to be funded by HMGP

Floyd 1999



Irene 2011

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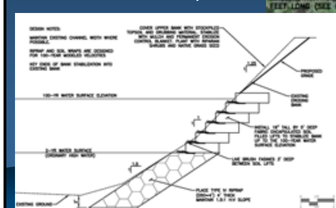
How Can the Plans be Used?

Riverbank Stabilization to be funded by HMGP



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Components of Hazard Mitigation Planning Process

- Identify natural hazards that could occur in Brookfield
- Assess the vulnerability of structures and populations and identify critical facilities and areas of concern
- Incorporate effects of federally declared disasters that have occurred in the last few years:
  - ✓ 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 document
- State and FEMA approvals
- Local adoption

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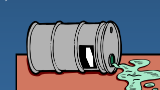
What a Hazard Mitigation Plan Does Not Address

- 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 Brookfield

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



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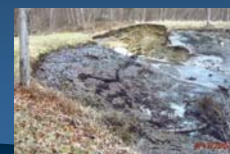
Primary Natural Hazards Facing Brookfield

- Winter storms and nor'easters
- Earthquakes
- Wildfires
- Dam failure





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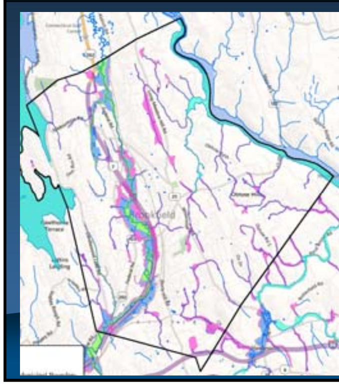
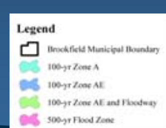
Floods



- Riverine/Overbank:
  - Still River
  - West Brook
  - Limekiln Brook
- Shallow/Nuisance
- Poor drainage
  - Meadowbrook Manor



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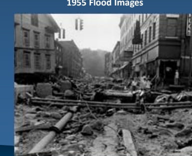
Hurricanes and Tropical Storms

- Strong winds
- Heavy rain
- Floods

1955 Flood Images

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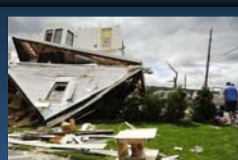
Summer Storms and Tornadoes

- Tornadoes
- Downbursts
- Lightning
- Heavy rain
- Hail



Tornado photos courtesy of the Hartford Courant


Milone & MacBroom

Winter Storms and Nor'easters

- Blizzards and nor'easters
- Heavy snow and drifts
- Freezing rain and ice
- Downed trees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Winter Storms and Nor'easters

- Collapsed Buildings

Photos courtesy of the Hartford Courant

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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 in Brookfield or upstream

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
- Develop mitigation strategies
- Prepare draft plans for review by the town and the public
- Adopt and implement the plan
- Seek hazard mitigation funds

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TOWN OF BROOKFIELD HAZARD MITIGATION PLAN
PUBLIC OUTREACH MEETING
NOVEMBER 30, 2013

A meeting was held on November 19, 2013 at 7:00pm to educate and answer any questions the public may have about the hazard mitigation planning process. A 30-minute power point presentation was given by David Murphy, P.E., CFM of Milone & MacBroom, Inc. followed by a 30-minute open discussion, addressing areas of concern.

The meeting attendees included:

- Bill Davidson, First Selectman
- Ralph Tedesco, Director of Public Works
- David Hannon, HVCEO
- 4 Brookfield Residents from the Meadow Brook Manor Neighborhood
- David Murphy, P.E., CFM, Milone & MacBroom, Inc.
- Craig Southern, CFM, Milone & MacBroom, Inc.

The following were discussion points:

- Candlewood Lake Road and Federal Road is an area that is historically known for flooding.
- Located in the Limekiln Brook watershed, the Meadow Brook Manor Neighborhood has been having stormwater system issues with clogged curb-inlets and outfalls; an outfall pipe located on Hillside Court has been scoured with much of the stabilizing soil matrix being eroded away. Ralph Tedesco, Director of Public Works indicated that a plan to divert water flow has been made with a new outfall pipe.
- A HMGP grant has been applied for and is being reviewed by CT DEMHS but the future approval of the proposed Hazard Mitigation Plan with help ensure that a grant can be awarded.
- Bill Davidson, First Selectman and Ralph Tedesco, Director of Public Works indicated to the residents from Meadow Brook Manor Neighborhood that there are roughly four phases or steps that the Town is taking to remedy flooding related issues: review and approval of the water diversion permit application, adoption of the Hazard Mitigation Plan, the application for hazard mitigation grants, and design of the drainage project.
- A future referendum will have to take place for the residents of Brookfield to approve or reject the Town implementing the estimated $2 million project for Meadowbrook Manor.

Carol Kaliff/Staff photographer

for the day

34, shovels the whole sidewalk up and down Meadow Street where he lives in Danbury, on
ng so "no one will get hurt" in the slippery snow.

uthority to
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ld at 7:30
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of The Stony Hill Inn, a landmark motel and inn that was torn down last year.

The inn served the community for more than 60 years.

The Historical Society is looking for photographs, videos, stories and interviews to include in the project.

Contact Marc Moorash at marc@bethelhistoricalsociety.com

The first version of the film will be premiered in April, when The Bethel Museum reopens for 2014 with new exhibits, including a display of memorabilia from, and relating to, The Stony Hill Inn.

Newtown

Idol ambassador

Former "American Idol" winner Scotty McCreery has been named the first "National Goodwill Ambassador" for the locally based 12.14 Foundation.

The platinum-selling country music singer, who visited with families of victims prior to the first anniversary of the tragedy, will play an "active role in promoting the foundation's arts programming, supporting its fundraising efforts and building awareness for the organization's plans to build a world-class performing arts and education center in Newtown."

"I'm honored to support the 12.14 Foundation, and greatly admire both the mission and work of this remarkable organization," McCreery said in a news release. "As a songwriter and performer, I know that music can bring hope and inspiration to those struggling to overcome great adversity. The foundation's vision of helping children and others heal through the performing arts really hits home for me as an entertainer. I will do everything I can to help communities affected by tragedy to heal and gain strength through the work of the 12.14 Foundation."

Brookfield

Flood mitigation

For the last two years, Meadowbrook Manor residents have been working to get public attention for their neighborhood's flooding problems, and there is progress in their application for federal funds to help with mitigation.

First Selectman Bill Tinsley said the neighborhood has just made the cut from 125 applications to 35 that are being reviewed as possible recipients of mitigation funds. The estimated cost to do a major renovation of storm drainage in that area is about $2.2 million. Tinsley said there is no guarantee that the funds will be granted, but said the project is at least under consideration.

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WEATHER

Have you had enough snow?

Page A5

Brookfield Selectmen Make Meadow Brook Manor Flooding a High Priority

Nanci G. Hutson, Staff Writer, Danbury News-Times
Friday, October 7, 2011

BROOKFIELD -- Mike Mascola of Hillside Circle showed telling photos to the Board of Selectmen of recent flooding in which he was neck deep in water trying to unclog a storm drain near his house. Standing behind him on dry ground were two highway workers. One leaned on a shovel as Mascola cleaned out the drain.

Mascola, a Meadow Brook Manor resident for 18 years, said he was enraged that he and his two teenage sons were getting wet while the town employees took no action. The workers, he said, claimed the problem is that the drains can't handle the volume of water from the recent storms.

Mascola disputed that notion. Once the drains are unclogged, he said, the water begins to recede, so his neighbors do not have a river roaring through their yards and into their homes.

Poor storm drainage has plagued the Meadow Brook Manor neighborhood -- now 128 homes -- for years, and during major storms the roads become impassable.

Mascola described the water flow as so swift and strong, "you could go white-water rafting" through their backyards. "It's just appalling," he said to the selectmen Monday night about the situation and the town's response to it.

First Selectman Bill Davidson told the residents that "We'll have a chit-chat with a couple employees." Davidson and fellow selectmen Howard Lasser and Steve O'Reilly, agreed that the neighborhood deserves a remedy soon.

The town needs to review the engineering plans drawn up a decade ago to see whether they can be updated and the flood water rerouted, they said. Davidson said it is unlikely to be a quick or easy fix. The cost could be "north of a million dollars," but it must be a priority, he said.

Several residents noted after Tropical Storm Irene some schoolchildren were forced to slog through the water-filled streets to get to the bus stop. Drinking water is often compromised, and flooded roads prevent emergency vehicles from entering the neighborhood, posing a potentially life-threatening situation, they said.

"There is a pipe with a deteriorated cement covering, with holes large enough for children to fall through," said Will Meikle, of Hillside Circle, who with his wife, Jean Harnett, organized the presentation to the selectmen. The couple have lived in the neighborhood about six years, and emphasized that the area was developed in 1956 with 36 homes.

Cars have been ruined, septic systems have failed and driveways have been destroyed, Meikle said. Some have lost furniture and other household contents when water backed up into their houses, he said.

Longtime resident Donna Sedlack of Hillside Circle said she and her neighbors are tired of empty promises. They want action. "We are very frustrated," she said. "We need this rectified. It's a safety issue."

APPENDIX C
HAZUS DOCUMENTATION

Hazus-MH: Flood Event Report

Region Name: Brookfield, CT Flood

Flood Scenario: East Brook 100 Year

Print Date: Tuesday, December 17, 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 20 square miles and contains 226 census blocks. The region contains over 6 thousand households and has a total population of 15,664 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 6,427 buildings in the region with a total building replacement value (excluding contents) of 1,743 million dollars (2006 dollars). Approximately 88.72% of the buildings (and 68.86% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,427 buildings in the region which have an aggregate total replacement value of 1,743 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	1,200,050	68.9%
Commercial	337,007	19.3%
Industrial	93,672	5.4%
Agricultural	4,581	0.3%
Religion	78,890	4.5%
Government	11,571	0.7%
Education	16,968	1.0%
Total	**1,742,739**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	22,823	35.5%
Commercial	37,719	58.6%
Industrial	3,749	5.8%
Agricultural	0	0.0%
Religion	0	0.0%
Government	71	0.1%
Education	0	0.0%
Total	**64,362**	**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 7 schools, 1 fire station, 1 police station and no emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Brookfield, CT Flood
Scenario Name:	East 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	1-10		11-20		21-30		31-40		41-50		Substantially	
Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	1	0	0	0
Hospitals	0	0	0	0
Police Stations	1	0	0	0
Schools	7	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 3 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 2 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 15,664) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 0.14 million dollars, which represents 0.21 % 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 0.14 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 11.76% 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	0.01	0.02	0.00	0.00	0.03
	Content	0.00	0.09	0.01	0.00	0.10
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.02**	**0.10**	**0.02**	**0.00**	**0.14**
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**	**0.02**	**0.10**	**0.02**	**0.00**	**0.14**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Connecticut				
Fairfield	15,664	1,200,050	542,689	1,742,739
Total	**15,664**	**1,200,050**	**542,689**	**1,742,739**
Total Study Region	**15,664**	**1,200,050**	**542,689**	**1,742,739**

Hazus-MH: Flood Event Report

Region Name: Brookfield, CT Flood

Flood Scenario: Limekin 100 Year

Print Date: Tuesday, December 17, 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 20 square miles and contains 226 census blocks. The region contains over 6 thousand households and has a total population of 15,664 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 6,427 buildings in the region with a total building replacement value (excluding contents) of 1,743 million dollars (2006 dollars). Approximately 88.72% of the buildings (and 68.86% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,427 buildings in the region which have an aggregate total replacement value of 1,743 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	1,200,050	68.9%
Commercial	337,007	19.3%
Industrial	93,672	5.4%
Agricultural	4,581	0.3%
Religion	78,890	4.5%
Government	11,571	0.7%
Education	16,968	1.0%
Total	**1,742,739**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	44,768	56.7%
Commercial	16,587	21.0%
Industrial	16,777	21.3%
Agricultural	236	0.3%
Religion	459	0.6%
Government	0	0.0%
Education	71	0.1%
Total	**78,898**	**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 7 schools, 1 fire station, 1 police station and no emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Brookfield, CT Flood
Scenario Name:	Limekin 100 Year
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

General Building Stock Damage

Hazus estimates that about 5 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the scenario. There are an estimated 3 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	2	40.00	3	60.00
Total	**0**		**0**		**0**		**0**		**2**		**3**	

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	2	40.00	3	60.00

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	1	0	0	0
Hospitals	0	0	0	0
Police Stations	1	0	0	0
Schools	7	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 105 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 4 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 14 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 11 people (out of a total population of 15,664) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 2.69 million dollars, which represents 3.40 % 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 2.69 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 63.51% 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	1.14	0.17	0.10	0.01	1.41
	Content	0.57	0.43	0.22	0.02	1.25
	Inventory	0.00	0.01	0.02	0.00	0.03
	Subtotal	**1.71**	**0.61**	**0.34**	**0.03**	**2.69**
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**	**1.71**	**0.61**	**0.34**	**0.03**	**2.69**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Connecticut				
Fairfield	15,664	1,200,050	542,689	1,742,739
Total	**15,664**	**1,200,050**	**542,689**	**1,742,739**
Total Study Region	**15,664**	**1,200,050**	**542,689**	**1,742,739**

Hazus-MH: Flood Event Report

Region Name: Brookfield, CT Flood

Flood Scenario: Still River 100 Year

Print Date: Tuesday, December 17, 2013

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

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There are an estimated 6,427 buildings in the region with a total building replacement value (excluding contents) of 1,743 million dollars (2006 dollars). Approximately 88.72% of the buildings (and 68.86% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,427 buildings in the region which have an aggregate total replacement value of 1,743 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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Occupancy	Exposure ($1000)	Percent of Total
Residential	1,200,050	68.9%
Commercial	337,007	19.3%
Industrial	93,672	5.4%
Agricultural	4,581	0.3%
Religion	78,890	4.5%
Government	11,571	0.7%
Education	16,968	1.0%
Total	**1,742,739**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	91,871	28.5%
Commercial	116,341	36.1%
Industrial	41,637	12.9%
Agricultural	1,056	0.3%
Religion	57,347	17.8%
Government	6,783	2.1%
Education	7,358	2.3%
Total	**322,393**	**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 7 schools, 1 fire station, 1 police station and no emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Brookfield, CT Flood
Scenario Name:	Still River 100 Year
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 25 buildings will be at least moderately damaged. This is over 11% of the total number of buildings in the scenario. There are an estimated 4 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	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	0	0.00	1	4.55	8	36.36	9	40.91	4	18.18
Total	**0**		**3**		**1**		**8**		**9**		**4**	

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	1	100.00	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	1	4.35	1	4.35	8	34.78	9	39.13	4	17.39

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	1	0	0	0
Hospitals	0	0	0	0
Police Stations	1	0	0	0
Schools	7	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 908 tons of debris will be generated. Of the total amount, Finishes comprises 64% of the total, Structure comprises 21% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 36 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 64 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 169 people (out of a total population of 15,664) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 52.71 million dollars, which represents 16.35 % 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 52.46 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 12.40% 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	4.29	5.76	2.13	1.62	13.80
	Content	2.25	17.33	6.50	11.07	37.15
	Inventory	0.00	0.51	0.98	0.03	1.52
	Subtotal	**6.53**	**23.59**	**9.62**	**12.72**	**52.46**
Business Interruption						
	Income	0.00	0.06	0.00	0.03	0.09
	Relocation	0.00	0.01	0.00	0.01	0.02
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.07	0.00	0.06	0.14
	Subtotal	**0.00**	**0.14**	**0.00**	**0.10**	**0.25**
ALL	**Total**	**6.54**	**23.74**	**9.62**	**12.82**	**52.71**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Connecticut				
Fairfield	15,664	1,200,050	542,689	1,742,739
Total	**15,664**	**1,200,050**	**542,689**	**1,742,739**
Total Study Region	**15,664**	**1,200,050**	**542,689**	**1,742,739**

Hazus-MH: Hurricane Event Report

Region Name: Brookfield

Hurricane Scenario: UN-NAMED-1938-4

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

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

The geographical size of the region is 20.37 square miles and contains 3 census tracts. There are over 5 thousand households in the region and has a total population of 15,664 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,743 million dollars (2006 dollars). Approximately 89% of the buildings (and 69% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,427 buildings in the region which have an aggregate total replacement value of 1,743 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	1,200,050	68.9%
Commercial	337,007	19.3%
Industrial	93,672	5.4%
Agricultural	4,581	0.3%
Religious	78,890	4.5%
Government	11,571	0.7%
Education	16,968	1.0%
Total	**1,742,739**	**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 7 schools, 1 fire stations, 1 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	UN-NAMED-1938-4
Type:	Historic
Max Peak Gust in Study Region:	95 mph

Building Damage

General Building Stock Damage

Hazus estimates that about 43 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	31	92.30	2	6.11	0	1.10	0	0.47	0	0.03
Commercial	435	94.21	23	4.92	4	0.77	0	0.10	0	0.00
Education	15	94.95	1	4.74	0	0.30	0	0.00	0	0.00
Government	10	95.01	1	4.69	0	0.30	0	0.00	0	0.00
Industrial	144	94.58	7	4.81	1	0.50	0	0.10	0	0.00
Religion	47	94.57	3	5.13	0	0.29	0	0.01	0	0.00
Residential	5,226	91.65	439	7.70	37	0.64	0	0.01	0	0.00
Total	**5,909**		**475**		**42**		**1**		**0**	

Table 3: Expected Building Damage by Building Type

Building	None		Minor		Moderate		Severe		Destruction	
Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	82	94.63	4	4.98	0	0.39	0	0.00	0	0.00
Masonry	543	92.27	37	6.31	8	1.35	0	0.07	0	0.00
MH	9	99.65	0	0.28	0	0.06	0	0.00	0	0.00
Steel	323	94.78	15	4.34	3	0.76	0	0.12	0	0.00
Wood	4,976	92.04	405	7.50	24	0.45	1	0.01	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	1	0	0	1
Police Stations	1	0	0	1
Schools	7	0	0	7

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 8,088 tons of debris will be generated. Of the total amount, 4,257 tons (53%) is Other Tree Debris. Of the remaining 3,831 tons, Brick/Wood comprises 29% 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 45 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 2,707 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 1 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 15,664) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 10.5 million dollars, which represents 0.60 % 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 10 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 85% 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	7,813.96	617.15	140.40	210.71	8,782.23
	Content	736.67	74.37	41.38	22.14	874.56
	Inventory	0.00	2.08	6.77	0.48	9.33
	Subtotal	**8,550.63**	**693.60**	**188.54**	**233.34**	**9,666.11**
Business Interruption Loss						
	Income	0.00	58.44	0.68	49.57	108.69
	Relocation	206.22	77.27	5.35	31.76	320.60
	Rental	122.41	42.74	0.70	3.16	169.01
	Wage	0.00	73.52	1.13	116.54	191.20
	Subtotal	**328.63**	**251.97**	**7.86**	**201.02**	**789.49**
Total						
	Total	**8,879.26**	**945.57**	**196.41**	**434.36**	**10,455.60**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Connecticut				
Fairfield	15,664	1,200,050	542,689	1,742,739
Total	**15,664**	**1,200,050**	**542,689**	**1,742,739**
Study Region Total	**15,664**	**1,200,050**	**542,689**	**1,742,739**

Hazus-MH: Hurricane Event Report

Region Name: Brookfield

Hurricane Scenario: GLORIA

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

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

The geographical size of the region is 20.37 square miles and contains 3 census tracts. There are over 5 thousand households in the region and has a total population of 15,664 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,743 million dollars (2006 dollars). Approximately 89% of the buildings (and 69% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,427 buildings in the region which have an aggregate total replacement value of 1,743 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	1,200,050	68.9%
Commercial	337,007	19.3%
Industrial	93,672	5.4%
Agricultural	4,581	0.3%
Religious	78,890	4.5%
Government	11,571	0.7%
Education	16,968	1.0%
Total	**1,742,739**	**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 7 schools, 1 fire stations, 1 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	GLORIA
Type:	Historic
Max Peak Gust in Study Region:	61 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	34	99.83	0	0.17	0	0.00	0	0.00	0	0.00
Commercial	461	99.77	1	0.23	0	0.00	0	0.00	0	0.00
Education	16	99.76	0	0.24	0	0.00	0	0.00	0	0.00
Government	11	99.74	0	0.26	0	0.00	0	0.00	0	0.00
Industrial	152	99.75	0	0.25	0	0.00	0	0.00	0	0.00
Religion	50	99.80	0	0.20	0	0.00	0	0.00	0	0.00
Residential	5,701	99.98	1	0.02	0	0.00	0	0.00	0	0.00
Total	**6,424**		**3**		**0**		**0**		**0**	

Table 3: Expected Building Damage by Building Type

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	87	99.71	0	0.29	0	0.00	0	0.00	0	0.00
Masonry	586	99.73	2	0.27	0	0.00	0	0.00	0	0.00
MH	9	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	340	99.74	1	0.26	0	0.00	0	0.00	0	0.00
Wood	5,405	99.99	0	0.01	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	1	0	0	1
Police Stations	1	0	0	1
Schools	7	0	0	7

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 tons of debris will be generated. Of the total amount, 0 tons (0%) is Other Tree Debris. Of the remaining 2 tons, Brick/Wood comprises 100% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 0 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 15,664) 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 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	9.99	0.00	0.00	0.00	9.99
	Content	0.00	0.00	0.00	0.00	0.00
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**9.99**	**0.00**	**0.00**	**0.00**	**9.99**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.06	0.00	0.00	0.00	0.06
	Rental	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.06**	**0.00**	**0.00**	**0.00**	**0.06**
Total						
	Total	**10.05**	**0.00**	**0.00**	**0.00**	**10.05**

<u>**Appendix A: County Listing for the Region**</u>

Connecticut
- Fairfield

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Connecticut				
Fairfield	15,664	1,200,050	542,689	1,742,739
Total	**15,664**	**1,200,050**	**542,689**	**1,742,739**
Study Region Total	**15,664**	**1,200,050**	**542,689**	**1,742,739**

Hazus-MH: Hurricane Event Report

Region Name: Brookfield

Hurricane Scenario: Probabilistic 10-year Return Period

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

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General Description of the Region

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- Connecticut

Note:
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There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,743 million dollars (2006 dollars). Approximately 89% of the buildings (and 69% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,427 buildings in the region which have an aggregate total replacement value of 1,743 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	1,200,050	68.9%
Commercial	337,007	19.3%
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Agricultural	4,581	0.3%
Religious	78,890	4.5%
Government	11,571	0.7%
Education	16,968	1.0%
Total	**1,742,739**	**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 7 schools, 1 fire stations, 1 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 10 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	34	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	462	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	16	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	11	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	152	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	50	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	5,702	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**6,427**		**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	87	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	588	100.00	0	0.00	0	0.00	0	0.00	0	0.00
MH	9	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	341	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	5,406	100.00	0	0.00	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	1	0	0	1
Police Stations	1	0	0	1
Schools	7	0	0	7

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 15,664) 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
- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Connecticut				
Fairfield	15,664	1,200,050	542,689	1,742,739
Total	**15,664**	**1,200,050**	**542,689**	**1,742,739**
Study Region Total	**15,664**	**1,200,050**	**542,689**	**1,742,739**

Hazus-MH: Hurricane Event Report

Region Name: Brookfield

Hurricane Scenario: Probabilistic 20-year Return Period

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

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The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

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

The geographical size of the region is 20.37 square miles and contains 3 census tracts. There are over 5 thousand households in the region and has a total population of 15,664 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,743 million dollars (2006 dollars). Approximately 89% of the buildings (and 69% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,427 buildings in the region which have an aggregate total replacement value of 1,743 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	1,200,050	68.9%
Commercial	337,007	19.3%
Industrial	93,672	5.4%
Agricultural	4,581	0.3%
Religious	78,890	4.5%
Government	11,571	0.7%
Education	16,968	1.0%
Total	**1,742,739**	**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 7 schools, 1 fire stations, 1 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 20 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	34	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	462	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	16	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	11	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	152	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	50	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	5,702	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**6,427**		**0**		**0**		**0**		**0**	

Table 3: Expected Building Damage by Building Type : 20 - year Event

Building	None		Minor		Moderate		Severe		Destruction	
Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	87	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	588	100.00	0	0.00	0	0.00	0	0.00	0	0.00
MH	9	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	341	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	5,406	100.00	0	0.00	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	1	0	0	1
Police Stations	1	0	0	1
Schools	7	0	0	7

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 15,664) 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

- Fairfield

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Connecticut				
Fairfield	15,664	1,200,050	542,689	1,742,739
Total	**15,664**	**1,200,050**	**542,689**	**1,742,739**
Study Region Total	**15,664**	**1,200,050**	**542,689**	**1,742,739**

Hazus-MH: Hurricane Event Report

Region Name: Brookfield

Hurricane Scenario: Probabilistic 50-year Return Period

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

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

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The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

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

The geographical size of the region is 20.37 square miles and contains 3 census tracts. There are over 5 thousand households in the region and has a total population of 15,664 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,743 million dollars (2006 dollars). Approximately 89% of the buildings (and 69% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,427 buildings in the region which have an aggregate total replacement value of 1,743 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	1,200,050	68.9%
Commercial	337,007	19.3%
Industrial	93,672	5.4%
Agricultural	4,581	0.3%
Religious	78,890	4.5%
Government	11,571	0.7%
Education	16,968	1.0%
Total	**1,742,739**	**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 7 schools, 1 fire stations, 1 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 50 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	34	99.60	0	0.39	0	0.01	0	0.00	0	0.00
Commercial	460	99.51	2	0.48	0	0.01	0	0.00	0	0.00
Education	16	99.50	0	0.50	0	0.00	0	0.00	0	0.00
Government	11	99.48	0	0.52	0	0.00	0	0.00	0	0.00
Industrial	151	99.48	1	0.52	0	0.00	0	0.00	0	0.00
Religion	50	99.60	0	0.39	0	0.01	0	0.00	0	0.00
Residential	5,691	99.81	11	0.19	0	0.01	0	0.00	0	0.00
Total	**6,412**		**14**		**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	86	99.41	1	0.59	0	0.00	0	0.00	0	0.00
Masonry	584	99.36	4	0.62	0	0.02	0	0.00	0	0.00
MH	9	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	339	99.48	2	0.52	0	0.01	0	0.00	0	0.00
Wood	5,398	99.86	7	0.14	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	1	0	0	1
Police Stations	1	0	0	1
Schools	7	0	0	7

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 55 tons of debris will be generated. Of the total amount, 0 tons (0%) is Other Tree Debris. Of the remaining 55 tons, Brick/Wood comprises 100% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 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 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 15,664) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 0.8 million dollars, which represents 0.05 % 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 94% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	786.70	33.70	9.37	10.74	840.51
	Content	3.44	0.00	0.00	0.00	3.44
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**790.13**	**33.70**	**9.37**	**10.74**	**843.95**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	1.37	0.27	0.00	0.05	1.70
	Rental	1.70	0.00	0.00	0.00	1.70
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**3.07**	**0.27**	**0.00**	**0.05**	**3.40**
Total						
	Total	**793.20**	**33.97**	**9.37**	**10.80**	**847.34**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Connecticut				
Fairfield	15,664	1,200,050	542,689	1,742,739
Total	**15,664**	**1,200,050**	**542,689**	**1,742,739**
Study Region Total	**15,664**	**1,200,050**	**542,689**	**1,742,739**

Hazus-MH: Hurricane Event Report

Region Name: Brookfield

Hurricane Scenario: Probabilistic 100-year Return Period

Print Date: Monday, November 18, 2013

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Education	16,968	1.0%
Total	**1,742,739**	**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 7 schools, 1 fire stations, 1 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 6 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	33	98.25	1	1.55	0	0.16	0	0.04	0	0.00
Commercial	455	98.41	7	1.45	1	0.14	0	0.01	0	0.00
Education	16	98.57	0	1.41	0	0.02	0	0.00	0	0.00
Government	11	98.54	0	1.44	0	0.02	0	0.00	0	0.00
Industrial	150	98.44	2	1.49	0	0.05	0	0.01	0	0.00
Religion	49	98.67	1	1.29	0	0.04	0	0.00	0	0.00
Residential	5,597	98.16	100	1.75	5	0.09	0	0.00	0	0.00
Total	**6,311**		**110**		**6**		**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	86	98.36	1	1.62	0	0.02	0	0.00	0	0.00
Masonry	574	97.69	12	2.05	2	0.26	0	0.01	0	0.00
MH	9	99.98	0	0.01	0	0.00	0	0.00	0	0.00
Steel	336	98.47	5	1.40	0	0.13	0	0.01	0	0.00
Wood	5,316	98.34	87	1.61	2	0.05	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	1	0	0	1
Police Stations	1	0	0	1
Schools	7	0	0	7

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 3,277 tons of debris will be generated. Of the total amount, 1,798 tons (55%) is Other Tree Debris. Of the remaining 1,479 tons, Brick/Wood comprises 24% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 14 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 1,129 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 15,664) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 3.7 million dollars, which represents 0.22 % 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. 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 93% 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	3,140.64	163.67	34.74	52.11	3,391.15
	Content	137.32	14.77	3.07	0.46	155.62
	Inventory	0.00	0.31	0.65	0.06	1.01
	Subtotal	**3,277.96**	**178.75**	**38.46**	**52.62**	**3,547.78**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	135.83	3.60	0.26	0.31	140.01
	Rental	61.42	0.00	0.00	0.00	61.42
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**197.25**	**3.60**	**0.26**	**0.31**	**201.42**
Total						
	Total	**3,475.21**	**182.35**	**38.72**	**52.93**	**3,749.21**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Connecticut				
Fairfield	15,664	1,200,050	542,689	1,742,739
Total	**15,664**	**1,200,050**	**542,689**	**1,742,739**
Study Region Total	**15,664**	**1,200,050**	**542,689**	**1,742,739**

Hazus-MH: Hurricane Event Report

Region Name: Brookfield

Hurricane Scenario: Probabilistic 200-year Return Period

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

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

The geographical size of the region is 20.37 square miles and contains 3 census tracts. There are over 5 thousand households in the region and has a total population of 15,664 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,743 million dollars (2006 dollars). Approximately 89% of the buildings (and 69% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,427 buildings in the region which have an aggregate total replacement value of 1,743 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	1,200,050	68.9%
Commercial	337,007	19.3%
Industrial	93,672	5.4%
Agricultural	4,581	0.3%
Religious	78,890	4.5%
Government	11,571	0.7%
Education	16,968	1.0%
Total	**1,742,739**	**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 7 schools, 1 fire stations, 1 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 36 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 : 200 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	32	93.16	2	5.47	0	0.95	0	0.40	0	0.02
Commercial	438	94.89	20	4.37	3	0.66	0	0.08	0	0.00
Education	15	95.51	1	4.24	0	0.24	0	0.00	0	0.00
Government	11	95.55	0	4.21	0	0.25	0	0.00	0	0.00
Industrial	145	95.22	7	4.29	1	0.41	0	0.08	0	0.00
Religion	48	95.21	2	4.54	0	0.24	0	0.01	0	0.00
Residential	5,278	92.57	392	6.87	31	0.55	0	0.00	0	0.00
Total	**5,967**		**424**		**35**		**1**		**0**	

Table 3: Expected Building Damage by Building Type : 200 - year Event

Building	None		Minor		Moderate		Severe		Destruction	
Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	83	95.21	4	4.48	0	0.31	0	0.00	0	0.00
Masonry	547	93.06	34	5.71	7	1.17	0	0.06	0	0.00
MH	9	99.72	0	0.23	0	0.05	0	0.00	0	0.00
Steel	325	95.38	13	3.88	2	0.64	0	0.10	0	0.00
Wood	5,024	92.94	361	6.67	20	0.38	0	0.01	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	1	0	0	1
Police Stations	1	0	0	1
Schools	7	0	0	7

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 7,640 tons of debris will be generated. Of the total amount, 4,064 tons (53%) is Other Tree Debris. Of the remaining 3,576 tons, Brick/Wood comprises 28% 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 40 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 2,569 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 1 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 15,664) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 9.6 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 10 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 85% 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	7,231.98	545.79	120.43	190.23	8,088.43
	Content	613.57	68.14	33.05	20.86	735.63
	Inventory	0.00	1.80	5.40	0.41	7.61
	Subtotal	**7,845.55**	**615.73**	**158.88**	**211.50**	**8,831.67**
Business Interruption Loss						
	Income	0.00	54.40	0.37	48.41	103.18
	Relocation	195.12	66.78	3.70	30.28	295.88
	Rental	113.98	37.26	0.38	3.05	154.67
	Wage	0.00	63.12	0.62	113.82	177.55
	Subtotal	**309.10**	**221.57**	**5.07**	**195.56**	**731.29**
Total						
	Total	**8,154.65**	**837.30**	**163.95**	**407.06**	**9,562.96**

Appendix A: County Listing for the Region

Connecticut
- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Connecticut				
Fairfield	15,664	1,200,050	542,689	1,742,739
Total	**15,664**	**1,200,050**	**542,689**	**1,742,739**
Study Region Total	**15,664**	**1,200,050**	**542,689**	**1,742,739**

Hazus-MH: Hurricane Event Report

Region Name: Brookfield

Hurricane Scenario: Probabilistic 500-year Return Period

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

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

The geographical size of the region is 20.37 square miles and contains 3 census tracts. There are over 5 thousand households in the region and has a total population of 15,664 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,743 million dollars (2006 dollars). Approximately 89% of the buildings (and 69% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,427 buildings in the region which have an aggregate total replacement value of 1,743 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	1,200,050	68.9%
Commercial	337,007	19.3%
Industrial	93,672	5.4%
Agricultural	4,581	0.3%
Religious	78,890	4.5%
Government	11,571	0.7%
Education	16,968	1.0%
Total	**1,742,739**	**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 7 schools, 1 fire stations, 1 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 228 buildings will be at least moderately damaged. This is over 4% of the total number of buildings in the region. There are an estimated 6 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	26	77.54	5	15.86	1	4.28	1	2.08	0	0.24
Commercial	378	81.74	63	13.69	18	3.89	3	0.68	0	0.00
Education	13	83.63	2	13.35	0	2.84	0	0.18	0	0.00
Government	9	84.09	1	12.92	0	2.82	0	0.17	0	0.00
Industrial	125	82.50	20	13.21	5	3.57	1	0.67	0	0.05
Religion	41	82.56	7	14.75	1	2.54	0	0.15	0	0.00
Residential	4,388	76.96	1,118	19.61	180	3.16	9	0.16	6	0.11
Total	**4,982**		**1,218**		**207**		**14**		**6**	

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

Building	None		Minor		Moderate		Severe		Destruction	
Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	72	82.80	12	13.45	3	3.56	0	0.20	0	0.00
Masonry	464	78.86	90	15.28	31	5.33	3	0.47	0	0.06
MH	9	97.64	0	1.62	0	0.63	0	0.01	0	0.10
Steel	283	83.07	41	12.00	14	4.00	3	0.92	0	0.01
Wood	4,188	77.47	1,059	19.59	145	2.68	9	0.16	5	0.10

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	1	0	0	1
Police Stations	1	0	0	1
Schools	7	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 15,842 tons of debris will be generated. Of the total amount, 7,718 tons (49%) is Other Tree Debris. Of the remaining 8,124 tons, Brick/Wood comprises 40% 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 129 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 4,907 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 16 households to be displaced due to the hurricane. Of these, 4 people (out of a total population of 15,664) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 32.1 million dollars, which represents 1.84 % 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 32 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 79% 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	19,844.75	2,190.23	627.66	705.44	23,368.09
	Content	4,172.10	564.84	323.31	137.93	5,198.18
	Inventory	0.00	16.48	49.08	2.90	68.46
	Subtotal	**24,016.85**	**2,771.55**	**1,000.05**	**846.27**	**28,634.72**
Business Interruption Loss						
	Income	0.00	330.32	9.50	97.34	437.16
	Relocation	971.14	412.56	51.40	109.89	1,544.99
	Rental	404.23	235.91	7.55	10.17	657.86
	Wage	0.00	349.89	15.80	425.18	790.87
	Subtotal	**1,375.38**	**1,328.67**	**84.25**	**642.58**	**3,430.87**
Total						
	Total	**25,392.23**	**4,100.22**	**1,084.30**	**1,488.84**	**32,065.59**

Appendix A: County Listing for the Region

Connecticut
- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Connecticut				
Fairfield	15,664	1,200,050	542,689	1,742,739
Total	**15,664**	**1,200,050**	**542,689**	**1,742,739**
Study Region Total	**15,664**	**1,200,050**	**542,689**	**1,742,739**

Hazus-MH: Hurricane Event Report

Region Name: Brookfield

Hurricane Scenario: Probabilistic 1000-year Return Period

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

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The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

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

The geographical size of the region is 20.37 square miles and contains 3 census tracts. There are over 5 thousand households in the region and has a total population of 15,664 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,743 million dollars (2006 dollars). Approximately 89% of the buildings (and 69% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,427 buildings in the region which have an aggregate total replacement value of 1,743 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	1,200,050	68.9%
Commercial	337,007	19.3%
Industrial	93,672	5.4%
Agricultural	4,581	0.3%
Religious	78,890	4.5%
Government	11,571	0.7%
Education	16,968	1.0%
Total	**1,742,739**	**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 7 schools, 1 fire stations, 1 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 609 buildings will be at least moderately damaged. This is over 9% of the total number of buildings in the region. There are an estimated 32 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	20	59.71	9	25.30	3	9.60	2	4.66	0	0.72
Commercial	300	64.95	103	22.32	49	10.51	10	2.20	0	0.02
Education	11	66.61	4	22.50	2	9.65	0	1.24	0	0.00
Government	7	66.78	2	21.97	1	9.96	0	1.29	0	0.00
Industrial	100	65.70	33	21.44	16	10.44	3	2.27	0	0.15
Religion	33	65.40	13	25.00	4	8.61	0	0.99	0	0.00
Residential	3,456	60.61	1,728	30.30	438	7.68	48	0.85	32	0.56
Total	**3,927**		**1,891**		**513**		**64**		**32**	

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

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	57	65.57	19	21.68	10	11.40	1	1.35	0	0.00
Masonry	365	62.05	138	23.39	74	12.66	10	1.67	1	0.23
MH	8	93.05	0	3.90	0	2.42	0	0.13	0	0.50
Steel	226	66.32	67	19.69	38	11.04	10	2.92	0	0.03
Wood	3,303	61.10	1,660	30.71	371	6.87	43	0.80	28	0.52

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	1	0	0	1
Police Stations	1	0	0	1
Schools	7	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 33,899 tons of debris will be generated. Of the total amount, 16,621 tons (49%) is Other Tree Debris. Of the remaining 17,278 tons, Brick/Wood comprises 39% 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 272 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 10,480 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 61 households to be displaced due to the hurricane. Of these, 12 people (out of a total population of 15,664) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 78.4 million dollars, which represents 4.50 % 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 78 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 79% 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	43,411.96	5,532.41	1,679.90	1,761.31	52,385.58
	Content	13,287.49	1,997.75	1,021.29	517.69	16,824.23
	Inventory	0.00	54.88	147.81	7.78	210.47
	Subtotal	**56,699.46**	**7,585.04**	**2,848.99**	**2,286.78**	**69,420.27**
Business Interruption Loss						
	Income	0.21	425.54	18.43	141.46	585.65
	Relocation	3,651.83	1,096.18	150.86	330.85	5,229.72
	Rental	1,284.99	611.24	19.40	30.01	1,945.63
	Wage	0.50	488.77	30.71	720.05	1,240.03
	Subtotal	**4,937.53**	**2,621.73**	**219.40**	**1,222.37**	**9,001.03**
Total						
	Total	**61,636.98**	**10,206.77**	**3,068.40**	**3,509.15**	**78,421.30**

Appendix A: County Listing for the Region

Connecticut
- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Connecticut				
Fairfield	15,664	1,200,050	542,689	1,742,739
Total	**15,664**	**1,200,050**	**542,689**	**1,742,739**
Study Region Total	**15,664**	**1,200,050**	**542,689**	**1,742,739**

Hazus-MH: Earthquake Event Report

Region Name: Brookfield

Earthquake Scenario: East Haddam

Print Date: November 18, 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 20.37 square miles and contains 3 census tracts. There are over 5 thousand households in the region which has a total population of 15,664 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,742 (millions of dollars). Approximately 89.00 % of the buildings (and 69.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 605 and 0 (millions of dollars), respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 6 thousand buildings in the region which have an aggregate total replacement value of 1,742 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 84% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of 0 beds. There are 7 schools, 1 fire stations, 1 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 0 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 11 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 605.00 (millions of dollars). This inventory includes over 28 kilometers of highways, 20 bridges, 451 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	20	404.10
	Segments	10	177.80
	Tunnels	0	0.00
		Subtotal	**581.90**
Railways	Bridges	1	0.00
	Facilities	0	0.00
	Segments	3	21.80
	Tunnels	0	0.00
		Subtotal	**21.90**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	1	1.30
		Subtotal	**1.30**
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	**605.10**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	4.50
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**4.50**
Waste Water	Distribution Lines	NA	2.70
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**2.70**
Natural Gas	Distribution Lines	NA	1.80
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**1.80**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	2	0.20
		Subtotal	**0.20**
		Total	**9.30**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	East Haddam
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-72.40
Latitude of Epicenter	41.50
Earthquake Magnitude	6.40
Depth (Km)	10.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Building Damage

Hazus estimates that about 160 buildings will be at least moderately damaged. This is over 2.00 % of the buildings in the region. There are an estimated 1 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	29	0.51	4	0.63	1	0.97	0	1.39	0	1.32
Commercial	387	6.78	48	8.55	23	16.06	4	22.59	0	27.34
Education	13	0.24	2	0.29	1	0.54	0	0.66	0	1.01
Government	9	0.16	1	0.20	1	0.39	0	0.47	0	0.69
Industrial	127	2.22	16	2.80	8	5.66	1	7.31	0	9.28
Other Residential	518	9.09	55	9.77	19	13.42	3	17.47	0	20.00
Religion	43	0.75	5	0.87	2	1.49	0	2.23	0	2.87
Single Family	4,574	80.25	436	76.89	88	61.48	8	47.88	0	37.50
Total	**5,700**		**567**		**143**		**16**		**1**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	4,866	85.37	453	79.89	81	56.91	5	32.31	0	9.33
Steel	281	4.94	36	6.27	19	13.53	3	15.98	0	20.45
Concrete	56	0.98	6	1.14	3	2.37	0	1.57	0	1.87
Precast	17	0.31	2	0.32	1	1.00	0	2.24	0	0.34
RM	97	1.70	7	1.26	5	3.53	1	5.57	0	0.22
URM	376	6.60	62	10.92	32	22.17	7	41.94	1	67.66
MH	6	0.11	1	0.20	1	0.48	0	0.39	0	0.13
Total	**5,700**		**567**		**143**		**16**		**1**	

*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	7	0	0	7
EOCs	0	0	0	0
PoliceStations	1	0	0	1
FireStations	1	0	0	1

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	10	0	0	10	10
	Bridges	20	0	0	20	20
	Tunnels	0	0	0	0	0
Railways	Segments	3	0	0	3	3
	Bridges	1	0	0	1	1
	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	1	0	0	1	1
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	2	0	0	2	2

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	226	9	2
Waste Water	135	4	1
Natural Gas	90	2	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	5,572	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 63.00% 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 160 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 3 households to be displaced due to the earthquake. Of these, 1 people (out of a total population of 15,664) 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	2	0	0	0
	Total	**2**	**0**	**0**	**0**
2 PM	Commercial	2	0	0	0
	Commuting	0	0	0	0
	Educational	1	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	**4**	**1**	**0**	**0**
5 PM	Commercial	2	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	1	0	0	0
	Total	**3**	**1**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 19.54 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 17.58 (millions of dollars); 22 % 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 47 % 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	0.85	0.03	0.08	0.98
	Capital-Related	0.00	0.01	0.71	0.02	0.02	0.75
	Rental	0.12	0.08	0.44	0.01	0.02	0.68
	Relocation	0.44	0.05	0.61	0.08	0.22	1.39
	Subtotal	**0.56**	**0.16**	**2.61**	**0.13**	**0.33**	**3.80**
Capital Stock Losses							
	Structural	1.13	0.12	0.78	0.18	0.23	2.44
	Non_Structural	4.47	0.52	2.11	0.57	0.67	8.35
	Content	1.19	0.12	0.97	0.34	0.31	2.91
	Inventory	0.00	0.00	0.03	0.06	0.00	0.09
	Subtotal	**6.79**	**0.75**	**3.88**	**1.14**	**1.22**	**13.78**
	Total	**7.35**	**0.91**	**6.50**	**1.27**	**1.55**	**17.58**

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	177.80	$0.00	0.00
	Bridges	404.13	$1.84	0.46
	Tunnels	0.00	$0.00	0.00
	Subtotal	**581.90**	**1.80**	
Railways	Segments	21.85	$0.00	0.00
	Bridges	0.04	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**21.90**	**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	1.25	$0.06	4.55
	Subtotal	**1.30**	**0.10**	
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	**605.10**	**1.90**	

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	4.50	$0.04	0.87
	Subtotal	**4.52**	**$0.04**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	2.70	$0.02	0.73
	Subtotal	**2.71**	**$0.02**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	1.80	$0.01	0.38
	Subtotal	**1.81**	**$0.01**	
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	0.20	$0.00	1.00
	Subtotal	**0.23**	**$0.00**	
	Total	**9.26**	**$0.07**	

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

Fairfield,CT

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Connecticut					
	Fairfield	15,664	1,200	542	1,742
Total State		**15,664**	**1,200**	**542**	**1,742**
Total Region		**15,664**	**1,200**	**542**	**1,742**

Hazus-MH: Earthquake Event Report

Region Name: Brookfield

Earthquake Scenario: Haddam

Print Date: November 18, 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 20.37 square miles and contains 3 census tracts. There are over 5 thousand households in the region which has a total population of 15,664 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,742 (millions of dollars). Approximately 89.00 % of the buildings (and 69.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 605 and 0 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 6 thousand buildings in the region which have an aggregate total replacement value of 1,742 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 84% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of 0 beds. There are 7 schools, 1 fire stations, 1 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 0 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 11 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 605.00 (millions of dollars). This inventory includes over 28 kilometers of highways, 20 bridges, 451 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	20	404.10
	Segments	10	177.80
	Tunnels	0	0.00
		Subtotal	**581.90**
Railways	Bridges	1	0.00
	Facilities	0	0.00
	Segments	3	21.80
	Tunnels	0	0.00
		Subtotal	**21.90**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	1	1.30
		Subtotal	**1.30**
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	**605.10**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	4.50
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**4.50**
Waste Water	Distribution Lines	NA	2.70
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**2.70**
Natural Gas	Distribution Lines	NA	1.80
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**1.80**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	2	0.20
		Subtotal	**0.20**
		Total	**9.30**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	Haddam
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-72.55
Latitude of Epicenter	41.77
Earthquake Magnitude	5.70
Depth (Km)	10.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Building Damage

Hazus estimates that about 33 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	33	0.52	1	0.66	0	1.00	0	1.24	0	1.00
Commercial	441	7.08	16	9.35	5	16.56	1	21.17	0	23.45
Education	15	0.25	1	0.31	0	0.51	0	0.60	0	0.88
Government	11	0.17	0	0.20	0	0.34	0	0.37	0	0.48
Industrial	145	2.33	5	2.93	2	5.24	0	6.08	0	6.49
Other Residential	572	9.19	18	10.90	5	15.96	1	19.61	0	24.58
Religion	48	0.77	2	1.03	1	1.84	0	2.54	0	3.45
Single Family	4,962	79.69	125	74.62	18	58.55	1	48.39	0	39.67
Total	**6,226**		**168**		**31**		**3**		**0**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	5,265	84.56	126	74.92	15	48.08	1	27.41	0	0.00
Steel	326	5.23	10	6.01	3	10.40	0	9.90	0	7.32
Concrete	64	1.03	2	1.04	0	1.52	0	0.62	0	0.00
Precast	20	0.32	1	0.42	0	1.41	0	2.73	0	0.20
RM	106	1.70	3	1.64	1	4.58	0	5.76	0	0.00
URM	439	7.05	26	15.71	10	33.42	1	53.30	0	92.48
MH	7	0.12	0	0.27	0	0.58	0	0.28	0	0.00
Total	**6,226**		**168**		**31**		**3**		**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	7	0	0	7
EOCs	0	0	0	0
PoliceStations	1	0	0	1
FireStations	1	0	0	1

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	10	0	0	10	10
	Bridges	20	0	0	20	20
	Tunnels	0	0	0	0	0
Railways	Segments	3	0	0	3	3
	Bridges	1	0	0	1	1
	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	1	0	0	1	1
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	2	0	0	2	2

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	226	1	0
Waste Water	135	1	0
Natural Gas	90	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	5,572	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 40 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 15,664) 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	**1**	**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	**1**	**0**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 3.52 (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 3.44 (millions of dollars); 23 % 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 48 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.00	0.17	0.00	0.02	0.20
	Capital-Related	0.00	0.00	0.14	0.00	0.00	0.15
	Rental	0.03	0.02	0.10	0.00	0.01	0.15
	Relocation	0.09	0.01	0.12	0.01	0.05	0.28
	Subtotal	**0.11**	**0.04**	**0.53**	**0.02**	**0.07**	**0.78**
Capital Stock Losses							
	Structural	0.26	0.03	0.16	0.04	0.05	0.54
	Non_Structural	0.90	0.10	0.40	0.10	0.13	1.63
	Content	0.17	0.02	0.16	0.06	0.05	0.46
	Inventory	0.00	0.00	0.00	0.01	0.00	0.02
	Subtotal	**1.34**	**0.15**	**0.73**	**0.21**	**0.23**	**2.66**
	Total	**1.45**	**0.18**	**1.26**	**0.23**	**0.31**	**3.44**

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	177.80	$0.00	0.00
	Bridges	404.13	$0.05	0.01
	Tunnels	0.00	$0.00	0.00
	Subtotal	**581.90**	**0.10**	
Railways	Segments	21.85	$0.00	0.00
	Bridges	0.04	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**21.90**	**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	1.25	$0.02	1.35
	Subtotal	**1.30**	**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	**605.10**	**0.10**	

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	4.50	$0.01	0.14
	Subtotal	**4.52**	**$0.01**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	2.70	$0.00	0.11
	Subtotal	**2.71**	**$0.00**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	1.80	$0.00	0.06
	Subtotal	**1.81**	**$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	0.20	$0.00	0.13
	Subtotal	**0.23**	**$0.00**	
	Total	**9.26**	**$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

Fairfield,CT

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Connecticut					
	Fairfield	15,664	1,200	542	1,742
Total State		**15,664**	**1,200**	**542**	**1,742**
Total Region		**15,664**	**1,200**	**542**	**1,742**

Hazus-MH: Earthquake Event Report

Region Name: Brookfield

Earthquake Scenario: Portland

Print Date: November 18, 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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The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

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

The geographical size of the region is 20.37 square miles and contains 3 census tracts. There are over 5 thousand households in the region which has a total population of 15,664 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,742 (millions of dollars). Approximately 89.00 % of the buildings (and 69.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 605 and 0 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 6 thousand buildings in the region which have an aggregate total replacement value of 1,742 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 84% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of 0 beds. There are 7 schools, 1 fire stations, 1 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 0 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 11 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 605.00 (millions of dollars). This inventory includes over 28 kilometers of highways, 20 bridges, 451 kilometers of pipes.

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	Segments	10	177.80
	Tunnels	0	0.00
		Subtotal	**581.90**
Railways	Bridges	1	0.00
	Facilities	0	0.00
	Segments	3	21.80
	Tunnels	0	0.00
		Subtotal	**21.90**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	1	1.30
		Subtotal	**1.30**
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	**605.10**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	4.50
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**4.50**
Waste Water	Distribution Lines	NA	2.70
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**2.70**
Natural Gas	Distribution Lines	NA	1.80
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**1.80**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	2	0.20
		Subtotal	**0.20**
		Total	**9.30**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	Portland
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-72.60
Latitude of Epicenter	41.60
Earthquake Magnitude	5.70
Depth (Km)	10.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Building Damage

Building Damage

Hazus estimates that about 41 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	32	0.52	1	0.65	0	0.98	0	1.30	0	1.05
Commercial	437	7.06	18	9.06	6	16.06	1	21.78	0	23.65
Education	15	0.25	1	0.30	0	0.51	0	0.63	0	0.88
Government	10	0.17	0	0.20	0	0.34	0	0.39	0	0.48
Industrial	144	2.33	6	2.86	2	5.14	0	6.28	0	6.63
Other Residential	568	9.18	22	10.71	6	15.53	1	20.10	0	24.48
Religion	47	0.76	2	1.00	1	1.77	0	2.61	0	3.43
Single Family	4,930	79.72	151	75.22	23	59.68	2	46.92	0	39.40
Total	**6,184**		**201**		**38**		**3**		**0**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	5,233	84.62	153	75.89	19	50.09	1	24.95	0	0.00
Steel	323	5.22	12	5.90	4	10.40	0	10.24	0	7.96
Concrete	63	1.03	2	1.04	1	1.58	0	0.69	0	0.32
Precast	20	0.32	1	0.40	1	1.34	0	2.76	0	0.18
RM	105	1.69	3	1.57	2	4.41	0	6.02	0	0.00
URM	433	7.00	30	14.95	12	31.63	2	55.05	0	91.54
MH	7	0.12	1	0.25	0	0.56	0	0.28	0	0.00
Total	**6,184**		**201**		**38**		**3**		**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	7	0	0	7
EOCs	0	0	0	0
PoliceStations	1	0	0	1
FireStations	1	0	0	1

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	10	0	0	10	10
	Bridges	20	0	0	20	20
	Tunnels	0	0	0	0	0
Railways	Segments	3	0	0	3	3
	Bridges	1	0	0	1	1
	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	1	0	0	1	1
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	2	0	0	2	2

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	226	2	0
Waste Water	135	1	0
Natural Gas	90	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	5,572	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 72.00% 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 40 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 15,664) 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	**1**	**0**	**0**	**0**
2 PM	Commercial	1	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	**1**	**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	**1**	**0**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 4.55 (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 4.44 (millions of dollars); 21 % 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 48 % 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	0.21	0.01	0.02	0.24
	Capital-Related	0.00	0.00	0.17	0.00	0.00	0.18
	Rental	0.03	0.02	0.12	0.00	0.01	0.18
	Relocation	0.11	0.01	0.15	0.02	0.06	0.35
	Subtotal	**0.14**	**0.04**	**0.64**	**0.03**	**0.09**	**0.95**
Capital Stock Losses							
	Structural	0.32	0.03	0.20	0.04	0.07	0.66
	Non_Structural	1.18	0.13	0.52	0.14	0.17	2.14
	Content	0.26	0.03	0.23	0.08	0.07	0.67
	Inventory	0.00	0.00	0.01	0.01	0.00	0.02
	Subtotal	**1.76**	**0.19**	**0.95**	**0.28**	**0.31**	**3.49**
	Total	**1.90**	**0.24**	**1.60**	**0.31**	**0.40**	**4.44**

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	177.80	$0.00	0.00
	Bridges	404.13	$0.07	0.02
	Tunnels	0.00	$0.00	0.00
	Subtotal	**581.90**	**0.10**	
Railways	Segments	21.85	$0.00	0.00
	Bridges	0.04	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**21.90**	**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	1.25	$0.02	1.88
	Subtotal	**1.30**	**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	**605.10**	**0.10**	

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	4.50	$0.01	0.15
	Subtotal	**4.52**	**$0.01**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	2.70	$0.00	0.13
	Subtotal	**2.71**	**$0.00**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	1.80	$0.00	0.07
	Subtotal	**1.81**	**$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	0.20	$0.00	0.22
	Subtotal	**0.23**	**$0.00**	
	Total	**9.26**	**$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

Fairfield,CT

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Connecticut					
	Fairfield	15,664	1,200	542	1,742
Total State		**15,664**	**1,200**	**542**	**1,742**
Total Region		**15,664**	**1,200**	**542**	**1,742**

Hazus-MH: Earthquake Event Report

Region Name: Brookfield

Earthquake Scenario: Stamford

Print Date: November 18, 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 20.37 square miles and contains 3 census tracts. There are over 5 thousand households in the region which has a total population of 15,664 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,742 (millions of dollars). Approximately 89.00 % of the buildings (and 69.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 605 and 0 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 6 thousand buildings in the region which have an aggregate total replacement value of 1,742 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 84% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of 0 beds. There are 7 schools, 1 fire stations, 1 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 0 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 11 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 605.00 (millions of dollars). This inventory includes over 28 kilometers of highways, 20 bridges, 451 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	20	404.10
	Segments	10	177.80
	Tunnels	0	0.00
		Subtotal	**581.90**
Railways	Bridges	1	0.00
	Facilities	0	0.00
	Segments	3	21.80
	Tunnels	0	0.00
		Subtotal	**21.90**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	1	1.30
		Subtotal	**1.30**
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	**605.10**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	4.50
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**4.50**
Waste Water	Distribution Lines	NA	2.70
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**2.70**
Natural Gas	Distribution Lines	NA	1.80
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**1.80**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	2	0.20
		Subtotal	**0.20**
		Total	**9.30**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	Stamford
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-73.60
Latitude of Epicenter	41.15
Earthquake Magnitude	5.70
Depth (Km)	10.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Building Damage

Hazus estimates that about 207 buildings will be at least moderately damaged. This is over 3.00 % of the buildings in the region. There are an estimated 1 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	28	0.50	4	0.64	2	1.00	0	1.47	0	1.42
Commercial	367	6.61	59	8.71	31	16.81	5	24.21	1	29.96
Education	13	0.23	2	0.30	1	0.57	0	0.72	0	1.12
Government	9	0.16	1	0.21	1	0.44	0	0.56	0	0.86
Industrial	120	2.16	19	2.85	11	6.00	2	8.07	0	10.59
Other Residential	502	9.05	65	9.73	24	13.20	4	16.91	0	18.87
Religion	41	0.74	6	0.87	3	1.48	0	2.21	0	2.84
Single Family	4,468	80.56	516	76.69	111	60.49	10	45.85	1	34.34
Total	**5,547**		**673**		**184**		**22**		**2**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	4,754	85.71	540	80.24	105	57.04	7	32.23	0	9.61
Steel	263	4.74	44	6.52	28	15.02	4	19.43	1	26.42
Concrete	53	0.95	8	1.18	5	2.64	0	2.03	0	2.31
Precast	17	0.30	2	0.31	2	0.97	0	2.17	0	0.40
RM	94	1.69	8	1.24	6	3.46	1	5.58	0	0.57
URM	361	6.50	69	10.31	37	20.38	8	38.09	1	60.52
MH	6	0.10	1	0.20	1	0.49	0	0.48	0	0.18
Total	**5,547**		**673**		**184**		**22**		**2**	

*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	7	0	0	7
EOCs	0	0	0	0
PoliceStations	1	0	0	1
FireStations	1	0	0	1

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	10	0	0	10	10
	Bridges	20	0	0	20	20
	Tunnels	0	0	0	0	0
Railways	Segments	3	0	0	3	3
	Bridges	1	0	0	1	1
	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	1	0	0	1	1
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	2	0	0	2	2

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	226	6	2
Waste Water	135	3	1
Natural Gas	90	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	5,572	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 0.01 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 58.00% 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 200 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 5 households to be displaced due to the earthquake. Of these, 2 people (out of a total population of 15,664) 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	2	0	0	0
	Total	**3**	**0**	**0**	**0**
2 PM	Commercial	3	0	0	0
	Commuting	0	0	0	0
	Educational	1	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**5**	**1**	**0**	**0**
5 PM	Commercial	2	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	1	0	0	0
	Total	**4**	**1**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 27.77 (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 26.40 (millions of dollars); 20 % 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 45 % 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	0.03	1.24	0.04	0.11	1.42
	Capital-Related	0.00	0.01	1.03	0.02	0.02	1.09
	Rental	0.15	0.10	0.62	0.02	0.03	0.93
	Relocation	0.56	0.07	0.88	0.11	0.30	1.92
	Subtotal	**0.71**	**0.22**	**3.77**	**0.19**	**0.46**	**5.36**
Capital Stock Losses							
	Structural	1.39	0.16	1.13	0.27	0.32	3.27
	Non_Structural	6.32	0.81	3.35	0.95	1.06	12.49
	Content	2.07	0.21	1.70	0.59	0.55	5.12
	Inventory	0.00	0.00	0.05	0.10	0.00	0.15
	Subtotal	**9.78**	**1.17**	**6.23**	**1.92**	**1.93**	**21.04**
	Total	**10.50**	**1.39**	**10.00**	**2.11**	**2.40**	**26.40**

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	177.80	$0.00	0.00
	Bridges	404.13	$1.22	0.30
	Tunnels	0.00	$0.00	0.00
	Subtotal	**581.90**	**1.20**	
Railways	Segments	21.85	$0.00	0.00
	Bridges	0.04	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**21.90**	**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	1.25	$0.10	8.05
	Subtotal	**1.30**	**0.10**	
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	**605.10**	**1.30**	

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	4.50	$0.03	0.64
	Subtotal	**4.52**	**$0.03**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	2.70	$0.01	0.53
	Subtotal	**2.71**	**$0.01**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	1.80	$0.00	0.27
	Subtotal	**1.81**	**$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	0.20	$0.01	2.48
	Subtotal	**0.23**	**$0.01**	
	Total	**9.26**	**$0.05**	

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

Fairfield,CT

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Connecticut					
	Fairfield	15,664	1,200	542	1,742
Total State		**15,664**	**1,200**	**542**	**1,742**
Total Region		**15,664**	**1,200**	**542**	**1,742**

APPENDIX D
RECORD OF MUNICIPAL ADOPTION

CERTIFICATE OF ADOPTION
TOWN OF BROOKFIELD BOARD OF SELECTMEN

A RESOLUTION ADOPTING THE TOWN OF BROOKFIELD HAZARD MITIGATION PLAN

WHEREAS, the Town of Brookfield 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 Brookfield 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 Brookfield; and

WHEREAS, the Plan recommends several hazard mitigation actions/projects that will provide mitigation for specific natural hazards that impact the Town of Brookfield, 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 Brookfield 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 Brookfield;
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 3rd **day of** Nov. **2014 by the Board of Selectman of Brookfield, Connecticut**

____
First Selectman

IN WITNESS WHEREOF, the undersigned has affixed his/her signature and the corporate seal of the Town of Brookfield this 4th day of Nov., 2014.

Jean M Locke
____
Town Clerk

APPENDIX E
MITIGATION STATUS WORKSHEETS

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 F
FEMA SNOW LOAD GUIDANCE

FEMA Snow Load Safety Guidance

FEMA

www.FEMA.gov

This flyer summarizes warning signs of overstress conditions during a snow event, key safety issues and risks a snow event poses to buildings, and what to do after a snow event.

Warning Signs of Overstress Conditions during a Snow Event

Overstressed roofs typically display some warning signs. Wood and steel structures may show noticeable signs of excessive ceiling or roof sagging before failure. The following warning signs are common in wood, metal, and steel constructed buildings:

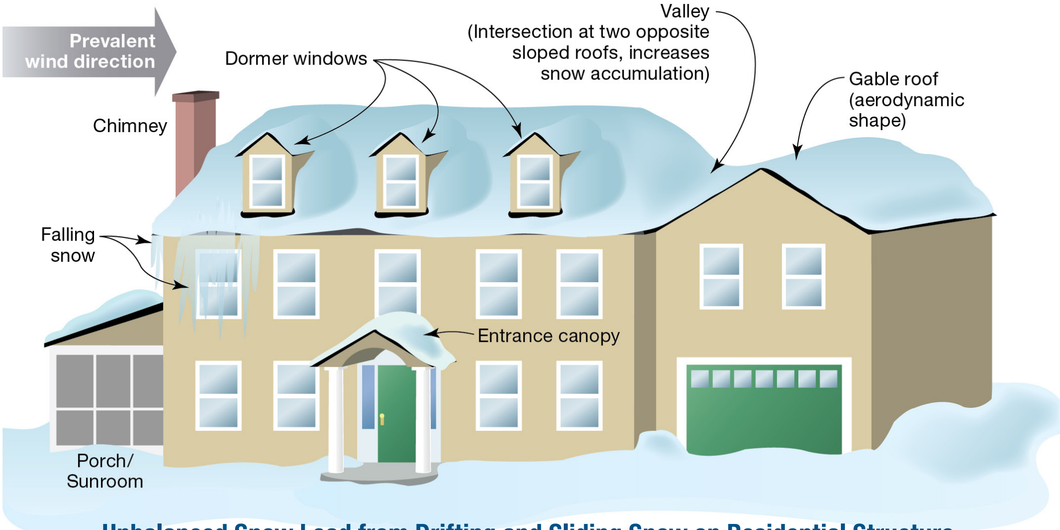
- Sagging ceiling tiles or boards, ceiling boards falling out of the ceiling grid, and/or sagging sprinkler lines and sprinkler heads
- Sprinkler heads deflecting below suspended ceilings
- Popping, cracking, and creaking noises
- Sagging roof members, including metal decking or plywood sheathing
- Bowing truss bottom chords or web members
- Doors and/or windows that can no longer be opened or closed
- Cracked or split wood members
- Cracks in walls or masonry
- Severe roof leaks
- Excessive accumulation of water at nondrainage locations on low slope roofs

Warning! If any of these warning signs are observed, the building should be promptly evacuated and a local building authority and/or a qualified design professional should be contacted to perform a detailed structural inspection.

Key Safety Issues and Risks

Snow accumulation in excess of building design conditions can result in structural failure and possible collapse. Structural failure due to roof snow loads may be linked to several possible causes, including but not limited to the following:

- **Unbalanced snow load from drifting and sliding snow.** When snow accumulates at different depths in different locations on a roof, it results in high and concentrated snow loads that can potentially overload the roof structure.
- **Rain-on-snow load.** Heavy rainfall on top of snow may cause snow to melt and become further saturated, significantly increasing the load on the roof structure.
- **Snow melt between snow events.** If the roof drainage system is blocked, improperly designed or maintained, ice dams may form, which creates a concentrated load at the eaves and reduces the ability of sloped roofs to shed snow. On flat or low slope roof systems, snow melt may accumulate in low areas on roofs, creating a concentrated load.
- **Roof geometry.** Simple roofs with steep slopes shed snow most easily. Roofs with geometric irregularities and obstructions collect snow drifts in an unbalanced pattern. These roof geometries include flat roofs with parapets, stepped roofs, saw-tooth roofs, and roofs with obstructions such as equipment or chimneys.



Unbalanced Snow Load from Drifting and Sliding Snow on Residential Structure

What to Do After a Snow Event

After a snow event, snow removal may be in order. To determine whether snow removal is necessary, one may enlist valuable resources such as a local building authority and/or a qualified design professional, who will be familiar with the snow conditions of the region and the design capacities of local buildings per the building code. If it is determined that the snow should be removed, snow removal should only be performed by qualified individuals. The qualified individual should follow necessary protocols for safe snow removal to minimize risk of personal injury and lower the potential for damaging the roof covering during the snow removal process.

Warning! Snow removal is a dangerous activity that should only be done by qualified individuals following safety protocols to minimize risks. If at any time there is concern that snow loads may cause a collapse of the roof structure, cease all removal activity and evacuate the building.

If subsequent snow events are anticipated, removing snow from the roof will minimize the risk of accumulating snow causing structural damage. One benefit of immediate snow removal is that the effort required to remove the snow from the rooftop is reduced.

Safety Measures for Snow Removal

Below are some safety measures to take during snow removal to minimize risk of personal injury.

- Any roof snow removal should be conducted following proper OSHA protocol for work on rooftops. Use roof fall arrest harnesses where applicable.
- Always have someone below the roof to keep foot traffic away from locations where falling snow or ice could cause injuries.
- Ensure someone confirms that the area below removal site is free of equipment that could be damaged by falling snow or ice.
- Whenever snow is being removed from a roof, be careful of dislodged icicles. An icicle falling from a short height can still cause damage or injury.
- When using a non-metallic snow rake, be aware that roof snow can slide at any moment. Keep a safe distance away from the eave to remain outside of the sliding range.
- Buried skylights pose a high risk to workers on a roof removing snow. Properly mark this hazard as well as other rooftop hazards.

Methods of Snow Removal

Below are some recommended methods of snow removal that allow the qualified individual to remove snow safely and minimize risk of personal injury and property damage.

- Removing snow completely from a roof surface can result in serious damage to the roof covering and possibly lead to leaks and additional damage. At least a couple of inches of snow should be left on the roof.
- Do not use mechanical snow removal equipment. The risk of damaging the roof membrane or other rooftop items outweighs the advantage of speed.
- Do not use sharp tools, such as picks, to remove snow. Use plastic rather than metal shovels.
- Remove drifted snow first at building elevation changes, parapets, and around equipment.
- Once drifted snow has been removed, start remaining snow removal from the center portion of the roof.
- Remove snow in the direction of primary structural members. This will prevent unbalanced snow loading.
- Do not stockpile snow on the roof.
- Dispose of removed snow in designated areas on the ground.
- Keep snow away from building exits, fire escapes, drain downspouts, ventilation openings, and equipment.
- If possible, remove snow starting at the ridge and moving toward the eave for gable and sloped roofs.
- In some cases a long-handled non-metallic snow rake can be used from the ground, thereby reducing the risk. Metal snow rakes can damage roofing material and pose an electrocution risk and should be avoided.
- Upon completion of snow removal, the roofing material should be inspected for any signs of damage. Additionally, a quick inspection of the structural system may be prudent after particularly large snow events.

If you have any additional questions on this topic or other mitigation topics, contact the FEMA Building Science Helpline at FEMA-Buildingsciencehelp@fema.dhs.gov or 866-927-2104.

You may also subscribe to the FEMA Building Science e-mail list serve, which is updated with publication releases and FEMA Building Science activities.

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Visit the Building Science Branch of the Risk Reduction Division at FEMA's Federal Insurance and Mitigation Administration at http://www.fema.gov/building-science.

Please scan this QR code to visit the FEMA Building Science web page.