

TOWN OF WARREN HAZARD MITIGATION PLAN

2014

MMI #3843-04

Prepared for the:

TOWN OF WARREN, CONNECTICUT



Warren Town Hall
50 Cemetery Road
Warren, CT 06754
(203) 868-7881
www.warren.webtownhall.com

Prepared by:

MILONE & MACBROOM, INC.
99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773
www.miloneandmacbroom.com

The preparation of this report has been financed in part through funds provided by the Connecticut Department of Emergency Services and Public Protection (DESPP) Division of Emergency Management and Homeland Security (DEMHS) under a grant from the Federal Emergency Management Agency. The contents of this report reflect the views of the Town of Warren and do not necessarily reflect the official views of DEMHS. The report does not constitute a specification or regulation.

ACKNOWLEDGEMENTS & CONTACT INFORMATION

This plan was prepared under the direction of the Town of Warren. The following individual should be contacted with questions or comments regarding the plan:

Mr. Craig Nelson
First Selectman
Town of Warren
7 Sackett Hill Road
Warren, CT 06754
(860) 868-7881 Phone

This Hazard Mitigation Plan could not have been completed without the time and dedication of the following individuals at the local level:

Mr. Jack Travers, Former First Selectman
Ms. Colleen Frisbie, First Selectman's Office
Ms. Miranda Pettit, Emergency Management Director
Mr. Craig Nelson, Former Land Use Office Official
Mr. Joe Manley, Building Official
Mr. Joe Perry, Road Foreman
Mr. Stan MacMillian, Fire Marshall
Ms. Jocelyn Ayer, Northwestern Connecticut Council of Governments (NWCCOG)

The consulting firm of Milone & MacBroom, Inc. (MMI) prepared the subject plan. The following individuals at MMI may be contacted prior to plan adoption with questions or comments regarding the plan using the contact information on the title page or the electronic mail addresses below:

Mr. David Murphy, P.E., CFM
Associate
davem@miloneandmacbroom.com

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LIST OF ACRONYMS

AEL	Annualized Earthquake Losses
ARC	American Red Cross
ASFPM	Association of State Floodplain Managers
BCA	Benefit Cost Analysis
BCR	Benefit-Cost Ratio
BFE	Base Flood Elevation
BOCA	Building Officials and Code Administrators
CLEAR	Center for Land Use Education and Research (University of Connecticut)
CM	Centimeter
CRS	Community Rating System
DEEP	Department of Energy & Environmental Protection
DEMHS	Department of Emergency Management and Homeland Security
DFA	Dam Failure Analysis
DMA	Disaster Mitigation Act
DOT	Department of Transportation
DPW	Department of Public Works
EAP	Emergency Action Plan
ECC	Emergency Communications Center
EOC	Emergency Operations Center
EOP	Emergency Operations Plan
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
GIS	Geographic Information System
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HURDAT	Hurricane Database (NOAA's)
HURISK	Hurricane Center Risk Analysis Program
ICC	International Code Council
IPCC	Intergovernmental Panel on Climate Change
KM	Kilometer
KT	Knot
LID	Low Impact Development
LOMC	Letter of Map Change
MM	Millimeter
MMI	Milone & MacBroom, Inc.
MPH	Miles per Hour
NAI	No Adverse Impact
NCDC	National Climatic Data Center
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
SCCOG	Southeastern Connecticut Council of Governments
SFHA	Special Flood Hazard Area
SLOSH	Sea, Lake and Overland Surges from Hurricanes
SRL	Severe Repetitive Loss
SSURGO	Soil Survey Geographic
STAPLEE	Social, Technical, Administrative, Political, Legal, Economic, and Environmental
TNC	The Nature Conservancy
USD	United States Dollars
USDA	United States Department of Agriculture
USGS	United States Geological Survey

EXECUTIVE SUMMARY

The Town of Warren has developed the subject hazard mitigation plan along with eight other communities in northwestern Connecticut through a grant to the Northwestern Connecticut Council of Governments (NWCCOG¹). Although each of the nine towns developed a single-jurisdiction plan, certain components of the planning process were shared throughout the nine-town regional planning area.

Warren is a rural town of nearly 1,500 that contains many active farms. Warren was settled as part of Kent in 1737 and Incorporated as the Town of Warren 1786. The town is home to Lake Waramaug. This lake is one of Connecticut's most beautiful and pristine water resources. The primary goal of this hazard mitigation plan is to reduce the damage to property, infrastructure, and natural, cultural and economic resources from natural disasters.

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

- The snow storms of January 2011 spurred the town to remove snow from many roofs including the town hall and schools.
- Although the flooding from Tropical Storm Irene was not as severe as it was further to the north and west, flooding from Irene was notable in Warren. A few culverts were overtopped and some washed out. College Farms Road was overtopped. Reed Road and Curtiss Road were washed out. Portions of Sucker Brook flooded and were out of bank.
- Winter Storm Alfred caused four days without power and town wide communication was severely hindered.

These storms have tested the resilience of Warren, demonstrating that the town has considerable capacity to recover from storms. Municipal officials believe that the local utility needs to arrive more quickly after storm events to shut off live wires, which would allow the town to clean up more quickly.

Currently, there is very little development occurring in the Town of Warren. Single homes resulting from small subdivisions are the main form of development. "Fox Fire" (five units) was recently completed along a new road known as Countryside Lane, and "Sandcastle" (five units) has started construction of the first home.

Warren remains primarily at risk to floods. The Sucker Brook corridor is the main area of concern in the town. The brook is a tributary to Lake Waramaug. One repetitive loss property is believed to be affected by flooding along Sucker Brook, and a few homes near the brook have flood risk. The Northwest Conservation District conducted a study of the Sucker Brook corridor and the Lake Waramaug Task Force has applied for grants to stabilize sections of the stream. The town would likewise be interested in stabilizing sections of the stream along roads and replace some bridges and culverts. The town's other repetitive loss property is adjacent to Lake Waramaug but is not believed to be at risk to flooding from the lake.

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

Although the entire town is at risk to wind events, the ash trees come down frequently along Curtiss Road. There seems to be a higher risk of utility damage here during wind and snow/ice events because of these vulnerable ash trees. Jack Corner Road and Tanner Hill Road have relatively higher risk of drifting snow compared to other parts of Warren.

Large areas of forests and farm fields are located in Warren, and some of the forests are state-owned. A few five-acre wildfires have occurred in the last few years. One notable fire was behind Brick School Road. The town does have some high-risk areas where Mountain Laurel and brush are found.

Two high hazard dams, owned by the City of Waterbury are located within the Town of Warren and are used to impound water. A moderate hazard dam is also located in Warren and is owned by the Town.

Warren has identified a number of mitigation strategies to decrease risks from future floods, wind events, snow storms, wildfires, and earthquakes. The town has also identified methods of increasing emergency service capabilities, such as securing standby power supplies.

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

When the town updates its hazard mitigation plan in five years², these mitigation strategies will be reviewed for progress and updated as needed.

² Updates will be pursued by the town or in connection with the Northwest Hills Council of Governments

1.0 **INTRODUCTION**

1.1 **Background and Purpose**

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

The primary purpose of a hazard mitigation plan (HMP) is to identify hazards and risks, existing capabilities, and activities that can be undertaken by a community or group of communities to prevent loss of life and reduce property damages associated with the identified hazards. Public safety and property loss reduction are the driving forces behind this plan. However, careful consideration also must be given to the preservation of history, culture and the natural environment of the region.

This HMP is prepared specifically to identify hazards in the Town of Warren, Connecticut. The HMP is relevant not only in emergency management situations but also should be used within the Town's land use, environmental, and capital improvement frameworks.

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

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



Pre-Disaster Mitigation (PDM) Program

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



Hazard Mitigation Grant Program (HMGP)

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



Flood Mitigation Assistance (FMA) Program

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

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



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

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

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

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

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

TABLE 1-1
Eligible Mitigation Project Activities by Program

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

Source: Table 3 – HMA Unified Guidance document

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

1.2 Hazard Mitigation Goals

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

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

- ❑ ***Increase access to and awareness of funding sources for hazard mitigation projects.***
Certain funding sources, such as the PDM program and the HMGP, may be available if the HMP is in place and approved.
- ❑ ***Identify mitigation initiatives to be implemented if and when funding becomes available.***
This HMP will identify a number of mitigation recommendations that can be prioritized and acted upon as funding allows.
- ❑ ***Connect hazard mitigation planning to other community planning efforts.*** This HMP can be used to guide Warren's development through interdepartmental and intermunicipal coordination.
- ❑ ***Improve the mechanisms for pre- and post-disaster decision making efforts.*** This Plan emphasizes actions that can be taken now to reduce or prevent future disaster damages. If the actions identified in this Plan are implemented, damage from future hazard events can be minimized, thereby easing recovery and reducing the cost of repairs and reconstruction.
- ❑ ***Improve the ability to implement post-disaster recovery projects*** through development of a list of mitigation alternatives ready to be implemented.
- ❑ ***Enhance and preserve natural resource systems.*** Natural resources, such as wetlands and floodplains, provide protection against disasters such as floods. Proper planning and protection of natural resources can provide hazard mitigation at substantially reduced costs.
- ❑ ***Educate residents and policy makers about hazard risk and vulnerability.*** Education is an important tool to ensure that people make informed decisions that complement the town's ability to implement and maintain mitigation strategies.

Local Plan Development Process

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

1.3 Identification of Hazards and Document Overview

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

- ☐ 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 Warren 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 Warren'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 Programs, Policies, and Mitigation Measures*; *Vulnerabilities and Risk Assessment*; and *Potential Mitigation Measures, Strategies, and Alternatives*, and, for chapters with several recommendations, a *Summary of Recommendations*. 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	Score
	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	1	5
Wildfires	1	2	1	4

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

Location

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

Frequency of Occurrence

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

Magnitude/Severity

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

**TABLE 1-3
Hazard Effect Ranking**

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

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

Location

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

Frequency of Occurrence

0 = unlikely: less than 1% probability in the next 100 years
 1 = possible: between 1 and 10% probability in the next year; or at least one chance in next 100 years
 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*** gives an overview of the measures that the Town is currently undertaking to mitigate the given hazard. These may take the form of ordinances and codes, structural measures such as dams, or public outreach initiatives.
- ❑ ***Vulnerabilities and Risk Assessment*** focuses on the specific areas at risk to the hazard. Specific land uses in the given areas are identified. Critical buildings and infrastructure that would be affected by the hazard are identified.
- ❑ ***Potential Mitigation Strategies and Actions*** identifies mitigation alternatives, including those that may be the least cost effective or inappropriate for Warren.
- ❑ ***Summary of Proposed Strategies and Actions*** provides a summary of the recommended courses of action for Warren, which is included in the STAPLEE analysis described below.

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

1.4 **Discussion of STAPLEE Ranking Method**

To prioritize recommended mitigation measures, it is necessary to determine how effective each measure will be in reducing or preventing damage. A set of criteria commonly used by public administration officials and planners was applied to each proposed strategy. The method, called STAPLEE, is outlined in FEMA planning documents such as *Developing the Mitigation Plan* (FEMA 386-3) and *Using Benefit-Cost Review in Mitigation Planning* (FEMA 386-5). STAPLEE stands for the "Social, Technical, Administrative, Political, Legal, Economic, and Environmental" criteria for making planning decisions. The Local Mitigation Planning Handbook (March 2013) also supports this type of methodology.

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

- ❑ **Social:**
 - Benefits: Is the proposed strategy socially acceptable to Warren?
 - Costs: Are there any equity issues involved that would mean that one segment of Warren could be treated unfairly? Will the action disrupt established neighborhoods, break up voting districts, or cause the relocation of lower-income people? Is the action compatible with present and future community values?
- ❑ **Technical:**
 - Benefits: Will the proposed strategy work? Will it reduce losses in the long term with minimal secondary impacts?
 - Costs: Is the action technically feasible? Will it create more problems than it will solve? Does it solve the problem or only a symptom?
- ❑ **Administrative:**
 - Benefits: Does the project make it easier for the community to administrate future mitigation or emergency response actions?

- Costs: Does Warren have the capability (staff, technical experts, and/or funding) to implement the action, or can it be readily obtained? Can Warren 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 Warren 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 Northwestern Connecticut Council of Governments (NWCCOG), the regional planning body responsible for Warren and eight other member municipalities: Canaan, Cornwall, Kent, North Canaan, Roxbury, Salisbury, Sharon and Washington.

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

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

- ❑ Jack Travers, Former First Selectman

- ☐ Colleen Frisbie, Administrative Assistant to First Selectman
- ☐ Miranda Pettit, Emergency Management Director
- ☐ Craig Nelson, Former Land Use Official
- ☐ Joe Manley, Building Official
- ☐ Joe Perry, Road Foreman
- ☐ Stan MacMillian, Fire Marshal
- ☐ Jocelyn Ayer, NWCCOG

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

- ☐ ***A project kickoff meeting was held September 24, 2013.*** Necessary documentation was collected, and problem areas within the Town were discussed.
- ☐ ***A field inspection was performed on September 24, 2013.*** Two repetitive loss properties were viewed.
- ☐ ***A regional public information meeting was held on November 7, 2013.***

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

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

The following were points of discussion:

- The Housatonic Valley Association will be conducting Stream Habitat Continuity Surveys in 2014 and 2015. As these assessments will focus on improving areas where roads cross over streams, there is the potential to tie these surveys into hazard mitigation planning activities.
- There were questions regarding how the plans are being funded. It was explained that the plan for each community was being 75% funded under a grant through FEMA. The remaining 25% of the funding is being paid for out of NWCCOG member dues.
- The group had additional questions regarding the FEMA grant programs. It was explained that these particular plans would not affect any funding opportunities to which NWCCOG communities were already entitled. Instead, adoption of the plans opens up additional opportunities to obtain grant funding.

- The group mentioned that the prevalence of dead end roads in the area make emergency access difficult, particularly when trees fall and strand residents. The representative from Warren indicated that their community had been opening up unimproved sections of roads in order to provide emergency access via a second egress.
- The Downtown Streetscape project in Kent was mentioned as a potential mitigation area for overhead power lines. It was explained that while moving overhead wires underground is a project eligible for grant funding, such projects are very expensive and often do not generate enough benefits to be considered cost-effective and therefore qualify for a grant.
- A discussion regarding the resizing of culverts took place. One example was how the West Cornwall Bridge overtopped in 1955 causing significant flooding along Main Street. While the current bridge was sized for a particular storm event at the time, as the frequency and magnitude of rainfall has been increasing over the past several decades many communities are finding that their infrastructure can no longer convey the same frequency storm event without overtopping. A standard recommendation in each plan will be to review culvert conveyance based on existing hydrology.
- The group mentioned that beaver dams were a big concern related to flooding, particularly in Cornwall. Town personnel should be contacted to obtain more information regarding these areas and potential mitigation measures.
- The importance of these particular FEMA grants in relation to being able to fund new generators was discussed. The Town of Cornwall is seeking a \$40,000 grant under HMGP for a new generator at the West Cornwall Fire House. He also mentioned that a section of streambed along River Road is located near the road elevation and a recent flood almost washed out the road. This could potentially be an area where a grant could be useful. Also, the Town has a concern with the maintenance of a privately-owned dam on Popple Swamp Road. The property owner lives in New York State and this is a second home/cottage. The Town has contacted the Dam Safety Division at DEEP but no progress has been made.
- Siltation in Lake Waramaug in Warren was mentioned as an issue. A large area has filled in with silt that is potentially reducing the flood storage capacity of the pond. The Town would like to obtain a grant to remove the sediment.

❑ *The Draft Plan was reviewed and approved by the Town in December 2013.*

❑ *The Plan was reviewed by DEMHS in May 2014 and by FEMA in July 2014.*

Public Participation

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

Opportunities for the public to review the Plan were implemented in advance of the public hearing to adopt this plan in 2014. The draft plan submitted to FEMA for the review and approval was posted on the Town website for public review and comment (<http://www.warren.webtownhall.com>).

Public Survey

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

88 people participated in the survey. Table 1-4 provides a summary of the number of responses from each of the NWCCOG municipalities.

**TABLE 1-4
Participant Municipalities**

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

Responses from the Town of Warren indicated that the residents were located on Brick School Road, Woodville Road, Partridge Road and Reed Road.

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

**TABLE 1-5
Contributors of Awareness of Natural Hazards**

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

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

**TABLE 1-6
Potential Hazard Threat Based on Survey Response**

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

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

**TABLE 1-7
Impact to Responder's Home or Business**

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

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

- ☐ Routes 341 and 45 have been partially washed out by heavy rains in the past few years.

Participants were asked if they had seen an increase in maintenance in their towns due to increased pressure on utility companies to harden overhead utility lines and manage vegetation. 40 responded yes and 22 responded no.

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

TABLE 1-8
Responses Regarding Increased Flood Insurance Premiums

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

One participant from Warren indicated that they were only affected by ground water flooding basement. However travel is impeded when local roads are flooded.

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

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

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

One participant offered the following additional comments regarding what the town could do:

- ☐ Improve cellular communications, prevent failure of land lines. The Town government does a good job of communicating thru reverse 911, but useful only when landlines are working.

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

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

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

- ☐ One participant from Warren indicated that they had installed interior curtain drains in the basement. However, they do not work to keep the basement dry. They also installed a water alarm in the basement and obtained a generator and sump pump.

When asked “If you could choose one action that could be taken in your town to reduce vulnerability to hazards and the disasters associated with these hazards, what would it be,” participants from Warren answered with the following

- ☐ Free seminars to prepare people for any list of hazards.
- ☐ Provide cell service; insure landlines are protected from failure.

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

- ☐ This should not be paid/funded in any way shape or form by the taxpayers of these towns. Strictly volunteer or fundraisers should be sufficient to support any hazard mitigation plans. As it is not fair to able bodied tax payers to have to pay for citizens who are not prepared for hazards affecting their residence or surrounding areas.
- ☐ Warren has almost no services for residents--no grocery, doctor, etc. We are dependent on the services of the other towns thru which we must travel to get services, supplies and medical care during an emergency situation. We applaud the cooperation between towns for hazard mitigation.

Thirty participants provided additional contact information for follow-up.

Overall, the survey revealed that NWCCOG residents see hurricanes, tropical storms, and winter storms as having the highest threat and impacting their own homes the most. Residents are primarily concerned with risks to power lines and overhead utilities during winter and wind

storms, and desire more maintenance and removal of trees. Secondary to the concerns about trees and power outages, a few residents have concerns about flooding.

1.7 Coordination with Neighboring Communities

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

For adjacent communities that are not part of the NWCCOG, letters were mailed to these adjacent communities to invite them to participate in the planning process for this hazard mitigation plan. To date, none of the surrounding communities have responded or accepted the invitation to participate.

2.0 COMMUNITY PROFILE

2.1 Physical Setting

The Town of Warren is located in central Litchfield County and is home to a population of approximately 1,400. Warren is bordered by the municipalities of Cornwall to the north, Litchfield to the east, Washington to the south, and to the west by Kent. Refer to Figures 2-1 and 2-2 for maps showing the regional location of Warren within the NWCCOG.

The topography of the town is characterized by a generally rolling terrain with high plateaus, steep slopes and river and stream valleys. The town is home to Lake Waramaug, one of Connecticut's most pristine water resources as well as the Upper Shepaug Reservoir and Shepaug Reservoir which are located in the eastern portion of the town. The varying terrain of Warren makes the town vulnerable to an array of natural hazards.

2.2 Existing Land Use

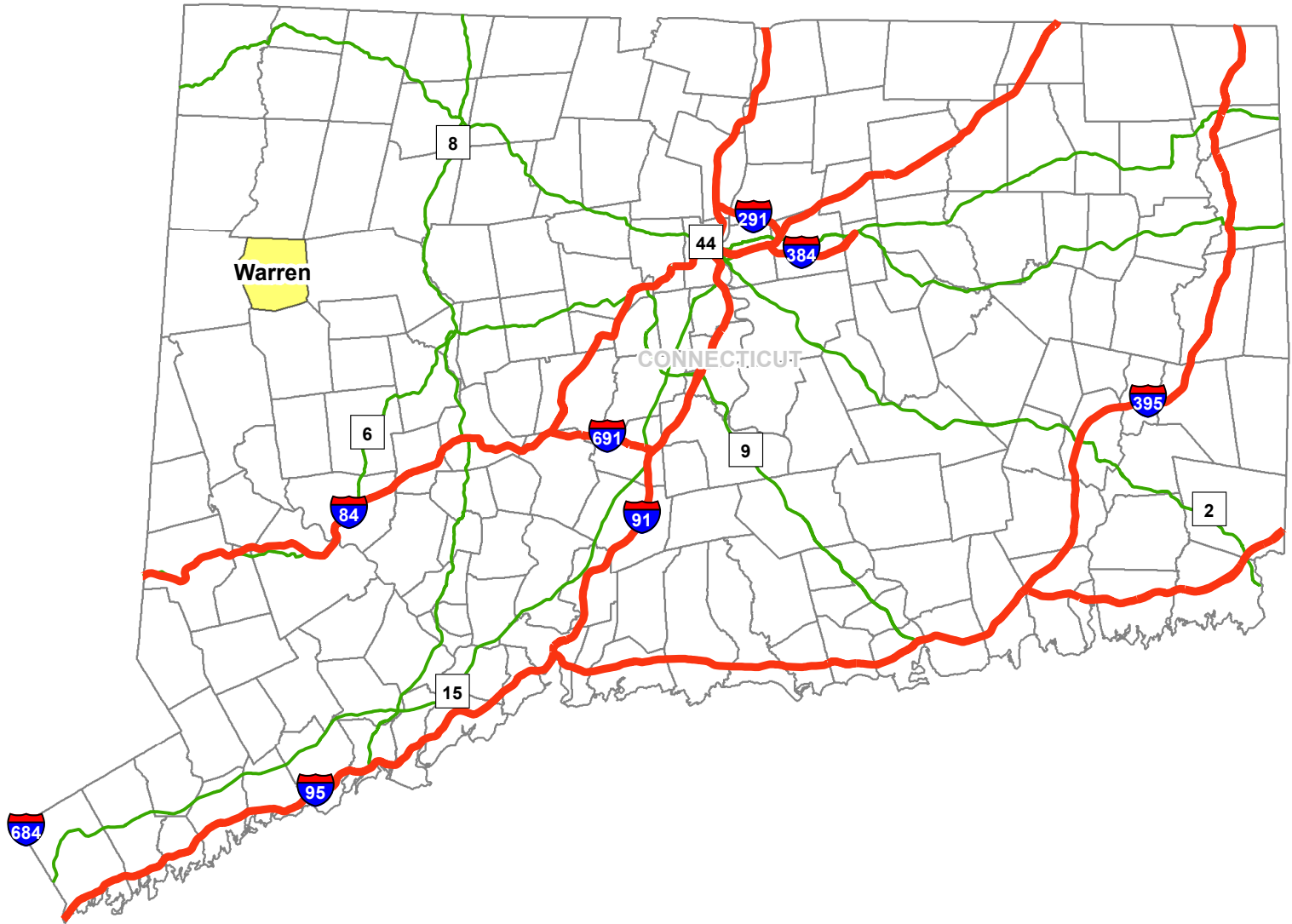
The land area of Warren is approximately 27.6 square miles with 1.2 square miles consisting of water. Warren is characterized as an agricultural community with a low density population. Since the 1800's the town has remained largely agricultural with minimal commercial and industrial uses. In fact, less than one percent of the land in Warren is used for commercial purposes.

In general, approximately one third of the town consists of managed or dedicated open space, with residential and agricultural encompassing another third. Table 2-1 summarizes land use data, which was taken from the Town's 2009 Plan of Conservation and Development (POCD). According to this data, about 29% of the town is considered "open space."

**TABLE 2-1
2009 Land Use**

Land Use	Acres	% Developed	% of Total Land
Residential	1,921	19%	11%
Business	13	<1%	<1%
Institutional (Private and Public)	457	5%	3%
Open Space Managed and Dedicated	5,128	52%	29%
Agricultural	1,734	17%	10%
Other Uses (Right of Way, Water Features, Utility)	699	7%	4%

Source: Plan of Conservation and Development, Town of Warren, 2009



Legend

- Warren
- Interstates
- Major Roads
- Town Boundary

SOURCE(S):
CT DEEP

Figure 2-1: Warren Location Map


LOCATION:
Warren, CT

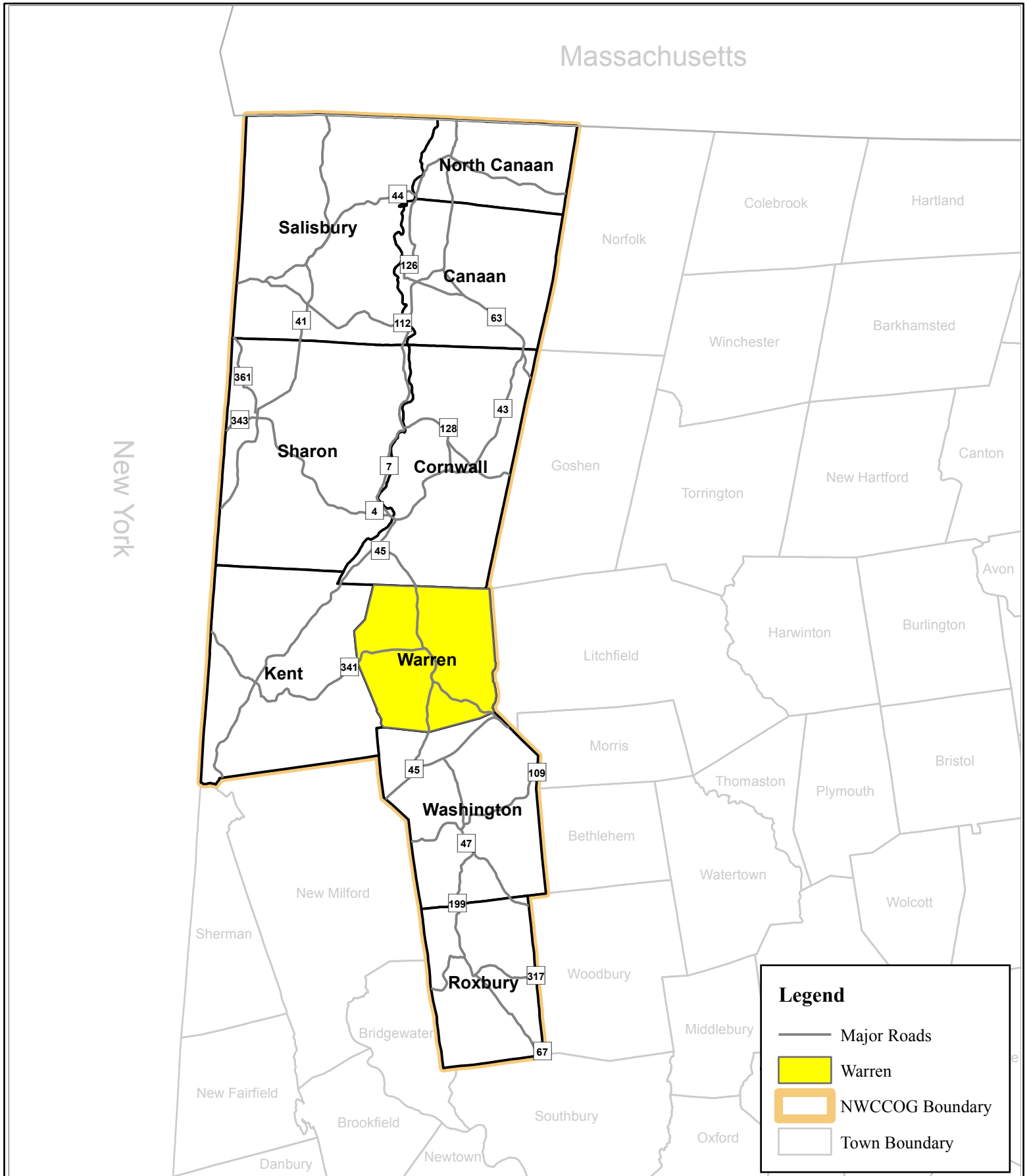


Town of Warren Natural Hazard Mitigation Plan

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

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

 **MILONE & MACBROOM**
99 Realty Drive Cheshire, CT 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com



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 Warren. The following discussion highlights Warren'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.

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

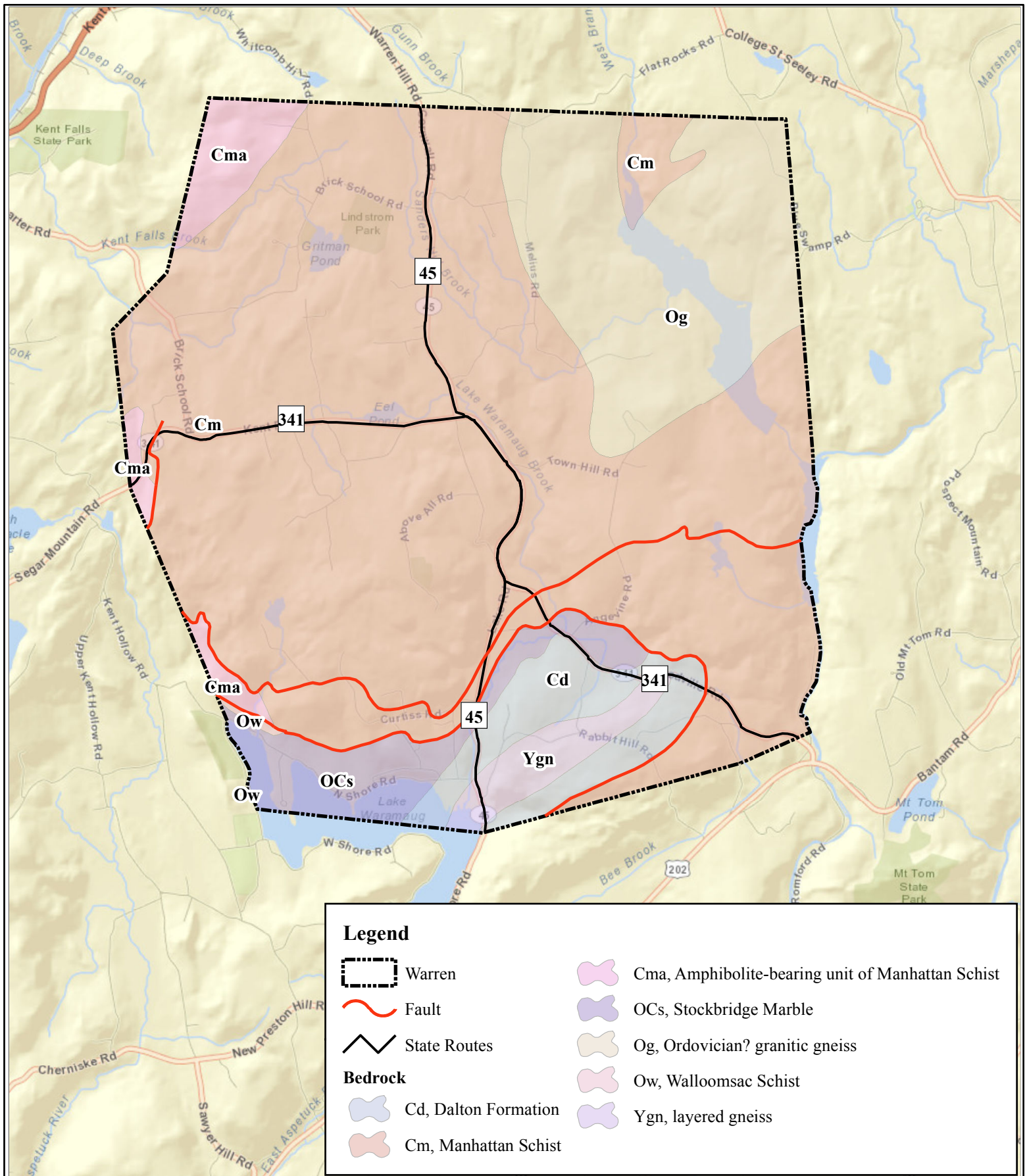
Continental ice sheets moved across Connecticut at least twice in the late Pleistocene era. As a result, Warren's surficial geology is characteristic of the depositional environments that occurred during glacial and postglacial periods. Refer to Figure 2-4 for a depiction of surficial geology.



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

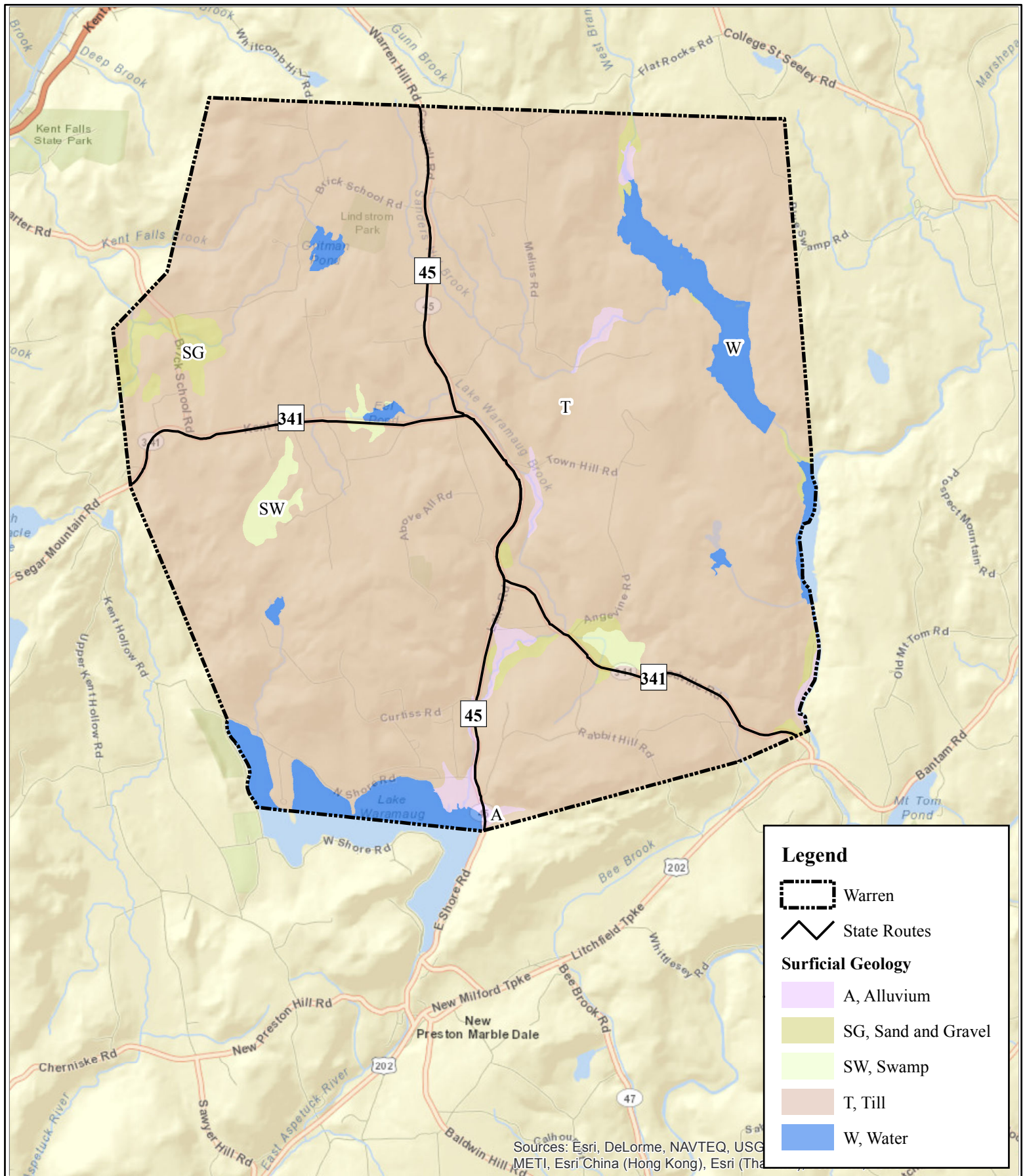
Warren is covered primarily by glacial till. Glacial till contains an unsorted mixture of clay, silt, sand, gravel, and boulders deposited by glaciers as a ground moraine. The deposits are generally less than 50 feet thick although deeper deposits of till are scattered across the hillier sections of the town. Stratified glacial meltwater deposits are related to the various water bodies in town, particularly the Shepaug River. These deposits primarily contain stratified sands and gravels.



2.4 Climate

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



SOURCE(S): CT DEEP	Figure 2-3: Bedrock Geology		LOCATION: Warren, CT
	Town of Warren Natural Hazard Mitigation Plan		Map By: JDW MMI#: 3843-04 Original: 12/12/2013 Revision: 1/22/2014 Scale: 1 inch = 1 mile
	MXD: P:\3843-04\GIS\Maps\Warren\Figure 2-3-Warren Bedrock Geology.mxd		 99 Realty Drive Cheshire, CT 06410 (203) 271-1773 Fax: (203) 272-9733 www.miloneandmacbroom.com



SOURCE(S): CT DEEP	Figure 2-4: Surficial Geology		LOCATION: Warren, CT
	Town of Warren Natural Hazard Mitigation Plan		Map By: JDW MMI#: 3843-04 Original: 12/12/2013 Revision: 1/22/2014 Scale: 1 inch = 1 mile
	MXD: P:\3843-04\GIS\Maps\Warren\Figure 2-4-Warren Surficial Geology.mxd		 MILONE & MACBROOM 99 Realty Drive Cheshire, CT 06410 (203) 271-1773 Fax: (203) 272-9733 www.miloneandmacbroom.com

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

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

Like many rural towns in the United States, Warren experienced a moderate population growth 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.

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

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

2.5 Drainage Basins and Hydrology

Warren is divided among the following six subregional drainage basins: the Housatonic River, Kent Falls Brook, West Aspetuck River, East Aspetuck River, Shepaug River and West Branch Shepaug. The drainage basins are shown on Figure 2-5 and described in detail below. The majority of the drainage basins have FEMA-defined Special Flood Hazard Areas (SFHAs) along the primary watercourses. Such areas consist of 1% annual chance storm floodplains without elevations, 1% annual chance storm floodplains with elevations, and 0.2% annual chance floodplains. Refer to Section 3 for more detail regarding SFHAs.

Housatonic River

The Housatonic River drains an area of 1,948 square miles from Pittsfield, Massachusetts to Milford, Connecticut where it empties into Long Island Sound. The river flows a total of 134 miles from its upper reach to the sound with 1,234 square mile of the total drainage area existing in Connecticut. Only a very small section of the Housatonic River main stem drainage basin lies in Warren, along its northern boundary with Cornwall.

Kent Falls Brook

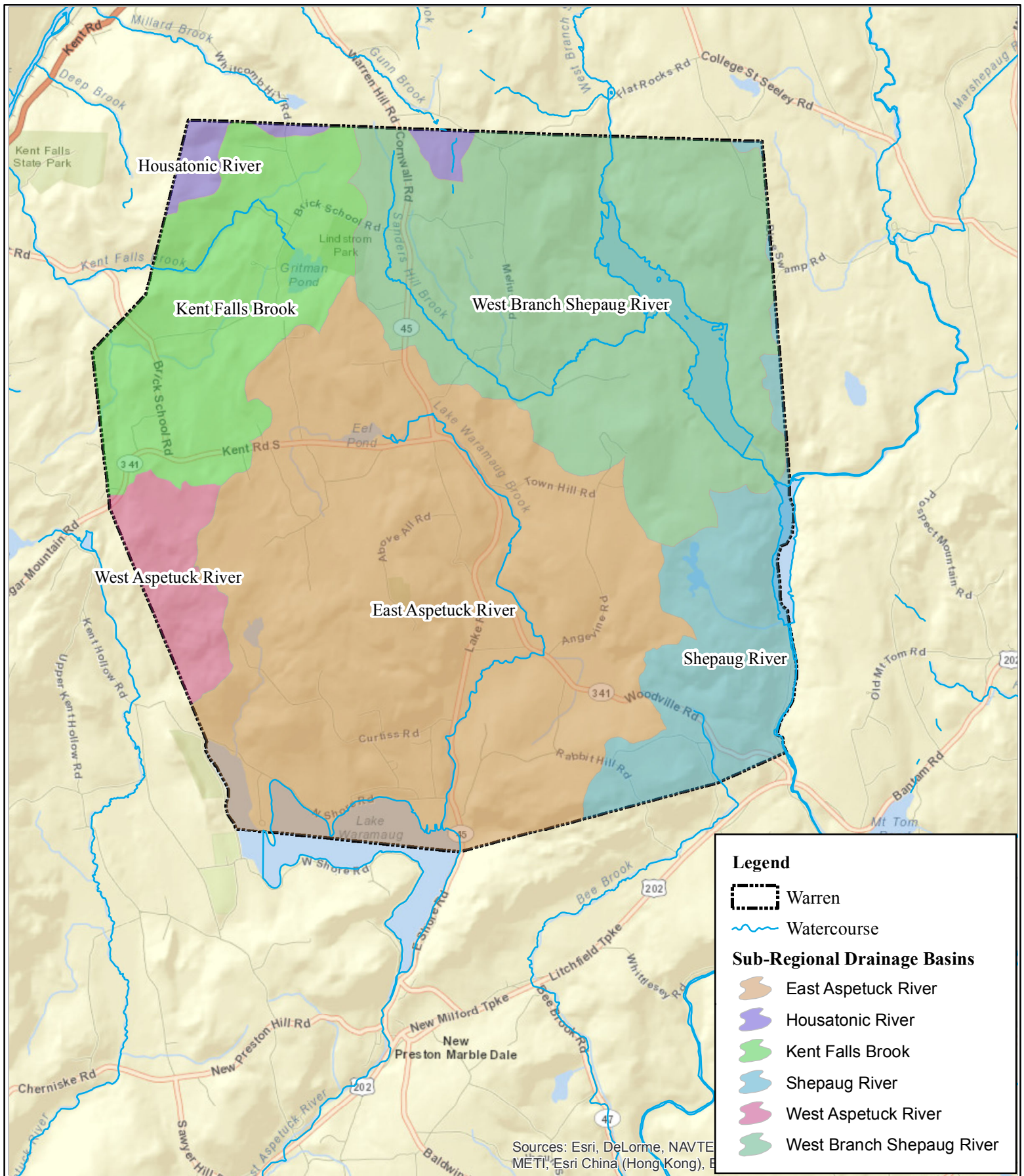
Kent Falls Brook originates in Warren at Gritman Pond, where downstream it merges with other tributaries to flow to the west. Gritman Pond Dam is classified as a moderate hazard dam and holds back the flow of the Kent Falls Brook forming the pond. More than halfway through the river course, Kent Falls Brook converges with a branch of several small unnamed tributaries and the main channel then orientates the flow northwest into the Housatonic River. Some of the tributaries in the headwaters are bordered by 100-year floodplains but the primary channel of Kent Falls Brook does not contain 100-year floodplains.

West Aspetuck River

The headwaters of the West Aspetuck River begin just before North and South Spectacle Ponds located in eastern Kent. The outflow of North Spectacle Pond flows east into Beaman Pond and then south with several merging tributaries including a stem joining just below Beaman that drains a section of Warren. Denman and Merryall Brook merge with West Aspetuck River in New Milford and just before pouring into the Housatonic, and then East Aspetuck River merges into the West Aspetuck. The entire sub regional watershed drains an area of approximately 25 square miles, although only a small portion lies within Warren.

East Aspetuck River

Lake Waramaug is located at the Warren-Washington town line. The lake is the origin of the East Aspetuck River and has several input tributaries including Lake Waramaug Brook, which is locally known as Sucker Brook. About a third of Warren drains into Lake Waramaug by means of Sucker Brook. The East Aspetuck River flows out of the lake's southern tip in the neighboring town of Washington with a southerly orientation, running parallel to Route 202 until it reaches the Housatonic River about ten miles from the start.



<p>SOURCE(S): CT DEEP</p>	<p>Figure 2-5: Sub-Regional Drainage Basins</p>	<p>LOCATION: Warren, CT</p>
<p>Town of Warren Natural Hazard Mitigation Plan</p>	<p>Map By: CMP MMI#: 3843-04 Original: 01/23/2014 Revision: 1/23/2014 Scale: 1 inch = 1 mile</p>	<p>MILONE & MACBROOM 99 Realty Drive Cheshire, CT 06410 (203) 271-1773 Fax: (203) 272-9733 www.miloneandmacbroom.com</p>

West Branch Shepaug River

The northeast section of Warren is dominated by the West Branch Shepaug River drainage basin and the Upper Shepaug Reservoir. The headwaters of the West Branch of Shepaug River begin upstream in Cornwall. The river continues for a short stretch in Warren before forming the Upper Shepaug Reservoir. A short distance below the Upper Shepaug Reservoir, the river forms the Shepaug Reservoir with the main stem of the Shepaug River. Out of approximately 10.5 square miles of total drainage area, around three quarters are in Warren, with the rest to the north in Cornwall, all feeding the Upper Shepaug Reservoir.

Shepaug River

Originating at the Shepaug Reservoir on the Warren-Litchfield town line, the Shepaug River flows directly south creating the lower east boarder of Warren. The Shepaug Reservoir is held back by the Shepaug River Dam which is classified as a high hazard dam. The Shepaug River continues to meander south through Washington and Roxbury with input from many streams and rivers including Bantam River, Bee Brook, Mallory Brook and other tributaries. After the rivers 26 mile stretch from its origin, it flows into the Housatonic River. The entire river is bordered by 100-year floodplains generally widening as the channel gets closer to the mouth.

2.6 Population and Demographic Setting

According to the 2000 U.S. Census, the Town of Warren had a population of 1,254. Warren had a population of 1,461 in 2010 according to the U.S. Census, an increase of 16.5%. As noted in Table 2-7, Warren ranks seventh out of the nine NWCCOG municipalities in Connecticut in terms of population. The Connecticut State Data Center predicts that population growth in Warren will increase over the next twelve years. The population in 2025 is projected to be 1,635.

Warren has a moderate population of people who are elderly and a very limited population of linguistically isolated individuals. According to data collected by the U.S. Census Bureau for the period around 2010, 1.8% of the population is aged 65 or over, but *none* of the residents speak English “less than very well.”

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

TABLE 2-2
Population by Municipality and Region, 2010

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

Source: Census 2010

2.7 Governmental Structures and Capabilities

The Town of Warren 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 departments play a role in hazard mitigation, including the Planning, Zoning and Inland Wetland Administrator, Building Official, the Fire Department, Emergency Management, and the Highway Department/Town Garage.

Drainage complaints are routed through the First Selectman's office before being sent to the Town Garage. 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

The Town of Warren was settled in 1737 as part of the Town of Kent. In 1750, a separate Parish of East Greenwich was established and a church was founded in 1756. In 1786, Warren was incorporated as a separate Town. The Town was named in honor of Revolutionary war hero General Joseph Warren.

Since its inception, Warren has largely been considered an agricultural community. However, by 1810, education was also becoming a significant part of the community as well.

According to the Town website "today residential development and the recreational facilities of Lake Waramaug have boosted the population to almost 1400, but its location in the Litchfield Hills has allowed it to retain its rural and historic character."

Recent Development

Development in Warren has been historically been limited and typically centered on small residential subdivisions. The "Sandcastle" subdivision was slated to consist of five homes. Of the five, only one home has been built to date. The "Fox Fire" subdivision, which consists of five homes, has been constructed on Countryside Lane. Commercial enterprises in the town are very limited.

Future development within the town may be generated by the needs of the residents. Based on the Town POCD, residents are encouraging the development of a "town center" which would allow them to obtain goods and services locally. This desire for a stronger town center may provide opportunities for future residential and commercial growth within the town.

Warren has a great deal of vacant land throughout the town. According to the 2009 POCD, 44% of the land area of Warren is not developed or committed. "When the 44% undeveloped land is combined with the 29% that is dedicated as open space and the 10% that is used for agricultural purposes, approximately 83% of the town is undeveloped."

While there is certainly acreage in the town for additional growth, it is unlikely that development would occur on much of the land due to unsuitable construction conditions such as steep slopes, wetlands and/or floodplains. The POCD states that “while the land use estimates that there were 7,738 acres which were vacant or uncommitted, not all of this land is easily developable. In fact, about 2,003 acres contain some type of significant physical constraint such as: wetlands, watercourses, slopes >25% or 100 year flood zones.”

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

2.9 **Critical Facilities, Sheltering Capabilities, and Emergency Response Capabilities**

Warren has identified seven critical facilities throughout the town. Table 2-3 identifies those critical facilities. The Town considers its 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 Warren continues.

TABLE 2-3
Critical Facilities

Facility	Address or Location	Comment	Emergency Power?	Shelter?	In 1% Annual Chance Floodplain?
Fire Department Headquarters	11 Sackett Hill Road	Emergency Operations Center	<input type="checkbox"/>	<input type="checkbox"/>	No
Town Hall	50 Cemetery Road	Critical Records, Backup Emergency Operations Center	<input type="checkbox"/>		No
Community Center	7 Sackett Hill Road	Primary Shelter	<input type="checkbox"/>	<input type="checkbox"/>	No
Warren Academy	8 Sackett Hill Road	Secondary Shelter		<input type="checkbox"/>	No
Warren Woods	251 Brick School Road	Tertiary Shelter		<input type="checkbox"/>	No
Warren Town Garage	18 Lake Road	Emergency Response Assistance	<input type="checkbox"/>		No
Warren Elementary School	21 Sackett Hill Road	Overflow Shelter (if necessary)			No

Emergency shelters are an important subset of critical facilities, as they are needed in many emergency situations. There are four identified shelters in the town that are also considered critical facilities. The Warren Community Center on Sackett Hill Road is the primary shelter for the town. The Warren Academy on Sackett Hill Road is considered the backup shelter. Both facilities have backup generators. The third shelter is Warren Woods; however this facility does not have standby power. Warren Elementary School would act as an overflow shelter if needed. However, the Department of Emergency Management and Homeland Security (DEMHS) Region 5 has indicated that they prefer that the schools are not used as shelters and the town has followed this directive.

The Town's Emergency Operations Center (EOC), including its Emergency Communications Center, is located at Fire Department Headquarters. The Town Hall is also a critical facility and acts as the backup EOC if needed.

Emergency Response Capabilities

Emergency response capabilities are overseen by the Emergency Management Director. The Director develops plans, protocols, and procedures that assure the safety of Warren's citizens. The Director also provides training for emergency response personnel, supports state and local emergency response exercises, and provides technical assistance to state and local emergency response agencies and public officials. The goal is to provide citizens with the highest level of emergency preparedness before, during, and after disasters or emergencies.

Warren utilizes the State of Connecticut "CT Alert" Emergency Notification System known as Everbridge to send geographically specific telephone warnings into areas at risk for natural hazard damage. This is extremely useful for natural 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.

The CT Alert system is defaulted to 911 listings of landline phone numbers. Residents are encouraged to sign up at <http://www.ctalert.gov/> to personalize how they receive emergency notifications (to cellular phones, texts, electronic mail, etc.).

However, town officials believe that communication remains problematic in Warren. Not many people are believed to have subscribed to CTAlert system. The town can send email blasts, but this action is not helpful when power is out.

Emergency services can also be cut off by fallen trees or washed out culverts during certain emergencies. The Town Garage performs tree and shrub removal and trimming on Town-owned lands and rights-of-way. During emergencies and following storms, the Town Garage, responds to calls related to downed trees.

3.0 **FLOODING**

3.1 **Setting**

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

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

In general, the potential for flooding is widespread across Warren, 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 Warren is considered likely for any given year, with flood damage potentially having significant effects during extreme events.

3.2 **Hazard Assessment**

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

- ❑ **Riverine Flooding:** Also known as overbank flooding, it occurs when channels receive more rain or snowmelt from their watershed than normal, or the channel becomes blocked by an ice jam or debris. Excess water spills out of the channel and into the channel's floodplain area.
- ❑ **Flash Flooding:** A rapid rise of water along a water channel or low-lying urban area, usually a result of an unusually large amount of rain and/or high velocity of water flow (particularly in hilly areas) within a very short period of time. Flash floods can occur with limited warning.
- ❑ **Shallow Flooding:** Occurs in flat areas where a lack of a water channel results in water being unable to drain away easily. The three types of shallow flooding include:
 - **Sheet Flow:** Water spreads over a large area at uniform depth.
 - **Ponding:** Runoff collects in depressions with no drainage ability.
 - **Urban Flooding:** Occurs when man-made drainage systems are overloaded by a larger amount of water than the system was designed to accommodate.

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

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

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.

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.

The Town has consistently participated in the NFIP since January 30, 1990 and intends to continue participation in the NFIP. SFHAs in Warren are delineated on a Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS). The FIRM delineates areas within Warren that are vulnerable to flooding. The original FIS and FIRMs for flooding sources in the town were originally published in January 1990.

A regulatory floodplain with AE designation has been mapped along Lake Waramaug and Lake Waramaug Brook (Sucker Brook) and portions of its tributaries. Areas identified as providing flood storage identified with A Zone designations, meaning they are regulated as floodplain, but flood elevations have not been established. Refer to Figure 3-1 for the areas of Warren susceptible to flooding based on FEMA flood zones. Table 3-1 describes the various zones depicted on the FIRM panel for Warren.

TABLE 3-1
FIRM Zone Descriptions

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

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

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

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

3.3 Historic Record

The Town of Warren 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.

Warren remains primarily at risk to floods. The Sucker Brook corridor is the main area of concern in the town. The brook is a tributary to Lake Waramaug. One repetitive loss property is believed to be affected by flooding along Sucker Brook, and a few homes near the brook have flood risk. The Northwest Conservation District conducted a study of the Sucker Brook corridor and the Lake Waramaug Task Force has applied for grants to stabilize sections of the stream. The town would likewise be interested in stabilizing sections of the stream along roads and replace some bridges and culverts.

The Town may want to consider evaluating the floodprone properties along the sucker brook corridor in an effort to determine potential flood damage reduction strategies. The evaluation should incorporate the Town's desire to stabilize the banks and replace bridges and culverts along the watercourse. This could potentially be a cooperative effort with the Northwest Conservation District and the Lake Waramaug Task Force.

According to the NCDC Storm Events Database, since 1996 there have been approximately 52 flooding and flash flooding events in Litchfield County. The following are descriptions of historic floods in the vicinity of the Town of Warren based on historic records and information in the NCDC Storm Events Database, supplemented by correspondence with municipal officials. Note that flooding was not necessarily limited to the described areas.

- ❑ July 13, 1996- The remnants of Hurricane Bertha tracked from the mid-Atlantic region northeast to Quebec, Canada dropping 3 to 5 inches of rain across Litchfield County. This caused flooding of several streams throughout the county along with scattered power outages from wind-blown tree branches onto wires.
- ❑ June 30, 1998- A cold front triggered several severe thunderstorms which knocked down trees across Litchfield County. A downburst blew down several large trees in Washington, which is immediately south of Warren. While torrential rains produced flash flooding across Woodbury and Roxbury.
- ❑ July 29, 1999- A strong warm front and wind shear aloft produced locally strong thunderstorms across northwestern Connecticut, depositing dime sized hail in Cornwall and Litchfield, located north and east of Warren respectively. The storms also produced torrential rainfall resulting in 6 to 8 inches of water that rapidly covered roadways in Litchfield.
- ❑ September 16, 1999- The remnants of Hurricane Floyd moved across the eastern seaboard on September 16 and the early hours of the 17th dropping 5 to 8 inches of rainfall in northwestern Connecticut. Specific rainfall amounts included 5.20 inches at Falls Village, 6.35 inches at Colebrook Dam, 7.89 inches at Bulls Bridge and 8.28 inches at Bakersville. Wide spread flooding was prevalent across the region including the Housatonic and Shepaug Rivers and many small streams and tributaries. The rains proved to be destructive flooding and washing out portions of roadways including Route 7 in several areas.
- ❑ September 8, 2011- Heavy rainfall combined with saturated soils from the passing of Irene in late August, led to widespread minor to moderate flooding on rivers and small streams across northwest Connecticut.
- ❑ January 19-21, 1999- Mild weather and rain resulted in rapid melting of snow between January 19th and 20th in Litchfield County. Runoff as well as ice jams breaking up triggered flooding of the Housatonic and Pomperaug Rivers.
- ❑ March 8, 2008- Heavy rainfall led to flooding across portions of Litchfield County where several roads were closed including Main Street in Hancock and Route 7 in Kent, just west of Warren.

- ❑ September 6, 2008- The remnants of tropical cyclone Hanna had interacted with a cold front to produce heavy rainfall across south western New England. Rainfalls estimates in the Litchfield region ranged from 3 to 6 inches with gusty winds.
- ❑ August 28-29, 2011- Tropical Storm Irene moved in north northeast across eastern New York and western New England producing widespread flooding due to extreme rainfall and heavy winds. Much of the rain had fallen within a 12-hour period and in Litchfield County totals ranged from 5 to 10 inches. Numerous road closures were reported due to flooding, downed trees and power lines causing some evacuations and widespread, long duration power outages. 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.

In Warren, a few culverts were overtopped and some washed out as a result of flooding from Tropical Storm Irene. College Farms Road was overtopped and Reed Road and Curtiss Road were washed out. The town received public reimbursement assistance in the amount of \$5,455.52 to conduct repairs on Cunningham Road due to flooding damage.

3.4 **Existing Capabilities**

Warren has *Zoning Regulations* and *Subdivision Regulations* that regulate development, and *Inland Wetland Regulations* that regulate activities near wetlands. While regulations have not been updated to specifically address hazard mitigation, the DEEP's model regulations were used to update the regulations as necessary.

Ordinances, Regulations, and Plans

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

- ❑ ***Zoning Regulations.*** The 2012 *Town of Warren Zoning Regulations* have been enacted to “lessen congestion in the streets; secure safety from fire, panic, flood and other damages; to promote health and general welfare; to provide adequate light and air; to prevent the overcrowding of land; to avoid undue concentration of the population and to facilitate the provision of transportation, water, sewage, schools, parks and other public requirements.”

Section 11 of the zoning regulations is essentially the town's local version of the NFIP Regulations. Section 11.1.1 requires new residential and commercial buildings are required to be elevated to the base flood elevation plus one foot.

- ❑ ***Inland Wetlands and Watercourse Regulations.*** The purpose of the 2012 inland wetlands and watercourses regulations is to protect the quality of the inland wetlands and watercourses within the Town of Warren by making provisions for the protection, preservation, maintenance, and use of inland wetlands and watercourses, including deterring and inhibiting the danger of flood and pollution.
 - Section 2 defines "Regulated Activities" “means any operation within or use of a wetland or water course involving removal or deposition of material, or any obstruction, construction, alteration or pollution, of such wetlands or watercourses, but shall not

includes the activities in section 22a-40 of the Connecticut General Statutes and section 4 of these regulations. Furthermore, any clearing, grubbing, filling, grading, paving, excavating, constructing, depositing, or removing of material and discharging of storm water on the land within the following upland review areas is a regulated activity.

- Section 4.1 states that no residential homes will be permitted "as of right" in wetlands and watercourses after July 1, 1987.
- Section 6 states that no person may conduct or maintain a regulated activity without obtaining a permit. Section 7 outlines the permit application requirements.

❑ ***Plan of Conservation and Development.*** This 2009 document is the Town vision statement for future development.

- Chapter 4 (page 25) indicates that the Town of Warren should maintain policies and programs which help protect water resources such as: wetland/watercourse regulations and floodplain regulations and requirements for buffers and setbacks near important water resources.
- Chapter 4 (page 26) recommends enacting new requirements for "low impact" development such as a no increase in the rate of runoff from a site and no increase in the amount of runoff from a site for certain storm events.
- Chapter 6 (page 54) indicates that improvements need to be made to the drainage system as problems often arise due to rainfall intensity and topography.

❑ ***Subdivision Regulations.*** Effective in 2006 and last amended in 2010, the Town of Warren's Subdivision Regulations are intended to provide for orderly development within the Town in accordance with the Town POCD. The regulations focus on maintaining the character of the town, providing appropriate utilities, providing a safe and convenient road system. Conservation of natural resources, encourage the use of energy efficient methods, provide flood protection and control soil erosion and sedimentation.

- Section 5.3 requires that land to be subdivided be "of such character that it can be used for building purposes without danger to health or the public safety: proper provision shall be made for water supply, sewage disposal, absence of flood and erosion hazards, open space, vehicular and pedestrian safety and accessibility to emergency services." Section 7.0 requires that the storm water drainage system shall provide for drainage from the entire parcel and shall take into account land outside the parcel that drains across the parcel.

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

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

- Ensure that purchasers of property are notified of special flood hazards
- Ensure the continued eligibility of owners of property in Warren for participation in the NFIP

NFIP, Flood Insurance, and Community Rating System

The degree of flood protection established by the variety of regulations in the Town exceeds the minimum reasonable for regulatory purposes under the NFIP because one foot of freeboard is required by Section 11 of the Zoning Regulations. The Town is not enrolled in the Community Rating System program.

Drainage and Street Flooding

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

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

Communications

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.

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

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 Warren. 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, two repetitive loss properties (RLPs) are located in the Town of Warren. Both properties are residential homes. General details are summarized in Table 3-2.

TABLE 3-2
Repetitive Loss Properties

Type	Flooding Source	Mapped Floodplain
Residential	Sucker Brook	AE to rear of home
Residential	Unknown – home is near Lake Waramaug	AE to rear of home

The repetitive loss property near Sucker Brook is probably affected by Sucker Brook flooding. This brook flooded during Tropical Storm Irene, for example. A few homes in this stream corridor have flood risk. The repetitive loss property near Lake Waramaug is not familiar to town officials. The home is situated much higher than the lake, but may experience basement or drainage-related flooding.

3.5.2 Vulnerability Analysis of Critical Facilities

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

3.5.3 Vulnerability Analysis of Areas Along Watercourses

The Shepaug River and the Sucker Brook pose the greatest flood risks to people, buildings and infrastructure. 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 pose a risk from flooding.

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

The most frequently flooded areas in the town are adjacent to the Sucker Brook corridor. This includes one repetitive loss property listed in section 3.5.1. According to town officials, this brook flooded during tropical storm Irene and a few homes in this area are at risk from flooding. The town would like to stabilize the brook along the roads and replace some bridges and culverts to alleviate some flooding and stabilization concerns.

It may be beneficial to conduct a comprehensive study of the Sucker Brook corridor to determine the best measure for protecting residents, property and structures from future flooding and storm damage. The town may consider coordinating with the NW Conservation District, who previously

conducted a stream study and with the Lake Waramaug Task Force who has applied for grants associated with this brook.

It should also be noted that during the regional public meeting on November 7, 2013, siltation in Lake Waramaug was mentioned as an issue. A large area has filled in with silt, and municipal officials believe this is potentially reducing the flood storage capacity of the pond. The Town would like to obtain a grant to remove the sediment. It is important to understand that in most cases, sediment removal does not improve the ability of a lake to mitigate flooding unless the impoundment was specifically designed to provide flood abatement (i.e., a flood control impoundment). However, understanding the concerns of the Town of Warren, this plan will support strategies related to siltation in the lake.

3.5.4 HAZUS-MH Vulnerability Analysis

HAZUS-MH is FEMA's loss estimation methodology software for flood, wind, and earthquake hazards. The software utilizes year 2000 U.S. Census data and a variety of engineering information to calculate potential damages (specified in year 2006 United States dollars [USD]) to a user-defined region. The software was used to perform a basic analysis and generate potential damages to Warren from a 1% annual chance riverine flood event occurring along all FEMA Zone AE flood areas which include Lake Waramaug Brook and Waramaug Lake. Hydrology and hydraulics for the streams and rivers were generated utilizing the United States Geological Survey's (USGS) 10-meter National Elevation Dataset. The summary report is included in Appendix D. The following paragraphs discuss the results of the *HAZUS-MH* analysis.

The FEMA default values were used for each of the town's census blocks in the *HAZUS* simulation. Approximately \$139 million of total building replacement value were estimated to exist within the Town of Warren. Of that total, the *HAZUS* 1% annual chance riverine flood event estimates that none of these buildings will be damaged. 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	\$ 109,402,000
Commercial	\$ 14,311,000
Other	\$ 14,518,000
Total	\$ 138,231,000

HAZUS-MH utilizes a subset of critical facilities known as "essential facilities" that are important following natural hazard events. The only critical facility in the *HAZUS* software for Warren is one school. The software noted that under the 1% annual chance flood the school would be unaffected.

The *HAZUS-MH* simulation estimated that a total of 48 tons of debris would be generated by flood damage for the 1% annual chance flood scenario. It is estimated that two truckloads (at approximately 25 tons per truck) will be required to remove the debris. The breakdown of debris is as follows:

- ❑ Finishes (drywall, insulation, etc.) comprise 37 tons.
- ❑ Structural material (wood, brick, etc.) comprise 10 tons.
- ❑ Foundation material (concrete slab, concrete block, rebar, etc.) would comprise one ton.

HAZUS-MH calculated the potential sheltering requirement for the 1% annual chance flood event. The model estimates that four households will be displaced due to flooding. Displacement includes households evacuated from within or very near to the inundated areas. Of these households, one person is predicted 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. It is important to note that *HAZUS* is only an estimate and rounding errors within the software can cause structure damage to not be quantified or be conservative; however economic losses may be quantified by the software. 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 \$460,000 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 \$370,000 thousand, commercial losses totaled \$80,000 and other (municipal and industrial) losses totaled \$10,000.

Based on the historic record and *HAZUS-MH* simulations of the 1% annual chance flood events, the SFHAs and nearby areas are vulnerable to flooding damages that can include direct structural damages, interruptions to business and commerce, emotional impacts, and minor displacement.

3.6 **Potential Mitigation Strategies and Actions**

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

3.6.1 **Prevention**

Prevention of damage from flood losses often takes the form of floodplain regulations and redevelopment policies that restrict the building of new structures within defined areas. These are usually administered by building, zoning, planning, and/or code enforcement offices through capital improvement programs and through zoning, subdivision, floodplain, and wetland ordinances. It also occurs when land is prevented from being developed through the use of conservation easements or conversion of land

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.

into open space. Ordinances pertinent to the Town were discussed in Section 3.4. The following are general recommendations for flood damage prevention:

Planning and Zoning: Zoning and Subdivision ordinances in Warren regulate development in flood hazard areas. Flood hazard areas should reflect a balance of development and natural areas although ideally they will be free from development. Policies also require the design and location of utilities to areas outside of flood hazard areas when applicable and the placement of utilities underground when possible. The Subdivision Regulations include extensive criteria for stormwater management planning, including mandating the predevelopment and postdevelopment runoff rates be equal.

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

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

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

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.

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.

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 Warren 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 Land Use office 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. Performing such measures for RLPs would provide the greatest benefit to the town and the NFIP. Potential measures for property protection include:

- ❑ ***Relocation of structures at risk for flooding to a higher location on the same lot or to a different lot outside of the floodplain.*** Moving an at-risk structure to a higher elevation can reduce or eliminate flooding damages to the structure. If the structure is relocated to a new lot, the former lot can be converted to open space in a manner similar to that described under the Acquisition section above.
- ❑ ***Elevation of the structure.*** Home elevation involves the removal of the building structure from the basement and elevating it on piers to a height such that the first floor is located above the 1% annual chance flood level. The basement area is abandoned and filled to be no higher than the existing grade. All utilities and appliances located within the basement must be relocated to the first floor level.
- ❑ ***Construction of property improvements such as barriers, floodwalls, and earthen berms.*** Such structural projects can be used to prevent shallow flooding. There may be properties within the town where implementation of such measures will serve to protect structures.
- ❑ ***Performing structural improvements that can mitigate flooding damage.*** Such improvements can include:
 - ⇒ ***Dry floodproofing of the structure to keep floodwaters from entering.*** Walls may be coated with compound or plastic sheathing. Openings such as windows and vents would be either permanently closed or covered with removable shields. Flood protection should extend only two to three feet above the top of the concrete foundation because building walls and floors cannot withstand the pressure of deeper water.
 - ⇒ ***Wet floodproofing of the structure to allow floodwaters to pass through the lower area of the structure unimpeded.*** Wet floodproofing should only be used as a last resort. If considered, furniture and electrical appliances should be moved away or elevated above the 1% annual chance flood elevation.
- ⇒ ***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.

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.

- ❑ ***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 Warren 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.

Two RLPs are located in the town, and there may be other structures within the same floodplains that are also susceptible to flooding. The Town should consider and pursue projects that will mitigate flooding to these properties.

3.6.3 Emergency Services

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

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

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

3.6.4 Public Education and Awareness

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

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

3.6.5 Natural Resource Protection

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

Measures for preserving floodplain functions and resources typically include:

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

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

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

- ☐ Pursue additional open space properties in floodplains by purchasing 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.

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 Warren are listed below.

Prevention

- ☐ 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.
- ☐ 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.
- ☐ Consider conducting a Sucker Brook flood mitigation study to identify appropriate methods of reducing flood risks.
- ☐ Conduct an evaluation of Lake Waramaug to determine the cause of siltation within the lake and characterize the impact to flood storage.
- ☐ Obtain funding to remove sediment from Lake Waramaug.

Property Protection for Floodprone Properties

- ☐ Evaluate floodprone properties on Sucker Brook to determine potential flood damage reduction methods for these properties.
- ☐ Provide technical assistance regarding floodproofing measures to interested residents. Pursue funding for home elevations should any residents become interested.
- ☐ Reach out to owners of repetitive loss properties and provide technical assistance to reduce flood risks and NFIP claims.
- ☐ Encourage property owners to purchase flood insurance under the NFIP.

Public Education

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

Natural Resource Protection

- ☐ Pursue the acquisition of additional municipal open space inside SFHAs and set it aside as greenways, parks, or other nonresidential, noncommercial, or nonindustrial use.
- ☐ Selectively pursue conservation recommendations listed in the Plan of Conservation and Development and other studies and documents.

Structural Projects

- ❑ Increasing the capacity of the culverts at College Farm Road, Curtiss Road and Reed Road.
- ❑ Pursue riverbank stabilization along Sucker Brook.
- ❑ Review culvert conveyances based on existing hydrology and Northeast Regional Climate Center guidance.
- ❑ When replacing or upgrading culverts, work with CT DOT to incorporate findings of the climate change pilot study and work with HVA to incorporate findings of the stream crossing assessment training.

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 Section 10.1.

4.0 HURRICANES AND TROPICAL STORMS

4.1 Setting

Several types of hazards may be associated with tropical storms and hurricanes including heavy or tornado winds, heavy rains, and flooding. While only some of the areas of Warren 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 Warren. A hurricane striking Warren is considered a possible event each year and could cause critical damage to the town and its infrastructure.

4.2 Hazard Assessment

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

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

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

The Saffir-Simpson Scale

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

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

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

- ❑ **Category One Hurricane:** Sustained winds 74-95 mph (64-82 kt). Minimal Damage: Damage is primarily to shrubbery, trees, foliage, and unanchored mobile homes. No real damage occurs in building structures. Some damage is done to poorly constructed signs.
- ❑ **Category Two Hurricane:** Sustained winds 96-110 mph (83-95 kt). Moderate Damage: Considerable damage is done to shrubbery and tree foliage, some trees are blown down. Major structural damage occurs to exposed mobile homes. Extensive damage occurs to poorly constructed signs. Some damage is done to roofing materials, windows, and doors; no major damage occurs to the building integrity of structures.
- ❑ **Category Three Hurricane:** Sustained winds 111-130 mph (96-113 kt). Extensive damage: Foliage torn from trees and shrubbery; large trees blown down. Practically all poorly constructed signs are blown down. Some damage to roofing materials of buildings occurs, with some window and door damage. Some structural damage occurs to small buildings, residences and utility buildings. Mobile homes are destroyed. There is a minor amount of failure of curtain walls (in framed buildings).
- ❑ **Category Four Hurricane:** Sustained winds 131-155 mph (114-135 kt). Extreme Damage: Shrubs and trees are blown down; all signs are down. Extensive roofing material and window and door damage occurs. Complete failure of roofs on many small residences occurs, and there is complete destruction of mobile homes. Some curtain walls experience failure.
- ❑ **Category Five Hurricane:** Sustained winds greater than 155 mph (135 kt). Catastrophic Damage: Shrubs and trees are blown down; all signs are down. Considerable damage to roofs of buildings. Very severe and extensive window and door damage occurs. Complete failure of roof structures occurs on many residences and industrial buildings, and extensive shattering of glass in windows and doors occurs. Some complete buildings fail. Small buildings are overturned or blown away. Complete destruction of mobile homes occurs.

4.3 **Historic Record**

Through research efforts by the National Oceanic and Atmospheric Administration's (NOAA) National Climate Center in cooperation with the National Hurricane Center, records of tropical cyclone occurrences within the Atlantic cyclone basin have been compiled from 1851 to present. These records are compiled in NOAA's hurricane database (HURDAT), which contains historical data recently reanalyzed to current scientific standards as well as the most current hurricane data. During HURDAT's period of record (1851-2011), one Category Three Hurricane, five Category Two Hurricanes, eight Category One Hurricanes, and 42 tropical storms have tracked within a 150-nautical-mile radius of Warren. The representative storm strengths were measured as the peak intensities for each individual storm passing within the 150-mile radius. The 14 hurricanes noted above occurred in August through October as noted in Table 4-1.

TABLE 4-1
Tropical Cyclones by Month Within 150 Miles of Warren Since 1851

Category	June	July	August	September	October
Tropical Storm ¹	4	1	11	14	8
One	0	0	2	4	2
Two	0	0	3	2	0
Three	0	0	0	1	0
Total	4	1	16	21	10

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

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

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

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

- ❑ The "Great Atlantic Hurricane" hit the Connecticut coast in September 1944. This storm was a Category Three Hurricane at its peak intensity but was a Category One Hurricane when its center passed over eastern Long Island and made landfall near New London, Connecticut. The storm brought rainfall in excess of six inches to most of the state and rainfall in excess of eight to 10 inches in Fairfield County. Most of the wind damage from this storm occurred in southeastern Connecticut although wind gusts of 109 mph were reported in Hartford, Connecticut. Injuries and storm damage were lower in this hurricane than in 1938 because of increased warning time and fewer structures located in vulnerable areas due to the lack of rebuilding after the 1938 storm.
- ❑ Another Category Two Hurricane, Hurricane Carol (naming of hurricanes began in 1950), made landfall near Clinton, Connecticut in late August of 1954 shortly after high tide and produced storm surges of 10 to 15 feet in southeastern Connecticut. This storm was also a Category Three Hurricane at peak intensity. Rainfall amounts of six inches were recorded in New London, and wind gusts peaked at over 100 mph. Near the coast, the combination of strong winds and storm surge damaged or destroyed thousands of buildings, and the winds toppled trees that left most of the eastern part of the state without power. Overall damages in the northeast were estimated at one billion dollars (1954 USD), and 48 people died as a direct result of the hurricane.

- ❑ Hurricane Edna was a Category Two Hurricane when its center passed southeast of Long Island in September 1954.
- ❑ The year 1955 was a devastating year for flooding in Connecticut. Connie was a declining tropical storm over the Midwest when its effects hit Connecticut in August 1955, producing heavy rainfall of four to six inches across the state. The saturated soil conditions exacerbated the flooding caused by Tropical Storm Diane five days later, the wettest tropical cyclone on record for the northeast. The storm produced 14 inches of rain in a 30-hour period, causing destructive flooding conditions along nearly every major river system in the state.
- ❑ 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 Irene in August 2011 produced five to 10 inches of rainfall across western Connecticut resulting in widespread flash flooding and river flooding. Local wind gusts exceeded 60 miles per hour. The combination of strong winds and saturated soil led to numerous downed trees and power outages throughout the region. Flooding caused the greatest impacts in Warren. Wind damage and power outages were reportedly minor.
- ❑ 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. Town officials indicated that a few trees were downed and a few residents used the public shelters during Sandy, but overall damage was minimal.

4.4 Existing Capabilities

Flooding

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

Wind

Wind loading requirements are addressed through the state building code. The 2005 Connecticut State Building Code was amended in 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 Warren is 90 miles per hour. Warren 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. The Town has a tree warden and owns some tree maintenance equipment. The tree warden assists in managing all trees on Town-owned property, including within the street rights-of-way.

Connecticut Light & Power, the local electric utility, provides tree maintenance near its power lines. In an effort to speed up clean up processed after storms, the Town would like to work closely with CL&P to ensure faster response times to shut off live wires.

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

During Tropical Storm Irene, the Town used the CT Alert Everbridge system to notify all residents in the SFHA that they may evacuate and use one of the shelters.. 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 City and Block Island, Rhode Island. For this analysis, these data are assumed to represent western Connecticut and eastern Connecticut, respectively.

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

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

According to the 2014 *Connecticut Natural Hazard Mitigation Plan Update*, hurricanes have the greatest destructive potential of all natural disasters in Connecticut due to the potential combination of high winds, storm surge and coastal erosion, heavy rain, and flooding that can accompany the hazard. It is generally believed that New England is long overdue for another major hurricane strike. As shown in Table 4-2, NOAA estimates that the return period for a Category Two or Category Three storm to strike 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 Storms Irene in 2011 and Hurricane Sandy in 2012 were reminders that hurricanes do track close to Connecticut.

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

Tropical Cyclone Vulnerability

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

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

The Town of Warren 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, Warren 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.

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 Warren while areas susceptible to flooding are even more vulnerable. Areas of known and potential flooding problems are discussed in Section 3.0, and tornadoes (which sometimes develop during tropical cyclones) will be discussed in Section 5.0.

The Town is also considers the area along Curtiss Road a high-risk area during heavy wind events. This is largely due to weak or dead ash trees that have significant impact on utility services when they fall over.

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

However, the town hall is relatively new, with modern construction (2010), and is believed more resilient with regard to wind damage. The town hall is pictured to the right.

Some critical facilities are more vulnerable to wind damage associated with hurricanes than other critical facilities.



Warren's housing stock consists of historic buildings greater than 50 and sometimes 100 years old, relatively younger buildings built before 1990 when the building code changed to address wind damage, and relatively recent buildings that utilize the new code changes. Since most of the existing housing stock in the town predates the recent code changes, many structures are highly susceptible to roof and window damage from high winds. Homes located within SFHAs are also at risk from flooding as a result of the heavy rainfall that typically occurs during tropical storms and hurricanes.

As the Town of Warren 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.

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

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

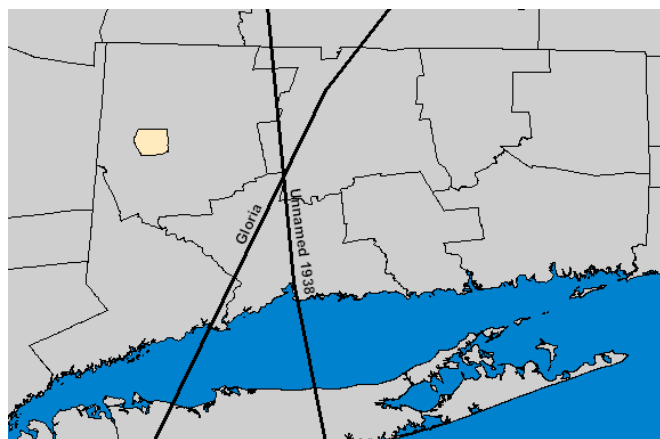


Figure 4-1: Historical Hurricane Storm Tracks

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 Warren. 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 68 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	37	None	None	None	None	None
20-Years	51	None	None	None	None	None
Gloria (1985)	58	None	None	None	None	None
50-Years	68	1	None	None	None	1
100-Years	80	10	None	None	None	10
200-Years	90	47	2	None	None	49
Unnamed (1938)	95	86	6	None	None	92
500-Years	102	155	18	None	None	173
1000-Years	110	259	48	4	3	314

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)	1	None	None	None	1
50-Years	1	None	None	None	1
100-Years	11	None	None	None	11
200-Years	49	2	None	None	51
Unnamed (1938)	89	6	None	None	95
500-Years	161	19	1	None	181
1000-Years	271	52	4	3	330

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 102 mph and greater with loss of use to all schools.

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

Return Period or Storm	School
10-Years	None or Minor
20-Years	None or Minor
Gloria (1985)	None or Minor
50-Years	None or Minor
100-Years	None or Minor
200-Years	None or Minor
Unnamed (1938)	None or Minor
500-Years	Minor Damage with loss of use to school
1000-Years	Minor damage with loss of use to school

Table 4-6 presents the estimated tonnage of debris that would be generated by wind damage during each HAZUS storm scenario. The model breaks the debris into four general categories based on the different types of material handling equipment necessary for cleanup. As shown in Table 4-6, minimal debris are expected for storms less than the 20-year event, and reinforced concrete and steel buildings are not expected to generate debris. Much of the debris that is generated is structure-related.

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

Return Period or Storm	Brick / Wood	Reinforced Concrete / Steel	Eligible Tree Debris	Other Tree Debris	Total
10-Years	None	None	None	None	None
20-Years	None	None	None	5	5
Gloria (1985)	None	None	1	12	13
50-Years	1	None	2	34	37
100-Years	12	None	44	833	889
200-Years	56	None	482	9,166	9,704
Unnamed (1938)	103	None	601	11,411	12,115
500-Years	204	None	703	13,363	14,270
1000-Years	432	None	1,545	29,346	31,323

Table 4-7 presents the potential sheltering requirements based on the various wind events simulated by HAZUS. There are no predicted sheltering requirements for wind damage. It is likely that hurricanes will produce heavy rain and flooding that may require sheltering need in Warren.

TABLE 4-7
HAZUS Hurricane Scenarios – Shelter Requirements

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

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	\$150	\$150	None	\$150
Gloria (1985)	\$10,690	\$10,690	None	\$10,690
50-Years	\$58,160	\$60,880	\$20	\$60,900
100-Years	\$227,800	\$234,240	\$2,470	\$236,710
200-Years	\$544,730	\$567,460	\$23,040	\$590,500
Unnamed (1938)	\$823,350	\$866,010	\$39,820	\$905,830
500-Years	\$1,487,050	\$1,596,870	\$170,070	\$1,766,940
1000-Years	\$3,351,770	\$3,652,540	\$524,820	\$4,177,350

Losses are minimal for storms with return periods of less than 20-years (51 mph) but increase rapidly as larger storms are considered. For example, a reenactment of the 1938 hurricane would cause approximately \$0.9 million in wind damages to Warren. 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 Warren. Based on the historic record and HAZUS-MH simulations of various wind events, the entire community is vulnerable to wind damage from hurricanes. These damages can include direct structural damages, interruptions to business and commerce, emotional impacts, and injury and possibly death.

4.6 Potential Mitigation Strategies and Actions

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

4.6.1 Prevention

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

- ☐ Perform periodic tree limb inspection and maintenance programs to ensure that the potential for downed power lines is diminished.
- ☐ Continue requiring the location of utilities underground in new developments or during redevelopment whenever possible.
- ☐ Continue to review and update the currently enacted Emergency Operations Plan, evacuation plans, supply distribution plans, and other emergency planning documents for the town as appropriate.
- ☐ Develop a phased approach to replacing aboveground utility lines with underground utility lines, taking advantage of opportunities such as streetscaping projects.

4.6.2 Property Protection

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

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

4.6.3 Emergency Services

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

4.6.4 Public Education and Awareness

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

4.6.5 Structural Projects

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

- ❑ Shutter mitigation projects protect all windows and doors of a structure with shutters, lamentations, or other systems that meet debris impact and wind pressure design requirements. All openings of a building are to be protected, including garage doors on

- residential buildings, large overhead doors on commercial buildings, and apparatus bay doors at fire stations.
- ❑ Load path projects improve and upgrade the structural system of a building to transfer loads from the roof to the foundation. This retrofit provides positive connection from the roof framing to the walls, better connections within the wall framing, and connections from the wall framing to the foundation system.
 - ❑ Roof projects involve retrofitting a building's roof by improving and upgrading the roof deck and roof coverings to secure the building envelope and integrity during a wind or seismic event.
 - ❑ Code plus projects are those designed to exceed the local building codes and standards to achieve a greater level of protection.

Given the relative infrequency of hurricane wind damage in the Town of Warren, 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 Warren are listed below.

- ❑ Develop a town wide tree limb inspection and maintenance programs to ensure that the potential for downed power lines is diminished.
- ❑ Remove weak or dead ash trees on Curtiss road in an effort to prevent utility damage during heavy wind events.
- ❑ The Building Department should have funding available to 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.
- ❑ Ensure that the town maximizes its use of the CT Alert Everbridge system by subscribing to as many residents as possible.

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 Warren. 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 Warren 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 Warren each year although lightning strikes have a limited effect. Strong winds and hail are considered likely to occur during such storms but also generally have limited effects. A tornado is considered a possible event in Litchfield County each year that could cause significant damage to a small area.

5.2 Hazard Assessment

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

Tornadoes

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

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

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

- ☐ A gustnado is a whirl of dust or debris at or near the ground with no condensation funnel 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.

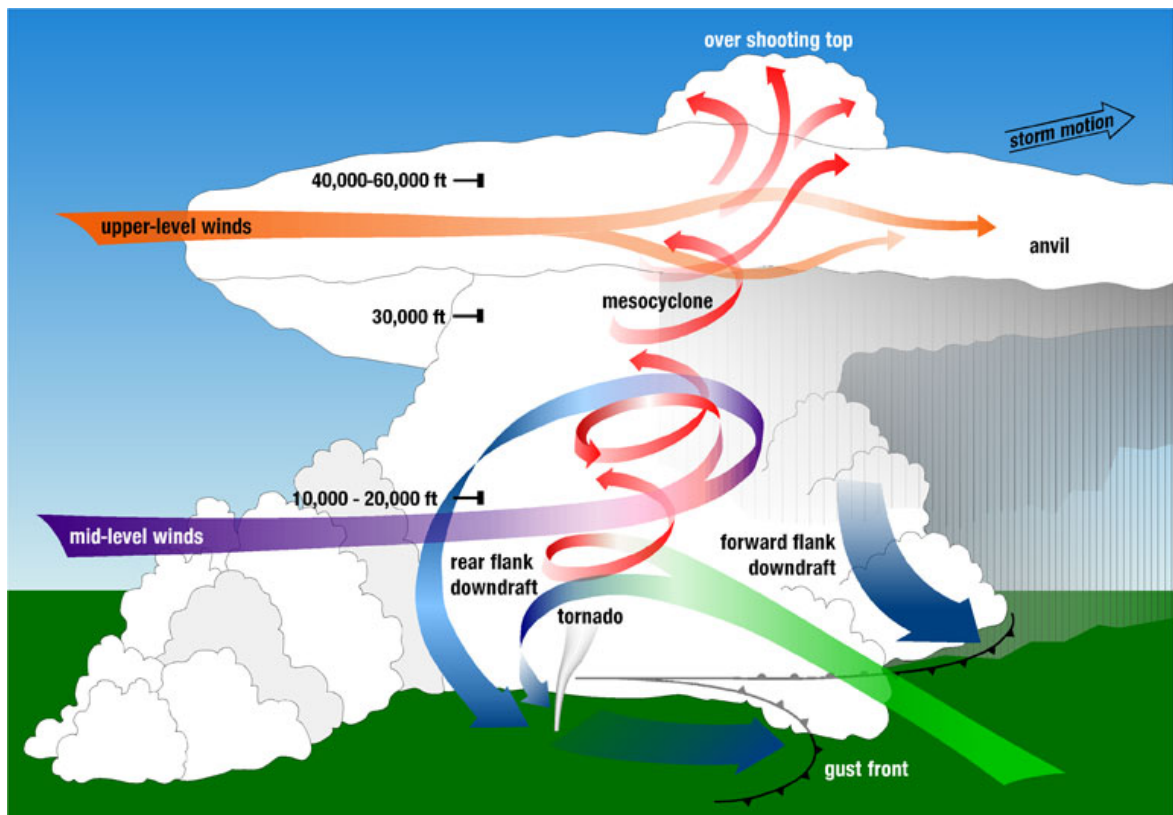
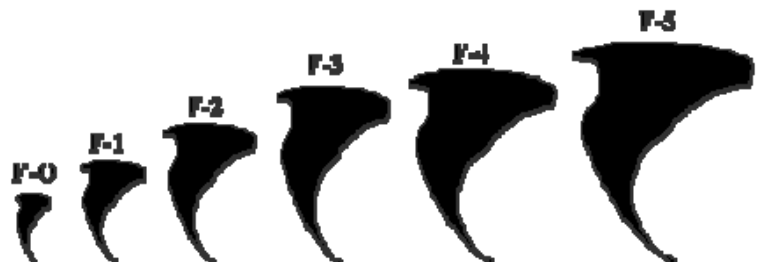


Figure 5-1: Anatomy of a Tornado. Image from NOAA National Severe Storms Laboratory.

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.



Fujita Tornado Scale. Image courtesy of FEMA.

**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	
<i>F Number</i>	<i>Fastest 1/4-mile (mph)</i>	<i>3-Second Gust (mph)</i>	<i>EF Number</i>	<i>3-Second Gust (mph)</i>	<i>EF Number</i>	<i>3-Second Gust (mph)</i>
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 Warren 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 Warren is presented in Section 5.3.

Downbursts

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

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

Downbursts fall into two categories:

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

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

Hail

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

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

5.3 Historic Record

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

An extensively researched list of tornado activity in Connecticut is available on Wikipedia. This list extends back to 1648 although it is noted that the historical data prior to 1950 is incomplete due to lack of official records and gaps in populated areas. Based on available information through July 2013, Litchfield County has experienced a total of 17 tornado events with reported damages totaling tens of millions of dollars. Table 5-3 summarizes the tornado events near Warren through July 2013 based on the Wikipedia list.

TABLE 5-3
Tornado Events Near Warren From 1648 to July 2012

Date	Location	Fujita Tornado Scale	Property Damage	Injuries / Deaths
June 3, 1836	Dutchess County NY to Salisbury CT	-	NR	NR
August 9, 1878	South Kent, CT	-	Major damages	No injuries
August 21, 1951	Southwest Litchfield County	F2	NR	NR
June 18, 1962	Litchfield County	F2	NR	NR
August 9, 1972	Southern Litchfield County	F1	NR	NR
June, 19 1975	Litchfield County	F1	NR	NR
July 10, 1989	Cornwall	F2	Damaged trees and homes	4 injured
May 31, 1998	Washington	F1	NR	NR

NR = None Reported

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

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

- ❑ May 24, 2009- Scattered thunderstorms were responsible for nickel sized hail that was reported near Cornwall during one event, immediately north of Warren.
- ❑ July 7, 2009- Severe thunderstorms developed leaving nickel sized hail in the Northville part of New Milford with several small tree limbs downed. Quarter sized hail was reported in New Hartford and Falls Village, golf ball sized hail in the Bakersville, and penny sized hail reported in Litchfield.
- ❑ July 26, 2009- Thunderstorms occurred across Litchfield County with some storms becoming severe. Nickel to ping pong ball sized hail was reported in New Milford and quarter sized hail was reported in Washington Depot, just south of Warren.
- ❑ July 21, 2010- A supercell moved across Litchfield County and produced intermittent damage along a track from Sharon to Litchfield with brief tornado touchdowns in East Litchfield, Thomaston, and Terryville. Hail ranging from a half inch up to golf ball size was reported in Litchfield and Torrington.
- ❑ June 8, 2011- Severe thunderstorms were triggered across Litchfield County with golf ball sized hail reported in Canaan, quarter sized hail reported in Falls Village and North Kent, and nickel sized hail approximately five miles northwest of Litchfield.

5.4 Existing Capabilities

Warning is the primary method of existing mitigation for tornadoes and thunderstorm-related hazards. The NOAA National Weather Service issues watches and warnings when severe weather is likely to develop or has developed, respectively. Tables 5-4 and 5-5 list the NOAA Watches and Warnings, respectively, as pertaining to actions to be taken by emergency management personnel in connection with summer storms and tornadoes.

TABLE 5-4
NOAA Weather Watches

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

TABLE 5-5
NOAA Weather Warnings

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

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

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

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

A severe thunderstorm warning is issued when a severe thunderstorm has been sighted or indicated by weather radar.

- ❑ 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
- ❑ Utilizing the CT Alert notification system to send warnings into potentially affected areas.

5.5 **Vulnerabilities and Risk Assessment**

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

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

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

In general, thunderstorms and hailstorms in Connecticut are more frequent in the western and northern parts of the state and less frequent in the southern and eastern parts. Thunderstorms are expected to impact Warren 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 Warren 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 Warren 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 is believed to be low for any given year. All areas of the town are susceptible to damage from high winds although more building damage is expected in the town center while more tree damage is expected in the less densely populated areas.

Secondary damage from falling branches and trees is more common than direct wind damage to structures. Heavy winds can take down trees near power lines, leading to the start and spread of fires. CL&P trims trees along power lines. The town tree warden can remove dead and diseased trees in rights-of-way or town land. 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 Warren are detected quickly, and any associated fires are quickly extinguished. Such fires can be extremely dangerous during the summer months during dry and drought conditions. It is important to have adequate water supply for fire protection to ensure the necessary level of safety is maintained.

Similar to the discussion for hurricanes in Section 4.5, no critical facility is believed to be more susceptible to summer storm damage than any other. Some critical facilities are more susceptible than others to flooding damage due to summer storms. Such facilities susceptible to flooding damage were discussed in Section 3.5.

In summary, the entire Town of Warren is at relatively equal risk for experiencing damage from summer storms and tornadoes. However, more frequent storm damages are relatively site specific and occur to private property (and therefore are paid for by private insurance). For municipal property, the Town budget for tree removal and minor repairs is generally adequate to handle summer storm damage.

5.6 Potential Mitigation Strategies and Actions

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

More information is available at:

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

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

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

NOAA information includes a discussion of family preparedness procedures and the best physical locations during a storm event. Although tornadoes pose a legitimate threat to public safety, as stated in Section 5.5 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, struck 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, additional mitigation strategies for mitigating thunderstorm winds, tornadoes, hail, and lightning are listed below:

- ☐ Develop a town wide tree limb inspection and maintenance programs to ensure that the potential for downed power lines is diminished.
- ☐ Remove weak or dead ash trees on Curtiss road in an effort to prevent utility damage during heavy wind events.
- ☐ The Building Department should have funding available to 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.
- ☐ Ensure that the town maximizes its use of the CT Alert Everbridge system by subscribing to as many residents as possible.

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

6.2 Hazard Assessment

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

- ❑ **Blizzards** include winter storm conditions of sustained winds or frequent gusts of 35 mph or greater that cause major blowing and drifting of snow, reducing visibility to less than one-quarter mile for three or more hours. Extremely cold temperatures and/or wind chills are often associated with dangerous blizzard conditions.
- ❑ **Freezing Rain** consists of rain that freezes on objects, such as trees, cars, or roads and forms a coating or glaze of ice. Temperatures in the mid to upper atmosphere are warm enough for rain to form, but surface temperatures are below the freezing point, causing the rain to freeze on impact.
- ❑ **Ice Storms** are forecasted when freezing rain is expected to create ice build-ups of one-quarter inch or more that can cause severe damage.
- ❑ **Nor'easters** are the classic winter storm in New England, caused by a warm, moist, low pressure system moving up from the south colliding with a cold, dry high pressure system moving down from the north. The nor'easter derives its name from the northeast winds typically accompanying such storms, and such storms tend to produce a large amount of rain or snow. They usually occur between November 1 and April 1 of any given year, with such storms occurring outside of this period typically bringing rain instead of snow.
- ❑ **Sleet** occurs when rain drops freeze into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and does not stick to objects. It can accumulate like snow and cause a hazard to motorists.
- ❑ **Snow** is frozen precipitation composed of ice particles that forms in cold clouds by the direct transfer of water vapor to ice.
- ❑ **Winter Storms** are defined as heavy snow events that have a snow accumulation of more than six inches in 12 hours or more than 12 inches in a 24-hour period.

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

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

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

TABLE 6-1
RSI Categories

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

RSI values are calculated within a GIS. The aerial distribution of snowfall and population information are combined in an equation that calculates the RSI score, which varies from around one for smaller storms to over 18 for extreme storms. The raw score is then converted into one of the five RSI categories. The largest RSI values result from storms producing heavy snowfall over large areas that include major metropolitan centers. Approximately 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. According to the NCDC, there have been 134 snow and ice events in the state of Connecticut between 1993 and April 2010, causing over \$18 million in damages. Additional examples of recent winter weather events to affect the Warren area, taken from the NCDC database, include:

- ❑ March 13-14, 1993 – A massive, powerful storm dubbed the "Storm of the Century" caused "whiteout" blizzard conditions stretching from Jacksonville, Florida into eastern Canada and affected 26 states, producing 24 inches of snow in Hartford and up to 21 inches of snow in New Haven County. A total of 40,000 power outages and \$550,000 in property damage was reported throughout Connecticut, and the state received a federal emergency declaration. The storm had a RSI rating of "Category 5 –Extreme" and is the second highest ranking storm recorded by RSI.
- ❑ January 15-16, 1994 – A Siberian air mass brought record to near-record low temperatures across Connecticut. Strong northwest winds accompanied the cold and drove wind chill values to 30 to 50 degrees below zero.
- ❑ December 23, 1994 – An unusual snowless late December storm caused gale force winds across the state. The high winds caused widespread power outages affecting up to 130,000 customers statewide. Numerous trees and limbs were blown down, damaging property,

vehicles, and power lines to a total of \$5 million in damages. Peak wind gusts of up to 64 mph were reported.

- ❑ January 7-8, 1996 – Winter Storm Ginger caused heavy snow and shut down the state of Connecticut for an entire day. The state received a federal major disaster declaration. The storm had a RSI rating of "Category 5 – Extreme" and is the third-highest ranked storm by RSI.
- ❑ March 31 – April 1, 1997 – A late season storm produced rain and wet snow. This storm caused over one million dollars in property damage and cost an additional one million dollars for snow removal and power restoration. This storm is ranked 36th on the RSI scale and is regarded as a "Category 2 – Significant" storm by RSI.
- ❑ November 13, 14, 1997 - A winter storm tracked from the southeast coast north to the coast of southern New England and then out to sea. In Litchfield county, heavy accumulations of sleet and freezing rain occurred after several inches of snow. The freezing rain produced scattered power outages and a brown out occurred in the New Preston area. Some specific snowfall totals included: 4 inches at Cornwall and 2 inches at New Preston.
- ❑ January 21, 2001 - A wave of low pressure developed along a stationary frontal boundary, across interior North Carolina, on Saturday January 20. This storm then deepened as it tracked northeastward by early Sunday morning, reaching a point about 100 miles east of Cape Cod by Sunday morning. This storm brought a significant snowstorm to Litchfield county during the predawn hours on Sunday January 21. A general 7-inch swath of snowfall was reported throughout the county. There were no unusual problems reported to the National Weather Service with this storm.
- ❑ February 17, 2003 – A heavy snowstorm caused near blizzard conditions and produced 24 inches of snow in areas of the state. The storm had a RSI rating of "Category 4 – Crippling" and is the 6th ranked winter storm by RSI. The State of Connecticut received a federal emergency declaration.
- ❑ February 12-13, 2006 – This nor'easter is ranked 30th overall and as a "Category 2 – Significant" storm on the RSI scale. The storm produced 18 to 24 inches of snow across Connecticut. Five Connecticut counties received a federal emergency declaration.
- ❑ December 19, 2008 – A winter storm produced 4.8 inches of snow in Cornwall just north of Warren.
- ❑ 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.
 - ❑ October 29, 2011 – Winter Storm Alfred (October 29-30, 2011) dumped up to 32" of snow and caused over 600,000 electrical customers in Connecticut to lose power for a significant amount of time. The entire state dealt with wet snow and ice and statewide power outages affecting Connecticut for a week or longer. The storm was unique in that much of the foliage had yet to fall from trees, which provided more surface area for snow to land and stick, therefore making the trees significantly heavier than if the storm was to occur when trees had lost their foliage. The storm resulted in the death of eight people in Connecticut, four from carbon monoxide poisoning. In all, approximately 90 shelters and 110 warming centers were opened state-wide. The overall storm impacts and damages resulted in another Presidential Disaster Declaration for Connecticut.
- In Warren, Winter Storm Alfred caused power outages up to four days. Mobile phones were down and communications were hindered town-wide.**
- ❑ 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. Town officials indicated that overall impacts from Nemo were minimal in Warren. However, snow removal was significant. The town submitted a FEMA public Assistance Reimbursement request in the amount of \$14,458 to recoup costs associated with snow assistance and emergency protective measures.

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

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

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

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

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 158-DR for Connecticut. A significant amount of snow removal was done throughout Warren during these storms, including the town hall and schools. However, the town did not experience any building collapses. This may be because Warren tends to get a lighter and drier snow than central and southern Connecticut.

6.4 Existing Capabilities

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

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

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

CTDOT plows all State roads and Interstates. The Town primarily uses Town staff for plowing operations on the remaining miles of roadway. The Town has several trucks for plowing.

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

6.5 Vulnerabilities and Risk Assessment

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 Warren, in particular, is susceptible to the impacts created by winter storms due to resource needs (heat, electricity loss, safe access to food, etc.).

The structures and utilities in the Town of Warren 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. The Town has indicated that Jack Corner Road and Tanner Hill Road have a higher risk of drifting snow than other areas.

Recall from Section 2.7 that elderly populations reside in the Town of Warren. It is possible that several members of the population impacted by a severe winter storm could consist of the elderly. It is important for Warren's emergency personnel to continue to be prepared to assist these special populations during emergencies such as winter storms.

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. However, Jack Corner Road and Tanner Hill Road have relatively higher risk of drifting snow compared to other parts of Warren. Snow drift control measures may be effective in these areas.

In summary, the entire Town of Warren is at relatively equal risk for experiencing damage from winter storms although some areas (such as icing trouble spots or roads with frequent snow drafts) are more vulnerable. Based on the historic record, it is difficult to determine if any winter storms have resulted in costly damages to the Town as damage estimates for severe storms are generally spread over an entire county. Many damages are relatively site specific and occur to private property (and therefore are paid for by private insurance) while repairs for power outages are often widespread and difficult to quantify to any one municipality.

6.6 Potential Mitigation Strategies and Actions

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

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

This can occur in both older buildings as well as newer buildings constructed in compliance with the most recent building codes. The Town should develop plans to prioritize the removal of snow from critical facilities and other municipal buildings and have funding available for this purpose. Heating coils may also be used to melt or evaporate snow from publicly and privately owned flat roofs.

6.6.3 Emergency Services

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

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

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

6.6.4 Public Education and Awareness

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

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

6.6.5 Structural Projects

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

6.7 Summary of Mitigation Strategies and Actions

Most of the recommendations in Section 3.6 for mitigating flooding and in Section 4.6 for mitigating wind damage are suitable for reducing certain types of damage caused by winter storms. These are not repeated in this subsection. While many potential mitigation activities for the remaining winter storm hazards were addressed in Section 6.6, the recommended mitigation strategies for mitigating wind, snow, and ice in the Town of Warren 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.
- ☐ Provide information on the dangers of cold-related hazards to people and property.
- ☐ 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 have funding available to 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 address snowdrift concerns in the vicinity of Jack Corner Road and Tanner Hill Road. Snow fencing and certain vegetation buffers may be helpful to reduce drifting.

7.0 EARTHQUAKES

7.1 Setting

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

7.2 Hazard Assessment

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

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

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

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

**TABLE 7-1
Comparison of Earthquake Magnitude and Intensity**

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

Unlike seismic activity in California, earthquakes in Connecticut are not associated with specific known faults. Instead, earthquakes with epicenters in Connecticut are referred to as intraplate activity.

Bedrock in Connecticut and New England in general is highly capable of transmitting seismic energy; thus, the area impacted by an earthquake in Connecticut can be four to 40 times greater than that of California. For example, the relatively strong earthquake that occurred in Virginia in 2011 was felt in Connecticut because the energy was transmitted over a great distance through hard bedrock.

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

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

7.3 **Historic Record**

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

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.

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.

- ❑ 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 Timiskaming, 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 a 2.0 magnitude earthquake with its epicenter occurred 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 a magnitude 5.8 earthquake that occurred 38 miles from Richmond, Virginia on August 23, 2011. The quake was felt from Georgia to Maine and reportedly as far west as Chicago. Many residents of Connecticut experienced the swaying and shaking of buildings and furniture during the earthquake although widespread damage was constrained to an area from central Virginia to southern Maryland. According to Cornell University, the August 23 quake was the largest event to occur in the east central United States since instrumental recordings have been available to seismologists.

7.4 Existing Capabilities

The Connecticut Building Codes include design criteria for buildings specific to each municipality as adopted by the Building Officials and Code Administrators (BOCA). These include the seismic coefficients for building design in the Town of Warren. 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 2010 regulations do not explicitly address the issue of construction on steep slopes. However, Section 5.5 states that “in reviewing the potential for further subdivision, the Commission shall consider the location of wetlands, steep slopes, sight lines and factors associated with potential building lots, driveway access and roads. The regulations also require that soil erosion and sediment control plans be developed for proposed projects.
- ❑ ***Zoning Regulations.*** The Town's Zoning Regulations address slope and soils management through the Excavation and Grading standards (Section 25).

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.

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.

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.

As explained in Section 2.3, some areas in the Town of Warren are underlain by sand and gravel, particularly in the northern sections of the town. 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 Warren, 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.

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.

*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.*

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 Warren. Results are presented in Table 7-2 below.

TABLE 7-2
Probability of a Damaging Earthquake in the Vicinity of Warren

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 Warren 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 Warren.

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 Warren. 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 D and presented below. These results are believed conservative and considered appropriate for planning purposes in Warren. 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	32	6	None	None	38
Portland – 5.7	35	7	None	None	42
Stamford – 5.7	29	6	None	None	35
East Haddam – 6.4	83	21	2	None	106

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	35	7	1	None	43
Portland – 5.7	38	8	1	None	47
Stamford – 5.7	31	6	1	None	38
East Haddam – 6.4	90	24	3	None	117

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	Schools (1)
Haddam – 5.7	Minor damage (84% functionality)
Portland – 5.7	Minor damage (83% functionality)
Stamford – 5.7	Minor damage (85% functionality)
East Haddam – 6.4	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 Warren transportation network and utility network includes the following:

- ❑ Highway: 3 major roadway bridges;
- ❑ A potable water system consisting of 123 total kilometers of pipelines;
- ❑ A waste water system consisting of 74 total kilometers of pipelines and;
- ❑ A total of 49 kilometers of natural gas lines

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

As shown in Table 7-6, highway bridges are not predicted to experience damage under any earthquake scenario. Although water, sewer, and gas lines are expected to have leaks and breaks, no loss of potable water or electrical service is expected. No displacement of people due to fire is expected.

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

Epicenter Location and Magnitude	Transportation Network	Utilities	Fire Damage
Haddam – 5.7	No damage	2 leaks in potable water system (<\$0.01 million). No loss of service expected. Total damage: Approximately \$0.01 million.	Fire damage will displace no people.
Portland – 5.7	No damage	1 leak in potable water system (<\$0.01 million). No loss of service expected. Total damage: Approximately \$0.01 million.	Fire damage will displace no people.
Stamford – 5.7	No damage	1 leak in potable water system (<\$0.01 million). No loss of service expected. Total damage: Approximately \$0.01 million.	Fire damage will displace no people.
East Haddam – 6.4	No damage	5 leaks and 1 major break in potable water system (\$0.02 million), 2 leaks and 1 major break in waste water system (\$0.01 million) and 1 leak in natural gas system (<\$0.01 million). No loss of service expected. Total damage: Approximately \$0.04 million.	Fire damage will displace no people.

For all earthquake scenarios there is no estimated debris generation for Warren. There are no predicted sheltering requirements or casualty estimates for all earthquake scenarios simulated by HAZUS-MH. However, it is possible that an earthquake could also produce a dam failure

(flooding) or be a contingent factor in another hazard event that could increase the overall sheltering need in the community. All earthquake scenarios cause only minor injuries or no injury at all.

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

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

Epicenter Location and Magnitude	Estimated Total Capital Losses	Estimated Total Income Losses	Estimated Total Losses
Haddam – 5.7	\$290,000	\$60,000	\$350,000
Portland – 5.7	\$320,000	\$70,000	\$390,000
Stamford – 5.7	\$240,000	\$50,000	\$290,000
East Haddam – 6.4	\$1,020,000	\$220,000	\$1,230,000

The maximum simulated damage considering direct losses and infrastructure losses is approximately \$1.2 million for the East Haddam scenario. Note that the losses are presented in 2006 dollars, which implies that they will be greater in the future due to inflation. It is also believed that the next plan update will be able to utilize 2010 census data within HAZUS-MH, providing a more recent dataset for analysis.

Despite the low probability of occurrence of damaging earthquakes, this analysis demonstrates that earthquake damage presents a potential hazard to Warren.

7.6 Potential Mitigation Strategies and Actions

As earthquakes are difficult to predict and can affect the entire Town of Warren, 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. 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 personnel 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 IT systems (Warren's town hall IT system is pictured to the right), 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, Warren will activate its Emergency Operations Plan and initiate emergency response procedures as necessary.

7.7 Summary of Specific Strategies and Actions

The following potential mitigation measures have been identified:

- ☐ Consider preventing new residential development in areas most prone to collapse or liquefaction.
- ☐ Ensure that municipal departments have backup plans and adequate backup facilities such as portable generators in place in case earthquake damage occurs to critical facilities, particularly the water and wastewater treatment facilities.
- ☐ The Town may consider bracing systems and assets inside critical facilities. This could help protect IT systems, important records and files, libraries.

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. With two inventoried high hazard dam within town limits, and potentially several other minor dams in the town, dam failure can affect several discrete parts of Warren. While flooding from a dam failure generally has a moderate geographic extent, the effects are potentially catastrophic. Fortunately, a major dam failure is considered only a possible hazard event in any given year.

8.2 Hazard Assessment

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

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

As of 2013, there were 15 DEEP-inventoried dams within the Town of Warren. These dams are shown in Figure 8-1. Two of these dams are considered high hazard and significant hazard (Class B or C). As shown in Table 8-1, the two high hazard dams in the town are owned the City of Waterbury to impound water for public water supply.

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

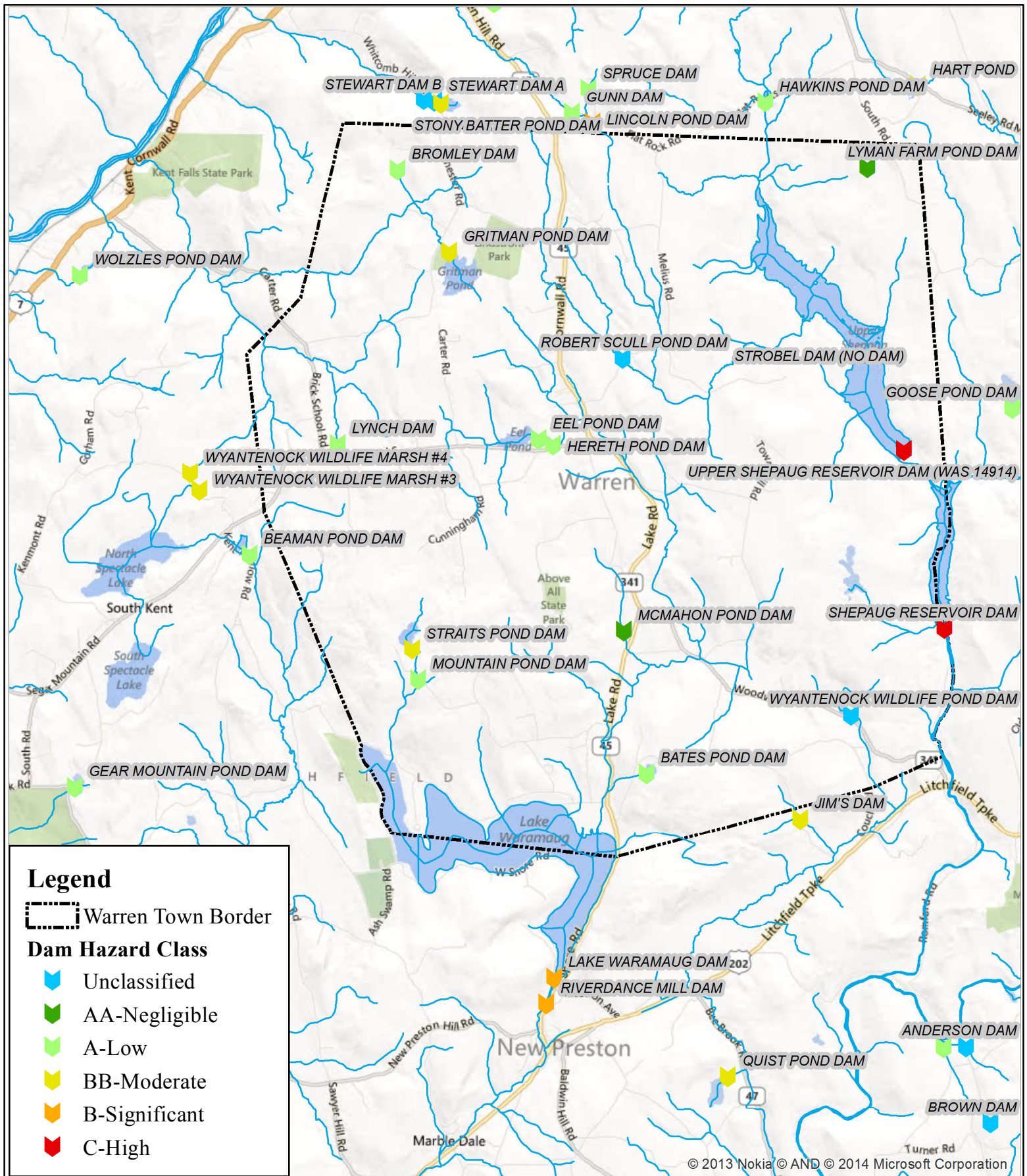


TABLE 8-1
High Hazard Dams with Potential to Affect the Town of Warren

Number	Name	Location	Class	Owner
14901	Upper Shepaug Reservoir	West Br Shepaug River, Warren	C	City of Waterbury
14912	Shepaug Reservoir	Shepaug River, Warren	C	City of Waterbury

8.3 Historic Record

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

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

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

TABLE 8-2
Dams Damaged Due to Flooding From October 2005 Storms

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

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

8.4 Existing Capabilities

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

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

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

Dams 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.

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.

Section 4.1.e of Warren's *Inland Wetlands and Watercourse Regulations* notes that the state regulates the construction or modification of any dam. In addition, owners of Class C dams are required to maintain Emergency Action Plans (EAPs). These types of plans were formerly known as Emergency Operation Plans (EOPs). The City of Waterbury maintains such plans for each of its Class C dams located in the Town of Warren. These include the Shepaug Reservoir Dam and Upper Shepaug Reservoir Dam. The Waterbury-owned water supply dams are inspected biennially by a licensed engineer. The Connecticut DEEP routinely performs inspections and prepares summary reports.

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

8.5 Vulnerabilities and Risk Assessment

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

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*. As such, they are appropriate for use in the Ct Alert emergency call database. These analyses should not be interpreted to imply that the dams evaluated are not stable, that the routine operation of the dams presents a safety concern to the public, or that any particular structure downstream of the dam is at imminent risk of being affected by a dam failure.

The Shepaug Reservoir Dam and Upper Shepaug Reservoir Dam are used as water supply dams for the City of Waterbury. Mapped failure inundation areas extend downstream through Warren into the Town of Washington as the reservoirs flow into each other in a southerly direction.

Upper Shepaug Reservoir (Dam No. 14901) - West Br Shepaug River, Warren

The Upper Shepaug Reservoir Dam, also known as the Cairns Dam, is a Class C dam located at the southern end of Cairns Reservoir and impounds a storage volume of 13,942 acre-feet from a contributing watershed of 10.4 square miles. The earthen dam was constructed in 1965 and is 87 feet in height and 1,000 feet in length. A 96" RCP diversion pipe through center of dam acts as a secondary outlet. It is owned by the City of Waterbury and used to impound a reservoir for public water supply. The structure was modified for flow monitoring in 2007 by the City of Waterbury (installation of a meter with phone/electric lines). In June 2008, the Waterbury Water Department installed release structures and gate valves in two existing 48" gates that serve the dam, as well as an automated gate valve control system.

An Emergency Operation Plan and Operation and Maintenance Manual were developed for the City of Waterbury in June 1989 by HRP Associates and revised in February 1991. The June 1989 plan includes a dam breach analysis. The analysis notes that the first significant downstream features are the Shepaug Reservoir and Dam. The model indicates that the Shepaug River Dam (described below) would begin breaching approximately 25 minutes after the Upper Shepaug Reservoir Dam breach begins.

Two bridges would be flooded to 10 to 44 feet above their decks, including Dugway Road and Valley Road. Population centers would be at risk from a flood wave. Woodville would be reached first at the 30-minute mark. The peak flood wave passage would occur approximately 30 minutes after the initial flood wave hits the area.

Shepaug Reservoir (Dam No. 14912) - Shepaug River, Warren

The Shepaug Reservoir Dam is a Class C dam located at the southern end of the Lower Shepaug Reservoir and impounds a storage volume of 2,937 acre-feet from a contributing watershed of 38.2 square miles. It is owned by the City of Waterbury and used to impound a reservoir for public water supply. The concrete gravity dam was constructed in 1933 and is 65 feet in height and 500 feet in length. The crest is approximately 8.5-feet above the spillway. A gate chamber discharges through the Shepaug Aqueduct to Fitch Reservoir or through two 48" blowoffs to Shepaug River. The Shepaug River downstream of the dam is contained within stone masonry walls.

The structure was inspected on April 23, 1997, and no major repair issues were noted. The structure was modified for flow monitoring in 2007. Repairs were permitted in February 2013 that included the restoration of downstream masonry training walls that had collapsed after TS Irene. The repairs were made possible using FEMA funds and were completed as of September 2013.

An EAP for the Shepaug Reservoir Dam was prepared in 2001 addressing actions to be taken during an emergency. The City of Waterbury is responsible for notifying all emergency response personnel. A 1982 Management Plan by HRP Associates includes the results of the dam breach analysis documented in the Upper Shepaug Reservoir EOP. The analysis indicates that Valley Road (from Shepaug River Dam to Warren/Washington Town Line) would be inundated by a flood wave.

Town officials noted that no emergency action plans are on file for any dams in Warren. This appears to be correctable, as Waterbury maintains EOPs for its two dams.

Other Dams

Town officials noted one dam (Gritman Pond Dam) is owned by the town. This is a Class BB dam (moderate hazard). Town officials also indicated that two of the DEEP-registered dams (Robert Scull Pond and Strobel, both unclassified hazard dams) are really beaver dams. If dams are truly not present, DEEP should be contacted about correcting its files for these “dams.”

8.6 Potential Mitigation Strategies and Actions

Dam failure presents a very real potential hazard to the Town of Warren. The Town should maximize its emergency preparedness for a potential dam failure by including potential inundation areas in the Town's CT Alert emergency notification database. The town may also wish to revise its dam failure inundation mapping to be based on a "more likely" failure scenario than a failure during the PMF (probable maximum flood) event. The analyses presented in Section 8.5 indicate that the majority of the inundation areas from each failure are related to the PMF and not to floodwaters from a dam failure occurring under normal flow conditions. For dams without a mapped failure inundation area, the 1% annual chance floodplain described in Section 3.1 could be utilized to provide approximate inundation areas.

The Town should inform private dam owners of potential resources available to them through various governmental agencies upon request. In particular, the Town should be prepared to provide technical assistance to private dam owners should they wish to develop Dam Failure Analyses and EAPs.

FEMA and the Association of Dam Safety Officials have a variety of resources available for dam owners. More information can be found at <http://www.fema.gov> and at <http://www.damsafety.org/resources/downloads/>

The Town should work with the Connecticut DEEP to stay up to date on the evolution of any EAPs and Dam Failure Analyses for the high and significant hazard dams in and around Warren should any be produced. In addition, copies of these documents should be made available in the Town Land Use Department for reference and public viewing, with a posted caveat that these documents show the potential inundation area for a dam failure caused by an extreme flood event that is very unlikely to occur.

8.7 Summary of Specific Strategies and Actions

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

- ☐ Include dam failure inundation areas in the CT Alert emergency contact database.
- ☐ Work with DEEP to update the registered dams list to indicate that Robert Scull Pond and Strobel are beaver dams.
- ☐ Ensure that EOPs/EAPs are on file for all high hazard dams located in Warren, including the two owned by the City of Waterbury.

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

9.0 **WILDFIRES**

9.1 **Setting**

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

The Town of Warren is generally considered a high risk area for 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 Warren are extensive. 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 nonstructure fire, other than a prescribed burn, that occurs in undeveloped areas. They are considered to be highly destructive, uncontrollable fires. Although the term brings to mind images of tall trees engulfed in flames, wildfires can occur as brush and shrub fires, especially under dry conditions. Wildfires are also known as "wildland fires." Areas within Warren vulnerable to wildfire are shown in Figure 9-1. 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.

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.

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

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

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

Warren has experienced a few five-acre wildfires over the last few years. One notable fire was behind Brick School Road. The town has some high-risk areas where Mountain Laurel and brush are found.

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.

Warren has mutual aid agreements with Kent and Washington for firefighting support. They borrow Washington's Gator and Kent's off-road vehicle if needed. Because of the number of State forests in Warren, DEEP personnel are often at forest fires and have a significant amount of experience.

The Town does not have an ordinance specifically requiring a source of fire protection water, such as cisterns or dry wells when municipal water service is not available for residential or commercial building development. However, the subdivision regulations state that the Commission "may require" cisterns or tanks for fire protection. The town has 13 dry hydrants, which are tested annually.

Unlike the west coast of the United States where the fires are allowed to burn toward development and then stopped, the Warren Fire Department goes to the fires whenever possible. This proactive approach is believed to be effective for controlling wildfires. The Fire Department has some water storage capability in its tanker trucks and storage tanks but primarily relies on the use of the municipal water system to fight fires throughout the town whenever possible.

Other capabilities for reducing wildfire risk include:

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

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

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

As noted above, Warren has experienced a few five-acre wildfires over the last few years. One notable fire was behind Brick School Road. The town has some high-risk areas where Mountain Laurel and brush are found.

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 Specific Strategies and Actions

The following recommendations could be implemented to mitigate fire risk:

- ☐ The Town should continue to require the installation of fire protection water in new developments, and sprinkler systems where access is limited for fire apparatus.
- ☐ Increase the availability of water sources in the town's areas of high risk, using the historic record (fires exceeding five acres) as a benchmark for locating high risk areas.
- ☐ Revise and enhance the town's website concerning the local regulatory requirements concerning Open Burning.

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

10.0 HAZARD MITIGATION STRATEGIES AND ACTIONS

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

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. As noted in Section 2.9, Town officials have indicated that communications in Warren are problematic. The town can send email blasts, but this action is not helpful when power is out. Therefore, the Town should utilize the CT Alert Everbridge system to its fullest capabilities. Databases should be set up as best possible for hazards with a specific geographic extent, particularly flooding and dam failure. Residents should also be encouraged to purchase a NOAA weather radio containing an alarm feature. In addition, the Town EOP should continue to be reviewed and updated at least once annually.

Public survey participants from Warren noted that mobile phone service can be challenging to rely on during disasters, and that it could be improved while ensuring that landlines are protected from outages. The strategies in this plan about protecting overhead utility lines will help maintain landline reliability whether the service provider is AT&T or a cable company, but new mobile phone facilities such as towers are needed to improve mobile phone reliability. The town can look for opportunities to increase coverage in Warren.

Public survey participants also requested that seminars be made available in Warren to prepare people for various hazards. This is something that can be coordinated by the EMD and supported with publications available free of charge from FEMA.

Finally, provision of standby power is considered important in Warren. The Warren Community Center on Sackett Hill Road is the primary shelter for the town. The Warren Academy on Sackett Hill Road is considered the backup shelter. Both facilities have backup generators. However the third shelter (Warren Woods) does not have standby power. This shelter is also the designated shelter for large animals. Securing standby power for Warren Woods may be desirable.

Warren Elementary School would act as an overflow shelter if needed. However, the Department of Emergency Management and Homeland Security (DEMHS) Region 5 has indicated that they prefer that the schools are not used as shelters and the town has followed this directive.

10.2 Summary of Proposed Strategies and Actions

Strategies and actions have been presented throughout this document in individual sections as related to each hazard. This section lists specific strategies of the Plan without any priority ranking. Strategies that span multiple hazards are only reprinted once in this section under the

most appropriate hazard event. Refer to the matrix in Appendix A for strategies with scores based on the STAPLEE methodology described in Section 1.0.

All Hazards

- ☐ Utilize the existing CT Alert emergency notification system to its fullest capabilities.
- ☐ Encourage residents to purchase and use NOAA weather radios with alarm features.
- ☐ Identify opportunities to work with utilities to increase mobile phone coverage in Warren.
- ☐ Review and update the Town EOP at least once annually.
- ☐ Provide standby power supply to Warren Woods.

Flooding

Prevention

- ☐ 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.
- ☐ 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.
- ☐ Consider conducting a Sucker Brook flood mitigation study to identify appropriate methods of reducing flood risks.
- ☐ Conduct an evaluation of Lake Waramaug to determine the cause of siltation within the lake and characterize the impact to flood storage.
- ☐ Obtain funding to remove sediment from Lake Waramaug.

Property Protection for Floodprone Properties

- ☐ Evaluate floodprone properties on Sucker Brook to determine potential flood damage reduction methods for these properties.
- ☐ Provide technical assistance regarding floodproofing measures to interested residents. Pursue funding for home elevations should any residents become interested.
- ☐ Reach out to owners of repetitive loss properties and provide technical assistance to reduce flood risks and NFIP claims.
- ☐ Encourage property owners to purchase flood insurance under the NFIP.

Public Education

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

Natural Resource Protection

- ☐ Pursue the acquisition of additional municipal open space inside SFHAs and set it aside as greenways, parks, or other nonresidential, noncommercial, or nonindustrial use.
- ☐ Selectively pursue conservation recommendations listed in the Plan of Conservation and Development and other studies and documents.

Structural Projects

- ☐ Increasing the capacity of the culverts at College Farm Road, Curtiss Road and Reed Road.
- ☐ Pursue riverbank stabilization along Sucker Brook.
- ☐ Review culvert conveyances based on existing hydrology and Northeast Regional Climate Center guidance.
- ☐ When replacing or upgrading culverts, work with CT DOT to incorporate findings of the climate change pilot study and work with HVA to incorporate findings of the stream crossing assessment training.

Emergency Services

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

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

- ☐ Develop a town wide tree limb inspection and maintenance programs to ensure that the potential for downed power lines is diminished.
- ☐ Remove weak or dead ash trees on Curtiss road in an effort to prevent utility damage during heavy wind events.
- ☐ The Building Department should have funding available to 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.
- ☐ Provide information on the dangers of cold-related hazards to people and property.
- ☐ 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 have funding available to 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 address snowdrift concerns in the vicinity of Jack Corner Road and Tanner Hill Road. Snow fencing and certain vegetation buffers may be helpful to reduce drifting.

Earthquakes

- ❑ Consider preventing new residential development in areas most prone to collapse or liquefaction.
- ❑ Ensure that municipal departments have backup plans and adequate backup facilities such as portable generators in place in case earthquake damage occurs to critical facilities, particularly the water and wastewater treatment facilities.
- ❑ The Town may consider bracing systems and assets inside critical facilities. This could help protect IT systems, important records and files, libraries.

Dam Failure

- ❑ Include dam failure inundation areas in the CT Alert emergency contact database.
- ❑ Work with DEEP to update the registered dams list to indicate that Robert Scull Pond and Strobel are beaver dams.
- ❑ Ensure that EOPs/EAPs are on file for all high hazard dams located in Warren, including the two owned by the City of Waterbury.

Wildfires

- ❑ The Town should continue to require the installation of fire protection water in new developments, and sprinkler systems where access is limited for fire apparatus.
- ❑ Increase the availability of water sources in the town's areas of high risk, using the historic record (fires exceeding five acres) as a benchmark for locating high risk areas.
- ❑ Revise and enhance the town's website concerning the local regulatory requirements concerning Open Burning.

10.3 Priority Projects and Procedures

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

1. Consider conducting a Sucker Brook flood mitigation study to identify appropriate methods of reducing flood risks.
2. Reach out to owners of repetitive loss properties and provide technical assistance to reduce flood risks and NFIP claims.
3. Continue to require the installation of fire protection water in new developments, and sprinkler systems where access is limited for fire apparatus.
4. Evaluate floodprone properties on Sucker Brook to determine potential flood damage reduction methods for these properties.
5. Provide outreach regarding home elevation and relocation, flood barriers, dry floodproofing, wet floodproofing, and other home improvement techniques to private homeowners and businesses with flooding problems.

6. Develop a plan to prioritize snow removal from the roofs 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 (to be updated in 2019, within the timeframe of this HMP).

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

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

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

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

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 Town Highway Department.

The Plan of Conservation and Development already includes several aspects of hazard mitigation. As noted on page 3-7 of this Hazard Mitigation Plan, the Plan of Conservation and Development recommends that the town maintain policies and programs to help protect water resources such as wetland and watercourse regulations and floodplain regulations and requirements for buffers and setbacks near important water resources; to enact new requirements for low impact development such as a no increase in the rate of runoff from a site and no increase in the amount of runoff from a site for certain storm events; and to make improvements to drainage system as problems often arise due to rainfall intensity and topography.

11.2 Progress Monitoring and Public Participation

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

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

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

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

Repetitive loss properties to be viewed biennially

Annual Reporting and Meeting – The local coordinator will be responsible for holding an annual meeting to review the plan. Matters to be reviewed on an annual basis include the goals and objectives of the HMP, hazards or disasters that occurred during the preceding year, mitigation activities that have been accomplished to date, a discussion of reasons that implementation may be behind schedule, and suggested actions for new projects and revised activities. Results of site reconnaissance efforts will be reviewed also. A meeting should be conducted in March or April of each year, at least two months before the annual application cycle for grants under the HMA program³. This will enable a list of possible projects to be circulated to applicable local departments to review and provide sufficient time to develop a grant application. The local coordinator shall prepare and maintain documentation and minutes of this annual review meeting.

Annual meeting to be conducted in March or April each year

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

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

³ PDM and FMA applications were most recently due in June 2014. A similar timetable may be anticipated in future years.

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

11.3 **Updating the Plan**

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

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

TABLE 11-1
Schedule for Hazard Mitigation Plan Update

Month and Year	Tasks
December 2015	Annual meeting to review plan content and progress
December 2016	Annual meeting to review plan content and progress
December 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
December 2018	Annual meeting to review plan content and progress
	Secure consultant to begin updating the plan, or begin updating in-house
May 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)
December 2019	Adopt updated plan

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

- ☐ The Northwest Hills Council of Governments
- ☐ Town of Kent

- ☐ Town of Washington
- ☐ Town of Litchfield
- ☐ Town of Cornwall

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

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

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

11.4 Technical and Financial Resources

This section is comprised of a list of resources to be considered for technical assistance and potential 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. ASFPM has developed a series of technical and topical research papers and a series of Proceedings from their annual conferences. Many "mitigation success stories" have been documented through these resources and provide a good starting point for planning.

Connecticut Association of Flood Managers (CAFM)

P.O. Box 960
Cheshire, CT 06410
ContactCAFM@gmail.com

CAFM is a professional association of private consultants and local floodplain managers that provides training and outreach regarding flood management techniques. CAFM is the local state chapter of ASFPM.

Institute for Business & Home Safety

4775 East Fowler Avenue
Tampa, FL 33617
(813) 286-3400
<http://www.ibhs.org/>

A nonprofit organization put together by the insurance industry to research ways of reducing the social and economic impacts of natural hazards. The Institute advocates the development and implementation of building codes and standards nationwide and may be a good source of model code language.

Multidisciplinary Center for Earthquake Engineering and Research (MCEER)

University at Buffalo
State University of New York
Red Jacket Quadrangle
Buffalo, New York 14261
(716) 645-3391
<http://mceer.buffalo.edu/>

A source for earthquake statistics, research, and for engineering and planning advice.

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

1301 K Street, NW, Suite 800 East
Washington, DC 20005
(202) 218-4122
<http://www.nafsma.org>

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

National Emergency Management Association (NEMA)

P.O. Box 11910
Lexington, KY 40578
(859)-244-8000
<http://www.nemaweb.org/>

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

Natural Hazards Center

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

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

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

Flood Relief Funds - After a disaster, local businesses, residents, and out-of-town groups often donate money to local relief funds. They may be managed by the local government, one or more local churches, or an ad hoc committee. No government disaster declaration is needed.

Local officials should recommend that the funds be held until an applicant exhausts all sources of public disaster assistance, allowing the funds to be used for mitigation and other projects that cannot be funded elsewhere.

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

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APPENDIX A
STAPLEE MATRIX

Strategies for the Town of Warren	Report Sections							Category	Responsible ¹ Department	Schedule	Cost	Potential Funding Sources ³	Weighted STAPLEE Criteria ⁴																Total STAPLEE Score
	Flooding	Hurricanes and Tropical Storms	Summer Storms and Tornadoes	Winter Storms	Earthquakes	Dam Failure	Fires						Benefits								Costs								
													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																													
Utilize the existing CT Alert emergency notification system to its fullest capabilities with as many residents participating as possible.	x	x	x	x	x	x	x	5	EM	2015	Low	Municipal	1	1	1	1	1	0	0	6.0	0	0	0	0	0	0	0	0.0	6.0
Encourage residents to purchase and use NOAA weather radios with alarm features.	x	x	x	x	x	x	x	5	EM	2016	Low	Municipal	1	1	1	1	1	0	0	6.0	0	0	0	0	0	0	0	0.0	6.0
Identify opportunities to work with utilities to increase mobile phone coverage in Warren.	x	x	x	x	x	x	x	6	PW	2015	Low	Municipal, Verizon, AT&T	1	1	1	1	1	0.5	0	7.0	0	0	-0.5	0	0	0	0	-0.5	6.5
Review and update the Town EOP at least once annually.	x	x	x	x	x	x	x	1	EM	2015	Low	Municipal	1	1	1	1	1	0	0	6.0	0	0	0	0	0	0	0	0.0	6.0
Provide standby power supply to Warren Woods.	x	x	x	x	x	x	x	6	PW	2016	Low	Municipal, HMA*	1	1	1	1	1	1	0	8.0	0	0	0	0	0	-1	0	-2.0	6.0
FLOODING - Prevention																													
Compile a checklist cross referencing flood-related ordinances and regulations and make this available to development applicants	x	x	x				x	1	P&Z	2016	Low	Municipal	1	1	1	1	1	0	1	7.0	0	0	-0.5	0	0	0	0	-0.5	6.5
Consider requiring new buildings constructed in floodprone areas to be protected to the highest recorded flood level regardless of being within a defined SFHA.	x	x	x				x	1,2	P&Z	2017	Low	Municipal	1	1	1	1	1	0	1	7.0	0	0	0	-0.5	-0.5	0	0	-1.0	6.0
Require developers to demonstrate whether detention or retention of stormwater is the best option for reducing peak flows downstream of a project and provide a design for the appropriate alternative.	x	x	x				x	1, 2	P&Z	2016	Low	Municipal	1	1	1	1	1	0	1	7.0	0	0	-0.5	-0.5	-0.5	0	0	-1.5	5.5
Consider conducting a Sucker Brook flood mitigation study to identify appropriate methods of reducing flood risks.	x	x	x				x	1, 2	PW	2016	Intermediate	Municipal, STEAP	1	1	1	1	1	1	1	9.0	0	0	-0.5	0	0	-0.5	0	-1.5	7.5
Conduct an evaluation of Lake Waramaug to determine the cause of siltation within the lake and characterize the impact to flood storage.	x	x	x				x	3	PW	2017	Intermediate	Municipal, STEAP, DEEP	1	1	1	1	0	0	1	6.0	0	0	0	0	0	-0.5	0	-1.0	5.0
Obtain funding to remove sediment from Lake Waramaug.	x	x	x				x	3	PW	2018	High	Municipal, STEAP, DEEP	0	1	1	1	1	0	1	6.0	0	0	0	0	0	-0.5	0	-1.0	5.0
FLOODING - Property Protection																													
Reach out to owners of repetitive loss properties and provide technical assistance to reduce flood risks and NFIP claims.	x	x	x				x	2	P&Z	2015	Low	Municipal	1	1	1	1	1	0.5	1	8.0	0	0	-0.5	0	0	0	0	-0.5	7.5
Evaluate floodprone properties on Sucker Brook to determine potential flood damage reduction methods for these properties.	x	x	x				x	2	P&Z, PW	2016	Intermediate	Municipal, STEAP	1	1	1	1	1	0.5	1	8.0	0	0	0	0	0	-0.5	0	-1.0	7.0
Encourage property owners to purchase flood insurance under the NFIP.	x	x	x				x	1,2	P&Z	2016	Low	Municipal	1	1	1	1	1	0	1	7.0	0	0	-0.5	-0.5	0	0	0	-1.0	6.0
Provide technical assistance regarding floodproofing measures to interested residents. Pursue funding for home elevations.	x	x	x				x	2	P&Z, PW	2017	Intermediate	Municipal, HMA*	1	1	1	1	1	0.5	1	8.0	0	0	0	0	0	-0.5	0	-1.0	7.0
FLOODING - Public Education																													
Ensure that the appropriate municipal personnel are trained in flood damage prevention methods.	x	x	x				x	1, 5	First Selectman	2015	Low	Municipal, EMI	1	1	1	1	1	0	1	7.0	0	0	-0.5	0	0	0	0	-0.5	6.5
Provide outreach regarding home elevation and relocation, flood barriers, dry floodproofing, wet floodproofing, and other home improvement techniques to private homeowners and businesses with flooding problems.	x	x	x				x	5	P&Z	2016	Low	Municipal	1	1	1	1	1	0.5	1	8.0	0	0	-0.5	-0.5	0	0	0	-1.0	7.0
FLOODING - Structural Projects																													
Review culvert conveyances based on existing hydrology and Northeast Regional Climate Center guidance.	x	x	x				x	2,4	PW	2016	Intermediate	Municipal	1	1	1	1	1	0	1	7.0	0	0	-0.5	0	0	-0.5	0	-1.5	5.5
When replacing or upgrading culverts, work with CT DOT to incorporate findings of the climate change pilot study and work with HVA to incorporate findings of the stream crossing assessment training.	x	x	x				x	2,4	PW	2017	Low	Municipal	1	1	1	1	1	0	1	7.0	0	0	0	0	0	-0.5	0	-1.0	6.0
Increase the capacity of the culverts at College Farm Road, Curtiss Road and Reed Road.	x	x	x				x	2, 4	PW	2017	High	Municipal, HMA	1	1	1	1	1	0.5	1	8.0	0	0	0	0	0	-1	0	-2.0	6.0
Pursue riverbank stabilization along Sucker Brook.	x	x	x				x	2,4	PW	2018	Intermediate	Municipal, HMA	1	1	1	1	1	0.5	1	8.0	0	0	0	0	0	-1	0	-2.0	6.0
FLOODING - Emergency Services																													
Ensure adequate barricades are available to block flooded streets in floodprone areas	x	x	x				x	6	EM	2015	Low	Municipal	1	1	1	1	1	0	0	6.0	0	0	-0.5	0	0	0	0	-0.5	5.5
WIND DAMAGE RELATED TO HURRICANES/SUMMER STORMS/WINTER STORMS																													
The Building Department should provide literature regarding appropriate design standards for wind.	x	x	x					5	Building Official	2015	Low	Municipal	1	1	1	1	1	0	0	6.0	0	0	0	0	0	0	0	0.0	6.0
Encourage the use of structural techniques related to mitigation of wind damage in new residential and commercial structures to protect new buildings to a standard greater than the minimum building code requirements. Require such improvements for new municipal critical facilities.	x	x	x					2	EMS	2016	Low	Municipal, HMA	1	1	1	1	1	0	0	6.0	0	0	0	0	0	-1	0	-2.0	4.0
Develop townwide tree limb inspection/maintenance program to ensure that the potential for downed power lines is diminished.								1,2	PW	2016	Intermediate	Municipal	1	1	1	1	1	0.5	0	7.0	0	0	-0.5	-0.5	0	0	0	-1.0	6.0
Remove weak or dead ash trees on Curtiss road in an effort to prevent utility damage during heavy wind events.	x	x	x					1	PW	2016	High	Municipal	1	1	1	1	1	0.5	0	7.0	0	0	-0.5	-0.5	0	-0.5	0	-2.0	5.0
WINTER STORMS																													
Develop a plan to prioritize snow removal from the roofs of critical facilities and other municipal buildings each winter. Ensure adequate funding is available in the Town budget for this purpose.				x				2	PW	2015	Low	Municipal	1	1	1	1	1	1	0	8.0	0	0	0	0	0	-0.5	0	-1.0	7.0
Provide information on the dangers of cold-related hazards to people and property.				x				5	PW	2015	Low	Municipal	1	1	1	1	1	0	0	6.0	0	0	-0.5	0	0	0	0	-0.5	5.5
Consider posting the snow plowing routes in Town buildings each winter to increase public awareness.				x				5	EM	2016	Low	Municipal	1	1	1	1	1	0	0	6.0	0	0	0	0	0	0	0	0.0	6.0
Emergency personnel should continue to identify areas that are difficult to access during winter storm events and devise contingency plans to access such areas during emergencies.				x				6	EM	2017	Low	Municipal	1	1	1	1	1	0	0	6.0	0	0	0	0	0	0	0	0.0	6.0
The Building Department should provide literature regarding appropriate design standards for mitigating icing, insulating pipes, and retrofits for flat-roofed buildings such as heating coils.				x				5	Building Official	2015	Low	Municipal	1	1	1	1	1	0	0	6.0	0	0	-0.5	0	0	0	0	-0.5	5.5
Develop a plan to address snowdrift concerns in the vicinity of Jack Corner Road and Tanner Hill Road. Snow fencing and certain vegetation buffers may be helpful to reduce drifting.				x				1	PW	2017	Low	Municipal	1	1	1	1	1	0.5	0	7.0	0	0	0	0	0	-0.5	0	-1.0	6.0

Strategies for the Town of Warren	Report Sections						Category	Responsible ¹ Department	Schedule	Cost	Potential Funding Sources ³	Weighted STAPLEE Criteria ⁴																Total STAPLEE Score	
	Flooding	Hurricanes and Tropical Storms	Summer Storms and Tornadoes	Winter Storms	Earthquakes	Dam Failure						Fires	Benefits								Costs								
													Social	Technical (x2)	Administrative	Political	Legal	Economic (x2)	Environmental	STAPLEE Subtotal	Social	Technical (x2)	Administrative	Political	Legal	Economic (x2)	Environmental		STAPLEE Subtotal
							1. Prevention 2. Property Protection 3. Natural Resource Prot. 4. Structural Projects 5. Public Information 6. Emergency Services		Year Provided or A. 2020-2025 B. 2026-2031	Low = Minimal ² Intermediate = <\$100,000 High = >\$100,000		Social	Technical (x2)	Administrative	Political	Legal	Economic (x2)	Environmental	STAPLEE Subtotal	Social	Technical (x2)	Administrative	Political	Legal	Economic (x2)	Environmental	STAPLEE Subtotal		
EARTHQUAKES																													
Consider preventing new residential development in areas most prone to collapse or liquefaction.					x		1	P&Z	2018	Low	Municipal	1	1	1	1	1	0	0	6.0	0	0	-0.5	-0.5	0	0	0	-1.0	5.0	
Ensure that municipal departments have backup plans and adequate backup facilities such as portable generators in place in case earthquake damage occurs to critical facilities, particularly the water and wastewater treatment facilities.					x		1,6	EM	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	
Consider bracing systems and assets inside critical facilities. This could help protect IT systems, important records and files, libraries.					x		1,6	EM, PW	2019	High	Municipal	1	1	1	1	1	0.5	0	7.0	0	0	0	0	0	-0.5	0	-1.0	6.0	
DAM FAILURE																													
Work with DEEP to update the registered dams list to indicate that Robert Scull Pond and Strobel Pond are beaver dams.					x		1	PW	2016	Low	Municipal	1	1	1	1	1	0	0	6.0	0	0	0	0	0	0	0	0.0	6.0	
Ensure that EOPs/EAPs are on file for all high hazard dams located in Warren, including the two owned by the City of Waterbury.					x		1,6	PW	2016	Low	Municipal	1	1	1	1	1	0	0	6.0	0	0	0	0	0	0	0	0.0	6.0	
Include dam failure inundation areas in the CT Alert emergency contact database.					x		6	EM	2017	Low	Municipal	1	1	1	1	1	0	0	6.0	0	0	0	0	0	0	0	0.0	6.0	
WILDFIRES																													
Continue to require the installation of fire protection water in new developments, and sprinkler systems where access is limited for fire apparatus.					x		1,6	P&Z	2015	Low	Municipal	1	1	1	1	1	1	0	8.0	0	0	-0.5	0	0	0	0	-0.5	7.5	
Increase the availability of water sources in the town’s areas of high risk, using the historic record (fires exceeding five acres) as a benchmark for locating high risk areas.					x		1,6	EM, Fire Department	2019	High	Municipal, AFG	1	1	1	1	1	1	0	8.0	0	0	0	0	0	-1	0	-2.0	6.0	
Revise and enhance the town’s website concerning the local regulatory requirements concerning Open Burning.					x		1,5,6	EM, Fire Department	2015	Low	Municipal	1	1	1	0.5	0.5	0	0	5.0	0	0	0	0	0	0	0	0.0	5.0	
Strategies and Actions for Implementation After the Timeframe of this Hazard Mitigation Plan but to be incorporated into CIPs and the POCD																													
FLOODING - Natural Resource Protection																													
Pursue acquisition of additional municipal open space in SHFAs and set it aside for greenways, parks, etc.	x	x	x		x		3	First Selectman	A	High	Municipal and Private	1	1	1	1	1	0	1	7.0	0	0	0	0	0	-1	0	-2.0	5.0	
Selectively pursue conservation recommendations listed in the Plan of Conservation and Development and other studies and documents	x	x	x		x		3	First Selectman	B	High	Municipal and Private	1	1	1	1	1	0	1	7.0	0	0	0	0	0	-1	0	-2.0	5.0	

1. Notes

- EM = Emergency Manager
- 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; Costs are less than \$10,000; Intermediate = Costs are less than \$100,000; High = Costs are > than \$100,000.

3. Notes

- HMA = Hazard Mitigation Assistance
- A * by "HMA" indicates that it has a potential for a benefit-cost ratio above 1.0
- DEEP = Connecticut Department of Energy and Environmental Protection
- EOC = Emergency Operations Center Grant (not currently active)
- AFG = Assistance to Firefighters Grant
- STEAP = Small Town Economic Assistance Program (State grant program)
- EMI = Emergency Management Institute (no charge for town staff)
- Private = Warren Land Trust, Weantinoge Heritage Land Trust, or private individuals

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
RECORD OF MUNICIPAL ADOPTION



Town of Warren

Selectman's Office
50 Cemetery Rd
Warren CT 06754
860-868-7881

CERTIFICATE OF ADOPTION

TOWN OF WARREN BOARD OF SELECTMEN

A RESOLUTION ADOPTING THE TOWN OF WARREN HAZARD MITIGATION PLAN

WHEREAS, the Town of Warren 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 Warren 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 Warren; and

WHEREAS, the Plan recommends several hazard mitigation actions/projects that will provide mitigation for specific natural hazards that impact the Town of Warren, 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 Warren eligible for funding to alleviate the impacts of future hazards; now therefore be it

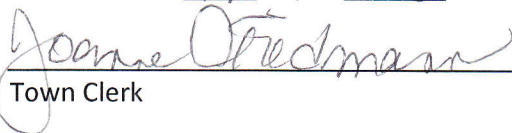
RESOLVED by the Board of Selectmen:

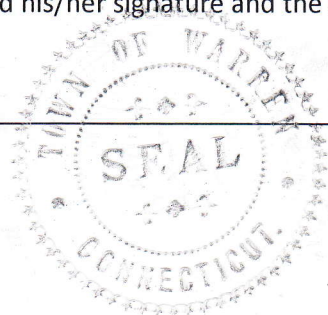
1. The Plan is hereby adopted as an official plan of the Town of Warren;
2. The respective officials identified in the mitigation strategy of the Plan are hereby directed to pursue implementation of the recommended actions assigned to them;
3. Future revisions and Plan maintenance required by 44 CFR 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 16 day of Dec, 2014 by the Board of Selectman of Warren, Connecticut


First Selectman

IN WITNESS WHEREOF, the undersigned has affixed his/her signature and the corporate seal of the Town of Warren this 17 day of Dec, 2014.


Town Clerk



APPENDIX C
MITIGATION STATUS PROJECT WORKSHEET

Mitigation Action Progress Report Form

Progress Report Period	From Date:	To Date:
Action/Project Title		
Responsible Agency		
Contact Name		
Contact Phone/Email		
Project Status	<input type="checkbox"/> Project completed <input type="checkbox"/> Project canceled <input type="checkbox"/> Project on schedule <input type="checkbox"/> Anticipated completion date: _____ <input type="checkbox"/> 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?	