# Local Hazard Mitigation Plan 2017 Update

## Westerly, Rhode Island

PREPARED FOR

Town of Westerly
45 Broad Street
Westerly, RI 02891

PREPARED BY

1 Cedar Street, Suite 400
Providence, RI 02903
401.272.8100

NOVEMBER 2017

Gina M. Raimondo
Governor

**RI Emergency Management Agency**

Peter T. Gaynor, Director
Samantha Richer, State Hazard Mitigation Officer Jessica
Henry, Former State Hazard Mitigation Officer

**Town of Westerly**

Town Council (2016-2018)
Mario P. Celico
John P. Carson, Sr.
Philip M. Overton
Edward P. Morrone
William J. Aiello
Jean L. Gagnier
Karen A. Cioffi

Former Town Council (2014-2016)
James V. Silvestri, President
Mario P. Celico, Vice President
John P. Carson, Sr.
Philip M. Overton
Jean L. Gagnier
Christopher A. Duhamel
Louis P. Sposato, Jr

Town Manager
Derrik M. Kennedy

Westerly Hazard Mitigation Committee
Peter Chiaradio, Public Works Superintendent
Paul Corina, Utilities
Benjamin Delaney, Planning Associate
Paul Duffy, Recreation
Amy Grzybowski, Emergency Management Coordinator
Blanche Higgins, Former Assistant Planner
David Murphy, Building Official
Jason Parker, Town Planner
Marilyn Shellman, Former Town Planner
Richard Silva, Chief of Police
Edward St. Clair, Former Chief of Police
Larry Stedman, Harbormaster
David Thompson, Assessor

# Table of Contents

# List of Tables

# List of Figures

# List of Appendices

# Executive Summary

## Purpose

The purpose of the Natural Hazard Mitigation Plan update is to identify local policies and actions that can be implemented to have long term impacts to reduce risk and future losses from hazards. These mitigation policies and actions are identified based on an assessment of hazards, vulnerabilities, and risks and the participation of a wide range of stakeholders and the public in the planning process.

Hazard Mitigation is a sustained action taken to permanently reduce or eliminate long-term risk to people and their property from the effect of natural hazards. Mitigation actions help safeguard personal and public safety, and can significantly reduce the impact of future disasters.

Pre-disaster planning and investment in preventative measures can significantly reduce the cost of tomorrow's post-disaster recovery and help post-disaster operations become more efficient. By planning ahead, Westerly minimizes the economic and social disruption that results from natural hazards including floods, severe weather, and hurricanes which can result in the destruction of property, loss or interruption of jobs, loss of business and loss of life.

Mitigation strategies include a mix of physical initiatives to limit the impacts of natural hazards, such as rebuilding riprap walls to protect against coastal erosion, as well as regulatory/planning initiatives such as revised zoning ordinances, and maintaining land use regulations.

The 2012 Hazard Mitigation Plan (HMP) consisted of 20 supporting mitigation measures. Four of these goals have been completed or substantially completed. This 2017 HMP consists of 18 mitigation actions that are focused on meeting the four goals established by the Hazard Mitigation Planning Committee:

- **GOAL 1**: Maintain open space in vulnerable areas of Westerly.
- **GOAL 2**: Minimize economic disruption resulting from natural hazards.
- **GOAL 3**: Reduce vulnerability of public and private infrastructure to natural hazards.
- **GOAL 4**: Enhance the capability of the natural environment to protect Westerly from coastal hazards such as storm surge and sea level rise.

## Strategy

The Westerly Hazard Mitigation Plan advocates the concepts of disaster resilient and sustainable communities. Westerly is building a disaster resistant community and achieving sustainable development through the commitment of state and local government and its policymakers to mitigate hazard impacts before disaster strikes.

Additionally, Westerly is striving to be a disaster resilient community, and therefore, safer community, through the implementation of mitigation programs and policies. The Town implements and institutionalizes hazard mitigation through its human, legal and fiscal resources; the effectiveness of intergovernmental coordination and communication; as well as with the knowledge and tools at hand to analyze and cope with hazard risks and the outcomes of mitigation planning.

The Westerly Mitigation Plan provides a coordinated, consistent set of goals for reducing or minimizing: human and property losses; major economic disruption; degradation of ecosystems and environmental critical habitats; destruction of cultural and historical resources from natural and technological disasters.

**Adoption Documentation**

THE TOWN OF WESTERLY

RESOLUTION
OF THE TOWN COUNCIL
No…….

WHEREAS, the Town of Westerly recognizes that the threat natural hazards pose to people and property within our community; and

WHEREAS, the Town of Westerly has prepared a multi-hazard mitigation plan, hereby known as the Westerly Local Hazard Mitigation Plan – 2017 Update in accordance with the Disaster Mitigation Act of 2000; and

WHEREAS, the 2017 Update identifies mitigation goals and actions to reduce or eliminate long-term risk to people and property in Westerly from impacts of future hazards and disasters; and

WHEREAS, adoption by the Town Council demonstrates their commitment to hazard mitigation and achieving goals outlined in the Westerly Local Hazard Mitigation Plan – 2017 Update.

NOW, THEREFORE, BE IT RESOLVED that the Town Council accepts and adopts the Town of Westerly, Local Hazard Mitigation Plan – 2017 Update.

IN COUNCIL
READ AND PASSED

Donna Giordano
Town Clerk

# 1

# Background

## 1.1 Introduction to Hazard Mitigation

Hazard Mitigation is a sustained action taken to permanently reduce or eliminate long-term risk to people, property, and infrastructure from the damaging effect of natural hazards. Mitigation actions help safeguard people and public safety, and can significantly reduce the impact of future disasters.

For the purposes of this plan, hazards are defined as natural, or naturally instigated, events which can seriously harm people, property, and the environment. Hazards referenced in this plan include floods, droughts, high winds, winter storms, nor'easters, hurricanes, tornadoes, dam failure, wild fire, and coastal erosion.

By planning ahead, Westerly minimizes the economic and social disruption that results from natural hazards including floods, severe weather and hurricanes which can result in the destruction of property, loss or interruption of jobs, loss of business and loss of life.

The purpose of this plan is to identify actions and policies for the Town of Westerly to minimize the social and economic loss and hardships resulting from natural hazards. These hardships include the loss of life, destruction of property, damage to critical infrastructure and facilities, loss/interruption of jobs, loss/damage to businesses, and loss/damage to significant historical structures.

To guide the efforts to protect present and future structures, infrastructure, and assets and to minimize the social and economic hardships, the Town of Westerly has developed the following Mission Statement:

*The mission of this Natural Hazard Risk Assessment and Mitigation Plan and Town officials charged with overseeing its implementation is to minimize the impact of natural hazards on Westerly's residents and visitors, built environment and natural resources. This document evaluates the natural hazards and vulnerabilities specific to Westerly, assesses their associated risks, and identifies opportunities to mitigate their potential adverse impacts. Preparing for natural hazards before they occur will facilitate the Town's response and recovery efforts following a natural disaster.*

Regulations pertaining to FEMA's flood mitigation grants and local hazard mitigation plans are provided in the Code of Federal Regulations (CFR), Title 44, Part 201.

Adoption of this Multi-Hazard Mitigation Plan will also increase Westerly's eligibility for federal grants available through FEMA's Hazard Mitigation Assistance (HMA) Programs, including the Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA), and Pre-Disaster Mitigation (PDM). In addition, the Rhode Island Emergency Management Agency (RIEMA) gives funding priority to municipalities that have completed a risk assessment and established mitigation projects with detailed information on the cost, timeline, and municipal department responsible for completing the project.

FEMA's Pre-Disaster HMA grant programs makes funding available for communities to implement flood mitigation planning and activities such as acquisition, relocation, and retrofitting of structures. This program is only available for communities who have an approved hazard mitigation plan.

FEMA's Post Disaster HMGP is only available for communities after a federally declared disaster. An approved mitigation plan expedites the application process for pre- and post-federal mitigation funding, as well as assisting in ensuring a funded project is eligible and technically feasible.

The following list does not imply a likelihood of risk with reference to Westerly, but instead sets forth the types of damages and expenses endured time and again by communities facing hazards similar to our own.

**Losses Associated with Inaction**

Initial Damages

- Casualties including residents, tourists, rescue personnel, pets, and livestock
- Infrastructure damage and prolonged interruption of utility services
- Temporary and permanent business closings
- Damage to invaluable historic structures
- Loss of vital government records and documents
- Loss of personal property including items of irreplaceable sentiment

Expenses and After-Effects

- Emergency response costs such as triage supplies
- Facility and infrastructure repairs

- Debris and contamination cleanup
- Depreciated real estate values
- Lost wages and sales tax revenue
- Reluctance of new business starts
- Permanent environmental damage via secondary "technological" hazards
- Home rebuilding costs and homeowner relocation costs

## 1.2 Community Planning Area

The planning area addressed in this Plan includes all lands within the geographical boundaries of the Town of Westerly. However, as natural hazards rarely respect boundaries, the strategies and actions contained in this plan have also been coordinated with the abutting communities of Charlestown and Hopkinton, RI, and Stonington, CT.

### 1.2.1 Geography

Westerly is a coastal community located in the southwest corner of Rhode Island that is bordered to the south by Block Island Sound and to the west and north by the Pawcatuck River. A key distinguishing feature of Westerly is its extensive system of Atlantic coast beaches which span seven miles of Westerly's south shore and for over a century had made the town a primary destination for tourists and seasonal residents. The total town land area is 30.1 square miles. Water accounts for slightly more than 5% of Westerly's area including major coastal salt ponds, including Quonochontaug Pond (733 acres), with its eastern half within the town of Charlestown and the western portion within Westerly, and Winnapaug Pond (446 acres).

### 1.2.2 Demographics

The official population of Westerly based on the 2010 census is 22,787– a slight decrease from the 2000 census (22,966) (U.S. Census Bureau, 2010). However, this figure belies the fact that the Census only counts a person's primary residence. Many of the homes located in particularly vulnerable areas of the community – particularly Watch Hill, Misquamicut, Weekapaug and Shelter Harbor – are seasonally occupied during the summer, effectively doubling Westerly's year round population. These coastal villages are also the areas where much of the town's residential development is occurring, either as new construction or as substantial upgrades to existing structures. The town's overall density is 763 people per square mile; however, this density varies considerably by location (Town of Westerly, 2012). The most populated area is Census Tract 508.01, which encompasses the downtown and North End neighborhoods, with about 4,400 people per square mile. In contrast, Census Tract 510, encompassing Watch Hill, Misquamicut and Weekapaug, has a density of 326 people per square mile. However, due to large numbers of seasonally occupied

dwellings, population density in these coastal Census Tracts more than doubles during the summer months (Town of Westerly, 2012).

As of the 2010 census there were a total of 12,320 housing units, with 78.5% occupied and 21.5% vacant for various reasons (e.g. unrented, for sale, seasonal use). Of the 9,666 units that were occupied, 6,322 (65.4%) were owner-occupied, with an average household size of 2.46 persons, and 3,344 (36.4%) were renter-occupied, with an average household size of 2.08 persons (U.S. Census Bureau, 2010).

The Westerly population is comprised of 22.9% of individuals under the age of 20, 16.2% of 20-34 year olds, 20.8% of 35-49 year olds, 21.5% of 50-64 year olds, and 18.5% of 65 year-olds and older (U.S. Census Bureau, 2010).

### 1.2.3 Land Use and Infrastructure

Westerly is comprised of many different neighborhoods. One of the most frequented neighborhoods is Downtown Westerly, which is the commercial and civic center of the town. This area includes late 19th and early 20th century eclectic masonry structures, stately 19th century houses in the styles of Greek Revival, Gothic Revival, Italianate, and Second Empire structures (Town of Westerly, 2010). Another section of Westerly is the Mill Village district which originally developed as workforce housing along the Pawcatuck River. Most of the structures are two or two-and-a-half stories and are set in areas of low, medium and high density residential, industrial, and open space/recreation (Town of Westerly, 2010).

South of Route 1A are the shoreline communities of Avondale, Watch Hill Misquamicut, Weekapaug and Shelter Harbor. Each of these areas has its individual distinctive character but all have the common element of seasonal and summer homes. The Watch Hill and Misquamicut areas attract significant concentrations of summer visitors to their commercial areas. In recent years, large areas of farmland surrounding these communities have been preserved from subdivision and development, primarily by the Weekapaug Foundation for Conservation and also by the Audubon Society and the Westerly Land Trust.

Dunn's Corner and the Bradford Road area of Westerly have the lowest density zoning as it consists of the town's largest area of working farmland. Route 91, a major road that bisects Dunn's Corner and Bradford runs through a large cedar swamp that is protected from development either by wetland regulations or habitat preservation.

Another section of Westerly is the Route 1 corridor in the heart of Westerly which is lined by commercial strip development similar to the sprawl which has inundated portions of other historic East Coast communities. Based on typical post-World War II zoning ordinances, this area is not characteristic of the rest of Westerly. Typical land uses in the Route 1 corridor include commercial and residential uses and is characterized by more recent development including subdivisions and strip malls.

Land use in Westerly is divided among competing uses, a brief breakdown of the percentage of land allotted to each type of use is as follows:

**Table 1.1 Land Use in Westerly**

| Land Use | Percentage |
|---|---|
| Residential | 36% |
| Conservation, recreation and open space, includes golf courses, marinas, beaches, and vacant land that is protected from development | 20.6% |
| Vacant, most of this land is forested or is potentially developable but is made up of wetlands, inland sandy soils, and rock outcrops | 11.9% |
| | |
| Community facilities, including schools, churches, government buildings, hospitals, public utilities | 10.7% |
| Agriculture, actively farmed land | 10.3% |
| Water, includes inland fresh water and salt ponds (excludes Pawcatuck River and Little Narragansett Bay) | 4.6% |
| Commercial mixed-use, commercial uses consisting of retail, services, and professional uses | 3.7% |
| | |
| Industrial, manufacturing and quarrying operations | 2.2% |

### 1.2.4 Community Development and Development Trends

The Town of Westerly last comprehensively updated its Zoning Ordinance in 1998 which establishes permitted uses, dimensional requirements, and development standards within the Town. There have been multiple updates since including, among others, the Affordable Housing Amendment in 2007. The Zoning Ordinance is a critical tool for controlling the type, density, and appearance of development within the town (Westerly Comprehensive Plan 2010).

Many developed areas within Westerly pre-date zoning ordinances which presents unique challenges to hazard mitigation. For example, the salt ponds in Westerly are separated from the ocean by narrow barrier beaches or spits and consist of extensive commercial and/or residential development. In the event of an emergency, waterfront residents who ignore evacuation warnings could easily be cut off from escape through excessive roadway flooding or bridge failure.

There are several community development efforts in progress in Westerly that are designed to attract new development and employment (Westerly Comprehensive Plan 2010). New developments however, must be in compliance with current floodplain, State building code, and stormwater standards. From January 2016 to June 30, 2017 about $82.75 million (value of work) has been permitted by the Town.

In 2010, $296 million in new residential and commercial construction had been approved by the Town Council. The Town continues to grow. From 2010 to April 2017, an additional $387 million in residential and commercial construction has been approved.

The Town has taken a number of initiatives to attract new development and employment. Westerly Landing, located along Main Street and the Pawcatuck River, and Westerly Depot, near Westerly Station, feature river access and the possibility of development and redevelopment of vacant and/or underutilized sites. The revitalization plan for the North End of Westerly provides for housing rehabilitation and adaptive reuse of existing commercial and industrial properties. The Westerly Tax-Free Arts District, located in the historic downtown, provides sales and personal tax exemptions for artists who live and work in the district or sell their original art in the district (Draft Westerly Comprehensive Plan, 2017).

None of the development efforts initiated or completed since the previous hazard mitigation plan have had a significant impact on the Town's vulnerability. Development within hazard prone areas follow the State Building Code and Town's permitting guidelines that are in place to prevent an increase to the vulnerability.

### 1.2.5 Historic and Natural Resources

Westerly's natural resources help to make Westerly a wonderful place to live today and are critically important to the town's future development. The Pawcatuck River, ocean beaches, and coastal salt ponds provide important ecosystem and habitat functions. They are an important factor in the quality of life for residents and a prime recreational attraction for tourists. Westerly's groundwater resources exist within three aquifers: Westerly, Ashaway, and Bradford. These aquifers are located within the Pawcatuck River Aquifer Region, which is the sole source of drinking water for the town. The designation of sole source means that the aquifer is source of potable water for the town. Wetlands along the rivers and streams, the shore and salt ponds, as well as Crandall Swamp and other interior wetlands remove nutrients, pollutants, and sediments from surface waters runoff, recharge groundwater, reduce shoreline erosion and flood risk, and provide fish and wildlife habitat. Farmland and forests provide important open space as well as wildlife habitat.

Westerly was incorporated as a town in 1669 and has six (6) neighborhoods that have been listed as Historic Districts on the National Register of Historic Places. These include Bradford Village, Main Street, North End, Watch Hill, Westerly Downtown, and Wilcox Park. In addition to these nationally recognized neighborhoods there are eight (8) structures and sites within the Town which have been listed individually on the National Register. These include the Babcock-Smith House, Flying Horse Carousel, Former Immaculate Conception Church (now George Kent Performance Hall), Lewis-Card-Perry House, Nursery Site RI-273, U.S. Post Office (Broad and High Streets), Westerly Armory, and the Weekapaug Inn. In 2002 Westerly was designated one of the "Dozen Distinctive Destinations" which are selected each year by the National Trust for Historic Preservation to reflect "unique and lovingly preserved communities in the United States" (National Trust for Historic Preservation).

### 1.2.6 Commerce

Employment is concentrated in the following key industry segments: health care, financial services, manufacturing, professional and technical services, and retail trade. During the summer months, the robust tourist/vacation economy boosts town revenues and employment, especially in the accommodations and food services sector. In addition to the Town of Westerly (which employs over 800 full-time equivalent positions), the largest employers in Westerly include the Westerly Hospital, Westerly Hospital, Relais & Chateaux hotels (seasonal), Walmart and the Washington Trust Company (Town of Westerly, 2017).

The travel and tourism sector is particularly important to Westerly. Tourism is a significant factor in the general local economy with estimates that for every one dollar of wages generated by tourism, $3.64 in economic activity is produced. Despite the global and national economic downturn, comparisons of adjusted 2007 and 2008 meal and hotel tax collections show a resiliency in this sector in Westerly (Town of Westerly, 2010).

Employers located outside of Westerly employ significant numbers of Westerly residents which include the State of Rhode Island (in particular the University of Rhode Island) and the Electric Boat division of General Dynamics at Quonset Point. Because of its location, Westerly's economy is vitally linked to southeastern Connecticut with significant employers at the U.S. Naval Submarine Base, Electric Boat Division of General Dynamics, Pfizer,  and Davis-Standard. All of these industries provide high-value research and technical jobs and also provide business for smaller companies in the area (Town of Westerly, 2010). The Westerly hospitality and tourism industry is also linked to tourism and entertainment venues in southeastern Connecticut, including Mystic Aquarium and Mystic Seaport and Foxwoods and Mohegan Sun gaming facilities (Town of Westerly, 2010).

Although Westerly has a robust economy and a typically slightly higher unemployment rate than the rest of Rhode Island, its dependence on three major industries leaves the regional economy vulnerable to shifts in the pharmaceutical, defense, and hospitality and tourism industries (Town of Westerly, 2010).

### 1.2.7 National Flood Insurance Program

Westerly participates in the National Flood Insurance Program (NFIP). This program is a direct agreement between the Federal Emergency Management Agency (FEMA) and the Town that provides flood insurance to home owners and businesses in exchange for community compliance with minimum floodplain management regulations.

Communities participating in the NFIP must adopt Flood Insurance Rate Maps (FIRMS) and the community Flood Insurance Study (FIS) produced by FEMA. In addition, a FEMA compliant floodplain management ordinance that regulates activity in the community's floodplains must be adopted and enforced.

Federal flood insurance is required for all buildings in Special Flood Hazard Areas (SFHAs) shown on FIRMS if they are financed by federally-backed loans or mortgages. All homeowners, business owners and renters in communities that participate in the NFIP may purchase federal flood insurance on any building, even if outside of a mapped flood zone. Flood insurance covers property owners from losses due to inundation from surface water from any source. Westerly's participation in the NFIP is essential to ensure that residents can obtain federally backed mortgages and loans in flood prone property.

**Table 1.2 Summary of Flood Insurance Policies as of November 17, 2017**

**Number of Policies in Each Zone**

| Zone | Policies |
|---|---|
| A-Zones | 636 |
| V-Zones | 88 |
| X-Zone (standard) | 102 |
| X-Zone (preferred) | 190 |

**Table 1.3 Summary of National Flood Insurance Program Activity in Westerly as of November 17, 2017**

| Total Policies | Total Premium | Value of Property Covered | Claims Since 1978 | CRS Premium Savings |
|---|---|---|---|---|
| 1,016 | $2,190,132 | $271,218,500 | 865 | $227,522 |

The NFIP's Community Rating System (CRS) encourages municipalities to voluntarily perform activities that exceed minimum standards of the NFIP. Communities must apply to the CRS and commit to implement and certify activities that contribute to reduced flood risk. Westerly, along with nine (9) other Rhode Island communities, including Bristol, Charlestown, East Providence, Middletown, Narragansett, North Kingstown, Pawtucket and Warwick) participate in the CRS program. The graphic below shows the current status of CRS communities in Rhode Island.

**Table 1.4 CRS Communities in Rhode Island**

| Municipality | CRS Entry Date | Current Effective Date | Current Class | % Discount for SFHA | % Discount for Non-SFHA |
|---|---|---|---|---|---|
| Town of Bristol | 5/1/13 | 5/1/13 | 7 | 15 | 5 |
| City of Warwick | 10/1/15 | 10/1/15 | 9 | 5 | 5 |
| Town of Middletown | 10/1/91 | 4/1/00 | 8 | 10 | 5 |
| City of Newport | 10/1/17 | 10/1/17 | 7 | 15 | 5 |
| City of East Providence | 5/1/14 | 5/1/14 | 8 | 10 | 5 |

| | | | | | |
|---|---|---|---|---|---|
| City of Pawtucket | 10/1/14 | 10/1/14 | 8 | 10 | 5 |
| Town of Narragansett | 10/1/92 | 10/1/07 | 7 | 15 | 5 |
| Town of North Kingstown | 10/1/93 | 10/1/93 | 9 | 5 | 5 |
| Town of Westerly | 5/1/13 | 5/1/13 | 8 | 10 | 5 |
| Town of Charlestown | 5/1/15 | 5/1/15 | 7 | 15 | 5 |

Each flood mitigation-related activity conducted by the Town (including preparation of this plan) earns CRS credit points towards a rating for the community. Based on this rating, flood insurance premiums for residents and businesses may be reduced by 5 to 45 percent. As of November 2017, Westerly maintains a designation as Class 8 within the CRS and receives a 10% discount of flood insurance premiums equating to $227,522 in NFIP premium savings for residents. The Town is currently working toward a better Class 7 rating.

## 1.3 Significant Weather Events

There have been several significant storm events that have impacted Westerly and the region since the HMP was last updated in 2012. Most notably are Hurricane/Tropical Storm Irene in August 2011, the significant snowstorms in January 2011 (not a Statewide declaration but still impacted Westerly), February 2013, & Jan-Feb 2015, and "Superstorm" Sandy in October 2012. Though it did not have a significant impact on Westerly, the Virginia Earthquake in August 2011 was felt in the region. Further explanation of these events is provided in Chapter 3.

# 2

# Planning Process

## 2.1 Purpose

The purpose of this Local Hazard Mitigation Plan is to set forth short-term and long-term actions that will mitigate the natural hazards of primary importance to Westerly, including floods, droughts, high winds, winter storms, nor'easters, hurricanes, tornadoes, dam failure, wildfire, and coastal erosion. This plan is a directive of FEMA and conforms specifically to 44 CFR Parts 201 and 206 Hazard Mitigation Planning and Hazard Mitigation Grant Program: Interim Final Rule. The Town of Westerly, upon adoption of this plan, will remain an eligible applicant for the Hazard Mitigation Assistance (HMA) program funding. This status enables the Town to file for resources that may be used to mitigate the effects of hazards on both public and private property (FEMA, 2013a).

The mission of this Local Hazard Mitigation Plan is to minimize the impact of natural hazards on Westerly's residents and visitors, built environment and natural resources. This document evaluates the natural hazards and vulnerabilities specific to Westerly, assesses their associated risks, and identifies opportunities to mitigate their potential adverse impacts. Preparing for natural hazards before they occur will facilitate the Town's response and recovery efforts following a natural disaster.

## 2.2 Building Support: Community Involvement

The development of this Plan is the result of the work performed by the Westerly Hazard Mitigation Committee (HMC) and the community as a whole. The HMC

consists of members (listed on page i) from the local town government, representatives of major organizations/institutions located in the Town, and the general public. This diverse membership allowed for the configuration of the group to reflect the permanent and transient demographics of the town. Planning in this fashion creates a Mitigation Plan that fully encompasses all aspects of disaster impact, from concerns of the residency, business community, and local disaster response and recovery activities.

### 2.2.1 Stakeholders

As part of the planning process, the Town of Westerly reached out to members of the community to ensure the final product was inclusive and represented a broad spectrum of the community. Inclusion started with the formation of the HMC, which is comprised of members from different sectors of the local town government for a representative background in hazard mitigation. The HMC held its first update meeting on August 8, 2014 at Westerly Town Hall. This first meeting focused on the update process and the development of an outreach strategy. The Town also reached out to key people and agencies that provided different perspectives and expertise on Mitigation Plan. Core stakeholder groups that the HMC pursued for input included land-use planners, construction and building officials, local business owners, insurance companies, and community leaders. Recognizing that hazards do not respect jurisdictional boundaries, the Director of Developmental Services coordinated with the municipalities that share transportation and coastal resources with Westerly.

### 2.2.2 Public

Residents and business owners of Westerly maintained an active role in the public process. To facilitate cohesion between planning efforts, public forums for the development of this Plan update were coordinated with meetings conducted for the Westerly Comprehensive Plan update. Public comments received throughout the Plan development were categorized and reviewed by members of the HMC for insertion where appropriate in the Plan. Input that did not necessarily pertain to the development of the Hazard Mitigation Plan was provided to the appropriate Town department for consideration and action.

The first opportunity for the public to provide input during the early planning stages was during a Natural Hazards session of a Comprehensive Plan workshop held on May 29, 2015 at the Public Library. During this session, participants were introduced to the concepts of hazard mitigation planning and strategy and were given the opportunity to provide input that would help identify issues and priorities. Of particular note were comments relating to power outages resulting from the 2010 flooding of a National Grid substation, and concerns regarding tree debris fouling the Pawcatuck River.

The next opportunity for public participation occurred on June 18, 2015 at the Westerly Police Station. This two (2) hour working session included a presentation

about hazard mitigation in general and a review of the objectives and actions from the previous planning period. Approximately 30 residents and Town staff participated and consultants supporting the development of the Comprehensive Plan update were in attendance. This forum was extremely engaging and interactive where participants expressed views and suggestions regarding a variety of topics and challenges. The minutes of this meeting are contained in Appendix B.

A combined HMC/Public workshop was conducted on May 19, 2016 to follow up on previous input received and review the draft plan. The minutes of this meeting are contained in Appendix B.

The draft Hazard Mitigation Plan Update was posted to the Town website on July 22, 2016*. One individual provided extensive comment on the plan format. Edits were incorporated where appropriate.

In addition to the public forums held specifically to obtain input for development of this Hazard Mitigation Plan there were several meetings held in support of the Comprehensive Plan update. To ensure a mutually supported approach to the two planning efforts, members of each planning team participated in many of the forums.

*Please note that since July 2016, there have been key staff changes within the Town of Westerly. Specifically, the Department of Development (which was created partway through this planning effort) was primarily responsible for the development of the Hazard Mitigation Plan. Although the vacant staff positions were filled as quickly as possible, the transition unfortunately resulted in the delay in finalizing the plan until August 2017.

### 2.2.3 Neighboring Communities

The strategies and actions contained in this plan have been coordinated with the abutting communities of Charlestown and Hopkinton, RI, and Stonington, CT. None of the neighboring communities provided specific comments or input, however the communities have agreed in principle to continue working collaboratively.

## 2.3 Understanding the Community's Risks

The 2017 Hazard Mitigation Plan has provided an opportunity for Westerly and its stakeholders to take stock of major climatic events that have affected the Town since the submission of the 2012 Hazard Mitigation Plan. Moreover, it has been an opportunity to examine how the Town aims to strengthen existing plan actions and move forward with new hazard mitigation strategies as part of the Town's larger integrated plan to improve physical, economic and social resiliency.

For the purposes of this mitigation plan, the following definitions have been used:

- **Hazard**: an event or physical condition that has the potential to cause fatalities, injuries, property and infrastructure damage, agricultural loss, damage to the environment, interruption of business, or other types of harm or loss
- **Risk**: the estimated impact that a hazard would have on people, services, facilities, and structures in the community. The natural hazard risk assessment weighs the magnitude, duration, and probability of potential natural hazard events occurring in town.
- **Vulnerability** : all populations and assets (environmental, economic, and critical facilities) that may be at risk from natural, human-caused, and technological hazards..

## 2.4 Updating the Mitigation Plan

Mitigation actions help safeguard personal and public safety. Retrofitting bridges, for example, can help keep them from being washed out, which means they will be available to fire trucks and ambulances in the event of a storm. Installing hurricane clips and fasteners can reduce personal and real property losses for individuals and can reduce the need for individual assistance in the event of a hurricane. Increasing coastal setbacks reduces the risk of deaths and property losses from tsunamis and storm surge. Increased setbacks also reduce the risk of property losses from coastal erosion.

An important benefit of hazard mitigation is that money spent today on preventative measures can significantly reduce the impact of disasters in the future, including the cost of post-disaster cleanup.

The adoption of this multi-hazard Mitigation Plan will enhance Westerly's eligibility for federal grants, which include FEMA's post-disaster Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation (PDM) Program and the Flood Mitigation Assistance (FMA) Program. Pre-disaster planning also helps post-disaster operations become more efficient. For instance, procedures and necessary permits can be identified prior to the disaster and permit streamlining procedures can be put into place. Priorities for mitigation during reconstruction can also be identified, helping to reduce the high costs of recovery after a disaster. The state emergency response effort will also run more smoothly because of the guidance provided in this strategy.

Documents that were referenced in the development of this Natural Hazard Mitigation Plan include the Rhode Island State Hazard Mitigation Plan Update 2014 and the Westerly 2010 and 2016 Comprehensive Plan. Other documents referenced in the development of the plan include local zoning laws and building and subdivision ordinances. The Hazard Mitigation Plan will help Westerly focus on strengthening existing plans, programs, policies and procedures by incorporating hazard mitigation as part of the ongoing process of community development. Other documents and plans that were integrated into this planning process include:

- Emergency Operations Plan

- GASB-34 Fixed Asset Inventory
- Phase II Stormwater Management Plan
- Zoning Ordinance & Subdivision Regulations
- Canal Street Infrastructure Improvement Plan
- Dune Restoration on Town owned properties
- Re-Entry Plan
- Debris Management Plan

Westerly has continously integrated hazard mitigation into the Town's Comprehensive Plan and this update of the Hazard Mitigation Plan was written simultaneously with the update to the Comprehensive Plan. The planning groups from both efforts contained many of the same people and agencies where mutually supporting meetings were conducted to facilitate a synergy between the plans. The Rhode Island Department of Administration (DOA) added a Natural Hazards section requirement to the state Comprehensive Plan format in 2012 and has since developed a series of tools and standards to support the development of the Natural Hazards section.

The success of Westerly's effort to reduce the impacts of natural hazards depends on widespread dissemination of this HMP and similar documents to appropriate Town agencies and organizations. The following types of activities will contribute to the overall preparedness of the community:

- Public Information Activities
- Community Involvement & Volunteer Activities
- Training Exercises
- Community Warning & Alert Systems

### 2.4.1 Recovery

Recovery sets the stage for reducing future losses and provides an opportunity for the community to address vulnerabilities. While short-term recovery efforts focus on stabilization and reestablishing critical lifelines, it is also the time to initiate damage assessments to determine the magnitude of the event. During this phase it is critical to maintain proper and detailed documentation of purchases and expenditures.

Economic recovery is also an essential element of the short-term recovery phase. A number of small locally-owned businesses are concentrated in flood prone areas along the Pawcatuck River, in Watch Hill and in the Misquamicut area. While business owners should educate themselves as to available post-disaster state and federal assistance programs, they should also conduct a realistic economic analysis of their market and customers. "Open for Business" information produced by the Institute for Business and Home Safety is an excellent tool for educating business owners on disaster effects and preparedness needs (www.ibhs.org). Businesses need to know:

- How the disaster affects their customer base (who is left, and what they can afford);
- The relative demand for their goods and services in a post-disaster setting;
- How the disaster affects their key suppliers;
- Competitive advantages that other areas not subject to flooding possess, and the likelihood of market-share shifting elsewhere as a result;
- New opportunities in the post-disaster setting that can be maximized by the small business; and
- How the government's short-term and long-term recovery plans for the area as a whole might support their particular business.

Long-term recovery includes environmentally and economically sustainable land use and design decisions. While recovery will take place as a series of small increments, goals and policies formulated prior to the natural disaster should be implemented over time via appropriate land use regulations and procedures. The bottom line goal is to implement a recovery program that avoids re-creating the same pre-disaster scenario that was susceptible to serious damage or destroyed by the natural disaster. Since no amount of planning can fully anticipate all of the adverse impacts, the key to a sustainable disaster recovery is to ensure that "lessons learned" become part of the solution.

The RI Coastal Resources Management Council (CRMC) developed post-hurricane and storm permitting procedures that impose a temporary moratorium on reconstruction after a disaster has been declared in order for municipalities to assess damages, determine changes that may have occurred to the coastline, and identify mitigation opportunities.

### 2.4.2 Identification and Review of Goals

Since the adoption of the 2012 HMP, the Westerly HMC and other local officials have met annually and after significant events to ensure mitigation actions are being implemented as intended. Prior to each meeting, each of the participating departments gathered data to assess progress toward meeting plan objectives and goals.

During the development of this update, the HMC and Town department representatives reviewed the goals and actions to assess their continued relevance and viability to support the overall Mitigation Plan.

Four goals were developed by the HMC and presented to the public and other interested parties for review and comment. While minor wording adjustments were made, the essence of the four goals remained intact.

- **GOAL 1**: Maintain open space in vulnerable areas of Westerly.
- **GOAL 2**: Minimize economic disruption resulting from natural hazards.

- **GOAL 3**: Reduce vulnerability of public and private infrastructure to natural hazards.
- **GOAL 4**: Enhance the capability of the natural environment to protect Westerly from coastal hazards such as storm surge and sea level rise.

Mitigation Actions developed for the 2012 HMP have been continuously tracked and assessed. The committee has maintained and updated the Natural Hazard Mitigation Plan Matrix throughout the life of the Plan. At the beginning of this update process the matrix was reviewed to determine which actions had been completed, which were in progress, those that should be considered for continued inclusion in the updated Plan, and those that should be considered for removal from the update. The committee reviewed completed actions to determine their effectiveness and also reviewed the actions that were not completed to determine the reasons why and assess the continued viability of those actions.

## 2.5 Bringing the Plan to Life: Implementation and Maintenance

The Town leadership realizes that a plan can only be successful if it is created in an atmosphere of collaborating and cooperation. To see the actions go from concepts to implementation requires a community-wide effort. The 2017 version of the Westerly Natural Hazard Mitigation Plan is aggressive, but realistic. We do not live in a world of unconstrained resources and we cannot control the forces of nature. The goals in this plan are challenging, but achievable. There are mitigation measures outlined to be implemented in the near-term that will support the concept of a resilient community for decades to come.

### 2.5.1 Mitigation Methodology

The HMC realized that assigning a time frame to each recommended mitigation action is important so that actions can be coordinated with other governmental functions, such as committee meetings, short- and long-term planning initiatives, and budget hearings. Assigned time frames also provide inputs to a project plan used for tracking the progress of all activities.

The Town of Westerly and the Westerly HMC realize that successful hazard mitigation is an ongoing process that requires implementation, evaluation, and updated revisions to this plan. Also realized is the importance of integrating appropriate sections of the plan into the Town's other strategic planning efforts. It is intended that this Plan and the ongoing efforts of the HMC will preserve and enhance the quality of life, property, and resources for the Town of Westerly.

#### 2.5.1.1 Plan Review, Adoption, and Approval

The 2017 Natural Hazard Mitigation Plan is a comprehensive strategy designed to help the Town of Westerly prepare for the impacts of natural disasters. The 2017

plan is an updated version of the 2012 plan and has gone through several stages of review before its adoption and implementation. Following a thorough review by several members of the HMC, the draft document was forwarded to the Town Council for its review and approval to forward the for official review by the Rhode Island Emergency Management Agency (RIEMA) and Federal Emergency Management Agency (FEMA) Region 1.

| Action | Date |
|---|---|
| Submitted to RIEMA for initial review | November 15, 2016 |
| Comments received from RIEMA | January 3, 2017 |
| Submitted for to RIEMA for second review | August 2017 |
| Submitted to RIEMA for third review | |
| Submitted to FEMA for review | TBD |
| Approved by FEMA pending adoption | TBD |
| Adopted by Town Council | TBD |

Once implemented, the 2017 Natural Hazard Mitigation Plan will guide future hazard mitigation efforts. All actions identified in this plan have been determined to be viable mitigation actions. As such the responsible departments for each action will work to develop appropriate implementation timeframes and funding mechanisms. Although the priority ranking of the listed mitigation actions should guide their implementation, final decisions on which actions are to be implemented will inevitably be based upon funding availability.

#### 2.5.1.2 Monitoring

The Westerly Hazard Mitigation Plan remains an evolving tool. The 2017 Local Hazard Mitigation Plan is a dynamic document to be reviewed on a regular basis as to its relevancy and usefulness and to add new tasks when old tasks are completed. The Town will review, monitor, and update its 2017 Local Hazard Mitigation Plan and make recommendations for the improvements and changes throughout the next five years of this plan's implementation.

The Westerly Development Services Department will be responsible for maintaining a permanent Hazard Mitigation Committee (HMC) and will work with the Emergency Management Director to schedule meetings and set agenda items. At a minimum, the HMC will meet every six months and following any significant events. This committee will continue to be comprised of members from public agencies, nongovernmental groups, academic institutions, business leaders, and private groups with demonstrated expertise in hazard mitigation. They will work collaboratively to strengthen communication and coordination within the Town on improving emergency hazard response, operating procedures, and resiliency. The Emergency Management Director will serve as the committee chair and will work in collaboration with the Development Services Department to determine applicable plan content. As actions are implemented or modified, the department responsible

for that action will update the Mitigation Action Table and apprise the other members of the committee.

#### 2.5.1.3 Evaluation

The Westerly HMC, under the direction of the Town Planner, will review proposed and implemented strategies to determine their effectiveness. The review criteria will evaluate each implemented action to determine the degree to which the action has met its intended purposes. This review is critical after a hazard event, as that is the time when the degree of protection offered by the strategy is especially apparent. When the HMC meets after an event, the original information regarding cost-to-benefit analysis of each action will be reviewed to determine which actions were the most cost effective. If the actions failed, then new actions will be explored to correct the vulnerability. This type of evaluation will help to shape future actions proposed by the HMC.

#### 2.5.1.4 Updates

The Hazard Mitigation Committee will evaluate and update the plan annually, after a disaster, as funding opportunities arise for the actions and projects identified in the plan, or as actions are completed in order to re-prioritize. Any updates to the plan will be reviewed and submitted to RIEMA upon local approval. The HMC will involve the public in the plan revision process by holding an annual advertised public meeting to present recommended revisions and solicit input. Revised plans will also be sent to the Town Planners of abutting communities.

In addition, the Town will initiate actions to satisfy the requirement for a 5 year plan update and FEMA review. The update process will be continuous throughout the life of this plan with the actual updating process to begin in year 3 of this plan and a submission to RIEMA by the end of year 4.

### 2.5.2 Continued Public Involvement

On behalf of the HMC, the Town Planner, under the direction of Town Council, will be responsible for ensuring that all Town departments and the public have adequate opportunity to participate in the continued planning process. Other administrative staff may be utilized to assist with the public involvement process.

The updated, and any in-cycle revisions, will be posted to the Town website. Public involvement will be maintained through the implementation of this plan through regular outreach and educational opportunities. Mitigation strategies and actions will be addressed at the meetings of the appropriate Town bodies. Several of the Mitigation Actions included in this update are based on developing, maintaining and increasing public awareness and outreach.

### 2.5.3 Plan Maintenance

The HMC, under the leadership of the Town Planner, will evaluate and update the plan annually, after a disaster, as funding opportunities arise for the actions and projects identified in the Plan, or as actions are completed in order to re-prioritize. Any updates to the Plan will be reviewed and submitted to RIEMA upon local approval. The Town Council will involve the public in the plan revision process by holding an annual advertised public meeting to present recommended revisions and solicit input. A copy of this plan will continue to be available for public viewing on the Town website.

# 3

# Risk Assessment

## 3.1 Defining Risk and Methodology

The purpose of this section is to provide a comprehensive overview of how various natural hazards can impact Westerly. In this section, natural hazards are ranked in order of priority based on the frequency of occurrence and area of impact affected.

Identifying the risk and vulnerability of Westerly to natural hazards is the primary factor in determining how to allocate finite resources to determine what mitigation actions are feasible and appropriate. The hazard analysis involves identifying all of the hazards that potentially threaten Westerly, and then analyzing them individually to determine the degree of threat that is posed by each natural hazard. Addressing risk and vulnerability through hazard mitigation measures will reduce societal, economic and environmental exposure to natural hazards impacts (Rhode Island Emergency Management Agency, 2014).

## 3.2 Hazards

A natural hazard is defined as an event or physical condition that has the potential to cause fatalities, injuries, property and infrastructure damage, agricultural loss, damage to the environment, interruption of business, or other types of harm or loss. A natural hazard can also be exacerbated by societal behavior and practice, such as building in a floodplain, along a sea cliff or an earthquake fault. Natural disasters are inevitable, but the impacts of natural hazards can, at a minimum, be mitigated or in some instances prevented entirely.

### 3.2.1 Hazard Identification

The Town of Westerly's HMC reviewed many hazards in this strategy. Hazards discussed in this Plan were included for a variety of reasons including historical records of past events, repetitive losses, and potential losses as identified by predictive modeling (Sea, Lake and Overland Surges from Hurricanes [SLOSH]) and/or FIRMs), as well as other expert and local knowledge. In order to fulfill the planning guidelines outlined in Section 322 of the Disaster Mitigation Act of 2000 (DMA 2000), this plan addresses only natural hazards, and does not consider human caused hazards (i.e., structural fires, hazardous materials, chemical spills, and weapons of mass destruction).

Keeping in line with the 2014 Rhode Island State Hazard Mitigation Plan's (SHMP) risk assessment, the natural hazards have been grouped into the following categories and are listed in order of frequency and impact, starting at the top of the list with the most frequently occurring natural hazards. Based on the Rhode Island SHMP and previous versions of the Town Plan, the following hazards will be discussed and analyzed in this report:

**Table 3.1 Natural Hazards Assessed for Westerly Hazard Mitigation Plan, Grouped by Category**

| Wind Related Hazards | Winter Related Hazards | Flood Related Hazards | Geologic Related Hazards | Additional Hazards |
|---|---|---|---|---|
| Storm surge | Snow | Riverine Flooding | Earthquakes | Wildfire |
| Hurricanes | Ice | Flash Flooding | | |
| Tornadoes | Extreme Cold | Coastal Flooding | | |
| High Winds | | Climate Change | | |
| | | Coastal Erosion | | |
| | | Dam Breach | | |

#### 3.2.1.1 Hazard Identification Table

For the purposes of historical analysis, the Westerly HMC grouped potential hazards into the following categories: severe weather (nor'easters, winter storms, ice storms, severe thunderstorms, wind, and tornadoes); hurricanes; flooding and dam failure; wildfire; and earthquakes.

Table 3.2 identifies the hazards posing the greatest risk to Westerly, including their probability of occurring over a five-year period and potential estimate of monetary impact. The HMC discussed other hazards such as drought, and extreme heat, and

deemed them to be of negligible risk to the community based on historical data and a low probability of occurring within the next five years.

**Table 3.2 Previous Occurrences**

| Hazard | Historical Dates | Potential Monetary Impact** |
|---|---|---|
| Wind and Winter Related Hazards* | 1978, 1993, 1996, 1997, 2001, 2005, 2010, 2011, 2012, 2013, 2015 | $500K + |
| Hurricanes | 1938, 1954, 1985, 1991, 2011, 2012 | 1M + |
| Flooding Related Hazards | 1978, 1991, 1997, 2003, 2010 | $500K + |
| Wildfire | 1996 (10 between 1994-2003) | 5M + |
| Earthquake | 1925, 1929, 1935, 1940, 1944, 1963, 1973, 2003 | 1M + |

* Excluding Hurricanes

** Amounts based on past disasters and repetitive losses

#### 3.2.1.2 Hazards Excluded from Risk Assessment

It should be noted that the above hazards are not a complete listing of hazards that may impact Westerly (Rhode Island Hazard Mitigation Plan, 2014). The State Interagency Hazard Mitigation Committee (SIHMC) agreed that this listing accurately represents those hazards that impact Rhode Island most frequently and have the potential to cause fatalities, injuries, property and infrastructure damage, agricultural loss, damage to the environment, interruption of business, or other types of harm or loss (Rhode Island Emergency Management Agency, 2014). The following hazards are not addressed in the plan because they are not commonly recognized to affect Westerly:

- Avalanche
- Hail (although present, not a concern for the Town at this time)
- Expansive soils
- Extreme heat
- Drought (although present, not a concern for the Town at this time)
- Land subsidence
- Landslides
- Tsunamis
- Volcanoes

### 3.2.2 Hazard Profiles

The following subsections present a description of each type of natural hazard Westerly may expect to experience, as determined by the HMC.

### 3.2.2.1 Wind Related Hazards

#### Description

Wind is the motion of air past a given point caused by a difference in pressure from one place to another. Severe wind poses a threat to Rhode Island in many forms, including that produced by severe thunderstorms and tropical weather systems. The effects can include blowing debris, interruptions in elevated power and communications utilities, and intensified effects of winter weather. Harm to people and animals, as well as damage to property and infrastructure, may be the result. Two (2) basic types of damaging wind events, other than tropical systems, affect Rhode Island: synoptic-scale winds and thunderstorm winds. Synoptic-scale winds are high winds that typically occur with cold frontal passages or Nor'easters. When thunderstorm winds exceed 58 miles per hour (mph), the thunderstorm is considered severe and a warning is issued. Downburst winds result from the sudden descent of cool or cold air toward the ground. As the air hits the ground, it spreads outward, creating high winds like those in a thunderstorm. Unlike tornadoes, downburst winds move in a straight line, without rotation. (Rhode Island Emergency Management Agency, 2016).

Based on historical tornado and hurricane data, FEMA has produced a map that depicts maximum wind speeds for design of safe rooms. Rhode Island is included in Wind Zone II (160 MPH). Rhode Island is also within the Hurricane-Susceptible Region as shown in Figure 1 (FEMA 2012).

**Figure 1 FEMA safe room design wind speed for the United States**

Rhode Island wind events can produce damage often associated with thunderstorms or tornadoes. In some instances, these events have been associated with weakening tropical weather systems, including downgraded tropical and sub-tropical storm systems. This section examines the risks associated with damaging wind events with emphasis on hurricanes, tornadoes, and thunderstorms (Rhode Island Emergency Management Agency, 2016).

**Location**

In the northern hemisphere, winds circle in a counterclockwise direction around a low-pressure center known as the eye. A storm with the eye tracking to the west of Rhode Island will result in the highest storm surges along the south shore. The forward momentum of the storm combined with the hurricane force winds circulating the eye pushes the ocean water mass onshore creating an elevated water surface (Town of Westerly, 2012). High winds can then lead to storm surge by pushing the water against the shoreline (Town of Westerly, 2012).

The south shore of Rhode Island is susceptible to hurricanes and other wind-related damage (Town of Westerly, 2012). A significant amount of development within the Town is located along the Pawcatuck River and the ocean front, as such many of these developed areas are susceptible to wind-related damage. Public properties that have historically suffered damage from such storms include Misquamicut State Beach and Westerly Town Beach which are located on the south shore of Westerly. Atlantic Avenue, a heavily developed commercial and residential road that runs parallel to Misquamicut Beach, has also proven to be vulnerable to wind damage. Additionally, Watch Hill, located in the southwestern portion of the Town, is situated on an exposed peninsula bounded by the open ocean and Little Narragansett Bay. A particularly susceptible area of Watch Hill is the Napatree Point Conservation area, which is a sandy spit that extends westward from the Watch Hill business district. Other areas prone to wind damage include the communities of Weekapaug and Shelter Harbor, which are typically seasonally occupied.

Tropical cyclones, including hurricanes and tropical storms, impact Rhode Island from the south and southwest during the summer and fall from June 1st through November 30th (Rhode Island Emergency Management Agency, 2014).

**Extent**

Besides the flooding damage from their storm surges, the wind from hurricanes can knock down structures or rip off their roofs. Nor'easters pose the same threat to compromised structures; moreover, if they bring a major snowfall along with heavy wind, the resulting snow drifts could block side streets for days (Rhode Island Emergency Management Agency, 2014).

Other hazards posed by high winds include downed power lines, which are lethally dangerous while they continue to carry power. Cable lines can also come down, thereby shutting off communication via telephone and Internet. ("Ice storms" associated with Nor'easters are also a threat to utility lines; see Section 3.2.2.5.) Other impacts include severe beach erosion, large waves, high winds, flooding,

marine over-wash, and loss or injury to life (Rhode Island Emergency Management Agency, 2014).

Hurricane and gale-force winds can also cover roadways with debris, making them impassable to conventional vehicles. This presents a dangerous situation for anyone requiring immediate medical attention (Rhode Island Emergency Management Agency, 2014). This proved to be valid as experienced on Atlantic Avenue during and after the Hurricane Sandy event. In addition to several homes and businesses along the road suffering massive damage or complete collapse, the road itself, which is located on a spit between Block Island Sound and the salt ponds, was covered in deep sand that measured up to six feet in depth in some areas (Goonan, October 30, 2012).

**Figure 2 Wind risk score for Rhode Island**


Source: American Society of Civil Engineers

**Previous Occurrences and Probability of Future Events**

Over the past century, 15 tropical cyclones (Category H 1-H 5) have directly hit or passed near Rhode Island. In addition, numerous other subtropical and tropical storms/depressions pass through Rhode Island each season generating large swells, storm surges and high winds that cause varying degrees of damage to property (Rhode Island Emergency Management Agency, 2014).

The events that represent much of the wind hazard for Westerly are coastal systems. As such, wind hazard areas can be prioritized based on the distance from the coast. Figure 2 shows the relative wind hazard ranking for Westerly and all of Rhode Island. These rankings are based on the American Society of Civil Engineers (ASCE) Minimum Design Loads for Buildings and Other Structures, ASCE 7-98. The Town of Westerly is located in the risk category 5 area. While these storms occur infrequently, they have the potential to cause large amounts of damage over a widespread area. The probability of future wind events is considered to be likely (Table 3.23).

#### 3.2.2.2 Hurricanes

**Description**

Tropical cyclones, a general term for tropical storms and hurricanes, are low pressure systems that usually form over the tropics. These storms are referred to as "cyclones" due to their rotation. Tropical cyclones are among the most powerful and destructive meteorological systems on earth. Their destructive phenomena include very high winds, heavy rain, lightning, tornadoes, and storm surge. As tropical storms move inland, they can cause severe flooding, downed trees and power lines, and structural damage (Rhode Island Emergency Management Agency, 2014).

There are three categories of tropical cyclones:

**Table 3.3 Tropical Cyclone Categories**

| | |
|---|---|
| Tropical Depression | Maximum sustained surface wind speeds less than 39 MPH |
| Tropical Storm | Maximum sustained surface wind speeds from 39-73 MPH |
| Hurricane | Maximum sustained surface wind speeds exceed 73 MPH |

Once a tropical cyclone no longer has tropical characteristics it is then classified as an extratropical system (Rhode Island Emergency Management Agency, 2014). The strength and potential impact from these storms are measured in several ways, including:

- **Size** – measured by the radius of maximum winds (Measured from the center of the hurricane to the location of the highest wind speeds within the storm. This radius may vary from as little as four (4) miles to as much as 50 miles);
- **Intensity** – measured by sea level pressure and maximum surface wind speeds at the storm center;
- **Path**, or forward track of the storm; and
- **Forward speed**.

The counterclockwise rotation of the hurricane's wind field in combination with the forward motion of the hurricane typically causes the highest surge levels to occur to the right of the hurricane's forward track (Rhode Island Emergency Management Agency, 2014). This phenomenon has been observed in regions where the shoreline is typically straight, not fragmented by large inlets and bays, and when a hurricane travels generally perpendicular to the shore. In Rhode Island, the increased wind stress from the rotational wind field has a significant effect on the level of surge. The contribution to surge generation from the forward motion of the storm can be greater than the contribution made by an increase in hurricane intensity (Rhode Island Emergency Management Agency, 2014).

The Rhode Island shoreline faces south, as such storms passing to the west raise the highest storm surges for Rhode Island. In addition, Narragansett Bay funnels the surge northward where decreasing surface area amplifies the surge height (Boothroyd 2008). The 1938 Hurricane made landfall west of Rhode Island as a Category 3 hurricane with a forward speed in excess of 50 miles per hour. With the

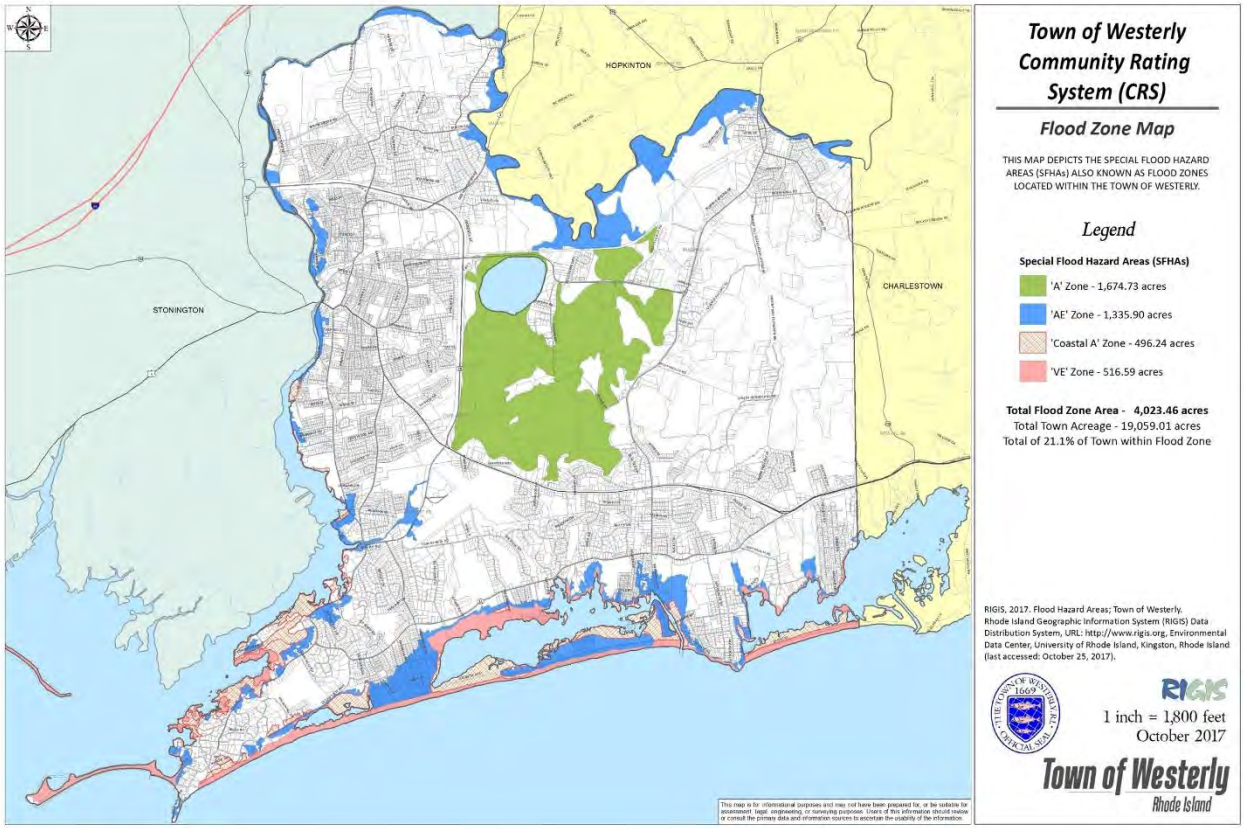
center of the storm making landfall in Connecticut, the Rhode Island shoreline experienced exceptionally high storm surge levels (Rhode Island Emergency Management Agency, 2014).

The reduction of atmospheric pressure within the storm system results in another surge-producing phenomenon known as the "inverted barometer" effect. Within the region of low pressure, the water level will rise at an approximate rate of 13.2” per inch of mercury drop. This can account for a rise of one (1) to two (2) feet near the center of the hurricane. This effect is considered to be a more important factor in the open ocean where there is no depth related restrictions to water flow (Rhode Island Emergency Management Agency, 2014).

**Location**

The entire State of Rhode Island is vulnerable to hurricanes and tropical storms, depending on the storm’s track. As a coastal community, the majority of Westerly is susceptible to the effects of hurricanes and tropical storms. The coastal barrier beaches that separate the Maschaug, Little Maschaug, Winnapaug and Quonochontaug Ponds from Block Island Sound have all been designated velocity (V) zones, as are lands located immediately north of the northern shorelines of these salt ponds (Figure 3). V zones are areas along coasts subject to inundation by the 1-percent-annual-chance flood event with additional hazards associated with storm-induced waves and velocity wave action (FEMA 2014).

**Figure 3 Flood zones in Westerly, RI**




### Extent

Hurricanes are classified by their damage potential according to a scale developed in the 1970s by Robert Simpson and Herbert Saffir, and updated slightly by the National Hurricane Center in 2012. The scale is designed to give public officials and the general public usable information on the magnitude of a storm. It gives an indication of the potential flooding and wind damages associated with each hurricane category and rates the intensity and effects of hurricanes based on wind speed and barometric pressure measurements as shown in Table 3.4.

**Table 3.4 Saffir/Simpson Scale of Hurricane Intensity**

| Wind Speed | Typical Effects |
|---|---|
| **Category One Hurricane – Weak** | |
| 74-95 MPH (64-82kt) | 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 – Moderate** | |
| 96-110 MPH (83-95kt) | 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 – Strong** | |
| 111-130 MPH (96-113kt) | 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 - Very Strong** | |
| 131-155 MPH (114-135kt) | 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 – Devastating** | |
| Greater than 155 MPH (135kt) | 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. Flooding causes major damage to lower floors of all structures near the shoreline. Massive evacuation of residential areas on low ground within 5-10 miles of the shoreline may be required. |

Source: Saffir-Simpson Hurricane Scale – National Weather Service: Schwab, Jim. 1998.

**Previous Occurrences and Probability of Future Events**

Rhode Island has experienced tropical depressions and tropical storms as well as hurricanes ranging from Category 1 to Category 3 (NOAA, 2013). There have been a total of nine hurricanes that have made direct hits on Rhode Island from 1851-2016 (NOAA, 2016). Hurricanes are rare but devastating events in Rhode Island (Rhode Island Emergency Management Agency, 2014). Hurricane wind damages can be costly but storm surge is by far the most destructive force acting on the Rhode Island coast.

There have been some devastating historical hurricanes in Rhode Island, most of which have impacted Westerly substantially. During the Great New England Hurricane of 1938 Rhode Island suffered an estimated $100 million in property damage and 262 deaths statewide. In Westerly the hurricane caused a 12-foot storm surge above high tide that was occurring at the time of impact. This wind-driven storm surge wiped out all of Napatree Point and the forty-four summer cottages that resided on it, as well as Fort Road that connected the rest of Watch Hill to Napatree Point (Greene 1938). The total deaths in Watch Hill totaled 24 and the storm also heavily damaged or destroyed many of the vessels in Watch Hill Cove (Town of Westerly, 2012). Other parts of Westerly were also devastated including the Misquamicut area which experienced extensive damage and destruction with over 50 deaths and 500 cottages destroyed as storm driven waves passed completely

over the narrow barrier beach protecting normally tranquil salt ponds (Town of Westerly, 2012). Streams within the Pawcatuck River watershed were swollen by nearly seven inches of rainfall in three hours, and as the storm surge moving upriver met this floodwater, many downtown Westerly homes and businesses were flooded with water up to eight feet deep. The high winds flattened trees, steeples, and telephone poles throughout the town. As a result of this storm, Sandy Point (currently a 35-acre island in Little Narragansett Bay) was severed from Napatree Point, and another breach way opened up in Weekapaug. The Town, as a whole, was crippled for weeks on end due to this benchmark storm (Town of Westerly, 2012).

Another notable hurricane that struck Westerly was Hurricane Carol in 1954. During the years following World War II many structures were built on the shore in locations leveled by the 1938 hurricane. In 1954, on the heels of a post-war building boom, Hurricane Carol hit at the astronomical high tide, creating a storm surge of about 11-feet (Westerly, 2012). Extensive damage resulted; however, due in part to the warning system which had been implemented by the National Weather Service after the 1938 storm, there were far fewer deaths associated with Carol (Town of Westerly, 2012).

In 2011, Tropical Storm Irene made landfall on the south coast of Rhode Island. Half of Rhode Island residents lost power from knocked down trees and power lines. Mandatory evacuations were ordered for several Rhode Island areas, including Westerly. High winds caused damage to commercial and private property along Westerly's coast. Flooding, fueled by storm surge inundated much of the Misquamicut area.

The most recent hurricane to strike Westerly and much of the East Coast was Hurricane Sandy in October 2012. By the time Sandy reached Rhode Island, it's intensity had reduced to Tropical Storm status, however Rhode Island still experienced a considerable amount of damage from the storm. Rhode Island sought and received a federal emergency declaration prior to the storm to ensure access to funds to assist in the recovery effort. This hurricane left over 122,000 people in Rhode Island without power. In total, Rhode Island received $39.4 million in support from federal disaster relief programs, a majority of which came from NFIP (Rhode Emergency Management Agency, 2014). In Westerly, Hurricane Sandy destroyed many of the sand dunes along Misquamicut Beach and heavily damaged or destroyed many residences and businesses along Atlantic Avenue (Hanarhan 2012). It also flooded the historic Watch Hill village.

The hurricane/tropical storm events that represent much of the wind hazard for Westerly are coastal systems. As such, wind hazard areas can be prioritized based on the distance from the coast. Figure 2 shows the relative wind hazard ranking for Westerly and all of Rhode Island. These rankings are based on the American Society of Civil Engineers (ASCE) Minimum Design Loads for Buildings and Other Structures, ASCE 7-98. Westerly is located in the risk Category 5 area. While these storms occur infrequently (rated a likely probability over the next five years), they have the potential to cause large amounts of damage over a widespread area.

**Figure 4 Aerial view of Atlantic Avenue and damaged local businesses along Misquamicut Beach**

Source: Kris Craig, Providence Journal.

### 3.2.2.3 Tornado

#### Description

A tornado is a violently rotating column of air in contact with and extending between a cloud and the surface of the earth. Winds in most tornadoes are 100 MPH or less, but in the most violent, and least frequent tornadoes, wind speeds can exceed 250 MPH. Tornadoes, typically track along the ground for a few miles or less and are less than 100 yards wide, though some can remain in contact with the earth for well over fifty miles and exceed one mile in width (Rhode Island Emergency Management Agency, 2014).

Several conditions are required for the development of tornadoes and the thunderstorm clouds with which most tornadoes are associated. Abundant low level moisture is necessary to contribute to the development of a thunderstorm, and a "trigger" (perhaps a cold front or other low level zone of converging winds) is needed to lift the moist air aloft. Once the air begins to rise and becomes saturated, it will continue rising to great heights and produce a thunderstorm cloud if the atmosphere is unstable. An unstable atmosphere is one where the temperature decreases rapidly with height. Finally, tornadoes usually form in areas where winds at all levels of the atmosphere are not only strong, but also turning with height in a clockwise or veering direction (Rhode Island Emergency Management Agency, 2014).

Tornadoes can appear as a traditional funnel shape or in a slender rope-like form. Some have a churning, smoky look to them, and others contain "multiple vortices" –

small, individual tornadoes rotating around a common center while others may be nearly invisible with only swirling dust or debris at ground level as the only indication of the tornado's presence (Rhode Island Emergency Management Agency, 2014).

A tornado begins in a severe thunderstorm called a supercell which can last longer than a regular thunderstorm. The wind coming into the storm starts to swirl and forms a funnel. The air in the funnel spins faster and faster and creates a very low pressure area which engulfs more air (and possibly objects) into it. The severe thunderstorms (which produce tornadoes) form where cold dry polar air meets warm moist tropical air. This is most common in a section of the United States called Tornado Alley (Rhode Island Emergency Management Agency, 2014).

Tornadoes can form any time during the year, however most form in the month of May. Northern latitude portions of the United States experience later peaks in the tornado season as it takes longer to warm the northern parts of the plains. Most tornadoes spin cyclonically but a few spin anti-cyclonically. There are records of anti-cyclonic tornadoes, however scientists don't think that the Coriolis Effect causes the rotations (Rhode Island Emergency Management Agency, 2014).

Local National Weather Service (NWS) offices are responsible for issuing tornado warnings. Tornado warnings indicate that a tornado has been spotted or that Doppler radar detects a thunderstorm circulation capable of spawning a tornado (Rhode Island Emergency Management Agency, 2014). Nationally the tornado season lasts from March to August with peak tornado activity normally occurring in April thru June. The highest concentrations of tornadoes historically have been in the Central U.S. and portions of the Gulf Coast states (Rhode Island Emergency Management Agency, 2014).

**Location**

Tornado Alley, which extends from Texas to the Dakotas, receives the most tornado activity, and while falling well outside of that region tornadoes may occur in Rhode Island at any time. This situation may be more dangerous than states in Tornado Alley because Rhode Island residents do not expect severe tornadoes and are ill-prepared to respond to a tornado strike.  Tornadoes are considered to be low frequency, high-impact events. All areas of Rhode Island face nearly uniform susceptibility to tornadoes (Rhode Island Emergency Management Agency, 2014).

**Extent**

The Fujita Scale, introduced in 1971 by Dr. Ted Fujita, provided a way to characterize tornadoes based on the damage they produced and relating that damage to the fastest quarter-mile wind at the height of a damaged structure. An Enhanced Fujita scale became operational in 2007 and improves upon the original scale by including more damage indicators, taking into account construction quality and variability, and providing a more definitive correlation between damage and wind speed (National Oceanic and Atmospheric Administration, 2007).

**Table 3.5 Fujita Scale and Enhanced Fujita Scale**

| Fujita Scale | | | Enhanced Fujita Scale | |
|---|---|---|---|---|
| **F Number** | **Fastest ¼ mile (MPH)** | **3 Second Gust (MPH)** | **EF Number** | **3 Second Gust (MPH)** |
| 0 | 40-72 | 45-78 | 0 | 65-85 |
| 1 | 73-112 | 79-117 | 1 | 86-110 |
| 2 | 113-157 | 118-161 | 2 | 111-135 |
| 3 | 158-207 | 162-209 | 3 | 136-165 |
| 4 | 208-260 | 210-261 | 4 | 166-200 |
| 5 | 261-318 | 262-317 | 5 | Over 200 |

The immediate threat of tornadoes is danger to life and property from wind and large debris carried by winds. Other vulnerabilities include electrical utilities, gas lines, and communications infrastructure. Damage to power lines, gas lines, or communication towers has the potential to cause power and communication outages for residents, businesses and critical facilities. In addition to lost revenues, downed power lines and broken gas lines present a threat to personal safety. Further, downed wires and lightning strikes have been known to spark fires.

Other critical infrastructure that can be damaged by tornadoes include water mains and sewer systems. Damage to these systems can interrupt drinking water service and cause water contamination if treatment systems fail.

A structure's tornado vulnerability is based in large part on building construction and standards. In general, mobile homes and wood-framed structures are more vulnerable to damage in a tornado than steel framed structures. Other factors, such as location, condition and maintenance of trees also plays a significant role in determining vulnerability.

Human exposure is based on the availability, reception and understanding of early warnings of tornadoes (i.e. Tornado Warning issued by the NWS) and access to substantial shelter. In some cases, despite having access to technology (computer, radio, television, outdoor sirens, etc.) that allows for the reception of a warning, language differences are sometimes a barrier to full understanding of the risk. Once warned of an impending tornado hazard, seeking shelter indoors on the lowest floor of a substantial building away from windows is recommended as the best protection against bodily harm.

**Previous Occurrences and Probability of Future Events**

Eight reported tornadoes touched down in Rhode Island between 1950 and 1994 resulting in 23 injuries and nearly $2 million in damage (Town of Westerly, 2012). The strongest tornado on record in Rhode Island occurred on August 7, 1986 (Del Santo May 21, 2013). This F2 tornado struck Providence County, mostly staying within Providence and Cranston, and caused 20 injuries. Damage costs totaled $5,237,067 (in 2012 dollars) (Del Santo May 21, 2013). However, these statistics rank Rhode Island among the lowest in the United States in terms of tornado frequency

and intensity (Town of Westerly, 2012). In addition, none of the reported tornadoes occurred in Washington County. Since tornadoes strike at random, the entire Town of Westerly is at an equal risk of experiencing the effects of a tornado (Town of Westerly, 2012).

While rare in the New England region, a powerful tornado outbreak occurred on June 1, 2011 that spanned southwest and south-central Massachusetts and southern Maine (National Oceanic and Atmospheric Administration, 2011). Four tornadoes, one ranked as an EF3, touched down in Massachusetts causing three deaths, over 200 injuries, and cost over $140 million in property damages (Spotts, 2011; Turner, 2011; Yee, 2011). More recently, an EF2 tornado with a wind speed of 120 mph struck the town of Revere, Massachusetts on July 28, 2014 (Schulteis, 2014). The tornado caused significant damages to over 60 homes and left 13 of them uninhabitable, however only minor injuries were reported (Schulteis, 2014). Thus, while uncommon, tornadoes occurring in New England are capable of inflicting substantial damage.

Current Rhode Island building design requirements use a design wind speed of 120 mph (Category 3 hurricane) which is considered effective in preserving structures from less severe categories of tornadoes and all but the most severe microbursts (Town of Westerly, 2012). The probability of a tornado or microburst in the next 5 years remains unlikely and is too low to warrant specific additional mitigation measures and actions.

#### 3.2.2.4 Thunderstorms (Lightning and Hail)

**Description**

Thunderstorms are formed when the right atmospheric conditions combine to provide moisture, lift, and warm unstable air that can rise rapidly. Thunderstorms occur any time of the day and in all months of the year but are most common during summer afternoons and evenings and in conjunction with frontal boundaries. The NWS classifies a thunderstorm as severe if it produces hail at least one inch in diameter, maintain winds of 58 MPH or greater, or generate a tornado. About 10 percent of the estimated 100,000 annual thunderstorms that occur nationwide are considered severe (NOAA 2016). Thunderstorms affect a smaller area compared to winter storms or hurricanes but can be as dangerous and destructive for a number of reasons. Storms can form in less than 30 minutes, giving very little warning and they have the potential to produce lightning, hail, tornadoes, powerful straight-line winds, and heavy rains that result in flash flooding (Rhode Island Emergency Management Agency, 2014).

All thunderstorms produce lightning, and therefore all thunderstorms are dangerous. Lightning often strikes outside of areas where it is raining and may occur as far as 10 miles away from rainfall. It can strike from any part of the storm and may even strike after the storm has seemed to pass. Hundreds of people across the nation are injured annually by lightning, most commonly when they are moving to a safe place but have waited too long to seek shelter. Lightning strike victims often

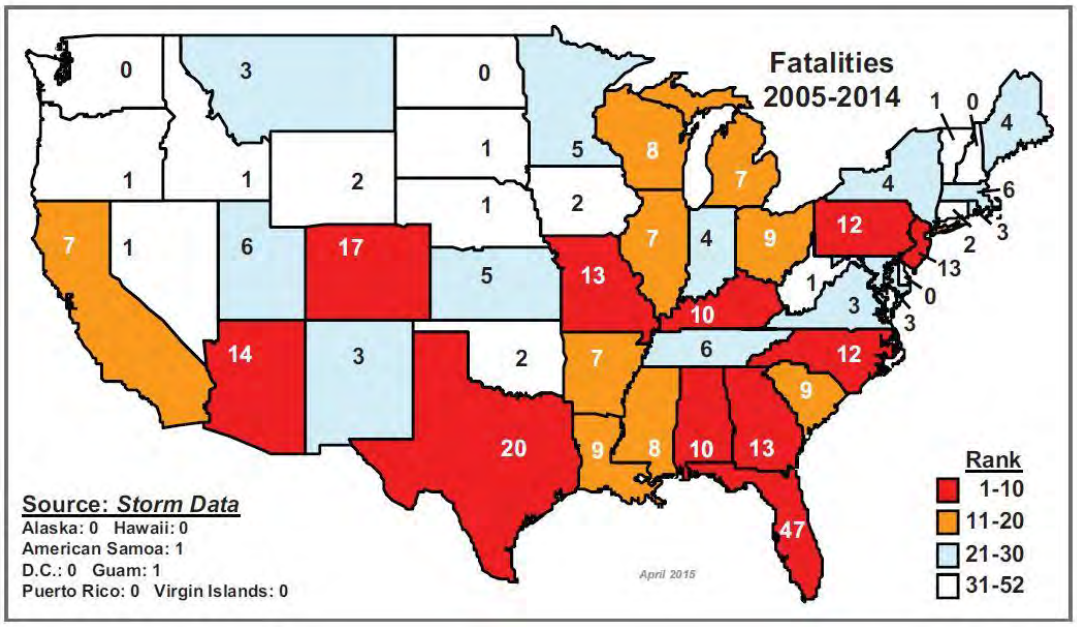
suffer long-term effects such as memory loss, sleep disorders, weakness and fatigue, chronic pain, depression, and muscle spasms. Lightning has the potential to start house fires as well as wildfires. Lightning causes an average of 55-60 fatalities, 400 injuries, and over $1 billion in insured losses annually nationwide (Rhode Island Emergency Management Agency, 2014).

Another potential effect from thunderstorms is hail. Hail is formed in towering cumulonimbus clouds (thunderheads) when strong updrafts carry water droplets to a height at which they freeze. Eventually, these ice particles become too heavy for the updraft to hold up, and they fall to the ground at speeds of up to 120 MPH. Hail falls along paths called swaths which can vary from a few square acres to up to 10 miles wide and 100 miles long. Hail larger than 0.75 inch in diameter can do great damage to both property and crops and some storms produce hail over two inches in diameter. Hail causes about $1 billion in damages annually in the U.S. (Rhode Island Emergency Management Agency, 2014).

**Location**

All areas of Rhode Island are vulnerable to severe thunderstorms and winds, especially those along the Atlantic coast in Washington and Newport counties, and those areas located on Narragansett Bay. Rhode Island has a low incidence of lightening-related fatalities and damages (Figure 5) (NOAA, National Lightning Safety Institute, 2016).

**Figure 5 Number of lightning deaths in the United States, 2005-2014**




Source: National Lightning Safety Institute, NOAA

**Extent**

There is no universally accepted standard for measuring the strength or magnitude of a lightning storm. Similar to modern tornado characterizations, lightning events

are often measured by the damage they produce. Building construction, location, and nearby trees or other tall structures will have a large impact on how vulnerable an individual facility is to a lightning strike. A rough estimate of a structure's likelihood of being struck by lightning can be calculated using the structure's ground surface area, height, and striking distance between the downward-moving tip of the stepped leader (negatively charged channel jumping from cloud to earth) and the object. In general, buildings are more likely to be struck by lightning if they are located on high ground or if they have tall protrusions such as steeples or poles which the stepped leader can jump to. Electrical and communications utilities are also vulnerable to direct lightning strikes. Damage to these lines has the potential to cause power and communications outages for businesses, residencies, and critical facilities.

Structure vulnerability to hail is determined mainly by construction and exposure. Metal siding and roofing is better able to stand up to the damages of a hailstorm than many other materials, although it may also be damaged by denting. Exposed windows and vehicles are also susceptible to damage. Crops are extremely susceptible to hailstorm damage, as even the smallest hail stones can rip apart unsheltered vegetation (Rhode Island Emergency Management Agency, 2014).

Human vulnerability is largely determined by the availability and reception of early warnings for the approach of severe storms, and by the availability of nearby shelter. Swimming, boating, and fishing are particularly dangerous during periods of frequent lightning strikes, which can also cause power outages, topple trees, and spark fires. Individuals who immediately seek shelter in a sturdy building or metal-roofed vehicle are much safer than those who remain outdoors. Early warnings of severe storms are also vital for aircraft flying through the area (Rhode Island Emergency Management Agency, 2014).

**Previous Occurrences and Probability of Future Events**

Rhode Island does not experience severe thunderstorms with the same frequency as the Midwestern and Southeastern states, but there has been a number of destructive wind, hail, and lightning events in recent history (Rhode Island Emergency Management Agency, 2014). The National Climate Data Center (NCDC) has recorded 151 significant (those causing injury, fatalities, and/or damage) lightning and hail events and 344 high wind events, and these events have caused more than $15.5 million in total damages. One death as a result of lightning was recorded on August 11, 2004, in Washington County. Eleven additional injuries have been recorded since 1956 due to lightning. Some of the most significant wind and lightning events in the state's history are listed in Table 3.6.

**Table 3.6 Significant National Climate Data Center hail, lightning, and wind events**

| Date | Type | County | Property Damage (Inflated to 2016 dollars) |
|---|---|---|---|
| 12/23/1994 | Wind | Statewide | $7,746,053 |

| Date | Type | County | Property Damage (Inflated to 2016 dollars) |
|---|---|---|---|
| 8/5/1994 | Lightning | Providence | $774,605 |
| 8/24/1996 | Wind | Washington | $1,097,481 |
| 6/22/1997 | Lightning | Kent | $357,621 |
| 6/17/2001 | Lightning | Kent | $357,621 |
| 8/21/2004 | Wind | Providence | $194,460 |
| 10/28/2006 | Wind | Kent | $170,828 |
| 6/9/2011 | Wind | Providence | $255,173 |
| 6/25/2012 | Lightning | Providence | $150,000 |
| 6/23/2015 | Wind | Statewide | $97,000 |
| 8/4/2015 | Wind | Statewide | $222,000 |

Lightning can pose a risk to people and property in Rhode Island. Examples of effects from recent thunderstorms include an incident on September 3, 2013 when a series of thunderstorms traveled through Rhode Island leaving more than 5,000 people without power. Lightning also struck a South Kingstown fire station twice, however no injuries were reported (Providence Journal, September 2013). While lightning strikes are uncommon they still occur. In 2012 in the northwestern town of Glocester three children were indirectly struck by lightning while playing in a yard (Boston.com, July 2012).

On average, Westerly annually experiences approximately 21 thunderstorms, mainly in August, September, and October. Most of these thunderstorms are mild to moderate, but every five to ten years Westerly may experience more severe storms with gale force winds or actual hurricanes.

#### 3.2.2.5 Winter Related Hazards

**Description**

A heavy **snow** is generally defined as having more than eight inches of accumulation in less than 24 hours. Heavy snow can bring a community to a standstill by inhibiting transportation, knocking down trees and utility lines, and by causing structural collapse in buildings not maintained or designed to withstand the weight of the snow. Repair and snow removal costs can be significant and routinely surpass annual municipal salt and snow removal budgets, usually towards the end of the season. A winter storm warning is issued when snowfall is expected to accumulate more than four inches in 12 hours and/or a quarter inch or more of freezing rain accumulation (Rhode Island Emergency Management Agency, 2016).

The storm radius of a **nor'easter** is often as large as 1,000 miles, and the horizontal storm speed is approximately 25 miles per hour traveling in a northeasterly direction up the eastern United States coast. Sustained wind speeds of 10-40 MPH are common during a nor'easter, with short-term wind speeds gusting up to 70 MPH. Unlike hurricanes and tropical storms, nor'easters can sit off shore, wreaking damage for days. Nor'easters are a common winter occurrence in New England and

repeatedly result in flooding, various degrees of wave and erosion-induced damage to structures, and erosion of beaches, dunes and coastal bluffs. The erosion of coastal features commonly results in greater potential for damage to shoreline development from future storms as their ability to buffer impacts from these storms is reduced (Rhode Island Emergency Management Agency, 2016).

Nor'easters cause varying amounts of coastal erosion depending on the intensity and the duration of the storm, the tidal phase at the time of the storm (neap or spring tide), the path of the storm, and the time interval between storms (Rhode Island State Hazard Mitigation Plan 2014). Back-to-back storms do not allow time for the beaches and dunes to recover sand that has eroded offshore. Damages resulting from nor'easters are often due to coastal erosion which undermine the structures that were previously behind the dunes or on the top of coastal bluffs. Damages to a house that topples off an embankment usually exceed damages resulting from localized areas of flooding (Rhode Island Emergency Management Agency, 2016).

An **ice storm** occurs when damaging accumulations of ice are expected during freezing rain situations. Ice storms result from the accumulation of freezing rain, which is rain that becomes super-cooled and freezes upon impact with cold surfaces. Freezing rain most commonly occurs in a narrow band within a winter storm that is also producing heavy amounts of snow and sleet in other locations. If extreme cold conditions are combined with low/no snow cover, the cold can better penetrate downward through the ground and potentially create problems for underground infrastructure as well. When utilities are affected, water and sewer pipes can freeze and even rupture (Rhode Island Emergency Management Agency, 2016).

**Extreme cold** may accompany winter storms, be left in their wake, or can occur without storm activity. Excessive cold can lead to hypothermia and frostbite to humans which are both serious medical conditions. The definition of an excessively cold temperature varies according to the normal climate of a region. In areas unaccustomed to winter weather, near freezing temperatures are considered "extreme cold." In Rhode Island, extreme cold usually involves temperatures below zero degrees Fahrenheit (Rhode Island Emergency Management Agency, 2016).

**Location**

Westerly lies outside the heavy snow regions of the northeast. Located along the southern New England coast, the Town of Westerly has a maritime climate that is cooler in the summer and warmer in the winter than many inland locations. As a result, Westerly experiences less snowfall, on average, than cities to the northwest. During an average year, coastal regions of Rhode Island receive nearly 36 inches of snow.

However, severe winter storms are spatially expansive during nor'easters. Westerly is susceptible to heavy amounts of snowfall, which can restrict travel and damage power lines and trees, effectively paralyzing the region.

### Extent

Other than characterizing a winter storm as an ice storm, snow squall, or blizzard, there is no universally accepted scale to measure them. Often, winter storms are defined by their components such as wind, snow, ice, and the resultant impact on visibility. The National Weather Service defines a blizzard as a storm that contains a large amount of snow, with winds in excess of 35 mph, and visibility of less than ¼ mile for an extended period of time. In the northeastern United States, the term nor'easter is used to describe storm events that have northeasterly winds that blow in from the ocean. If a nor'easter hits the coast as a blizzard, the ensuing snowfall can collapse weak roofs, as well. The winds also produce storm surges that, because nor'easters are prolonged events, can continue through multiple high tides – the period when the threat of flooding is greatest along coastal land such as Westerly.

The Northeast Snowfall Impact Scale (NESIS) developed by Paul Kocin and Louis Uccellini of the National Weather Service characterizes and ranks high-impact Northeast snowstorms. These storms have large areas of 10 inch snowfall accumulations and greater. NESIS has five categories: Extreme, Crippling, Major, Significant, and Notable shown in Table 3-8. The index differs from other meteorological indices in that it uses population information in addition to meteorological measurements. Thus NESIS gives an indication of a storm's societal impacts.

**Table 3.7 NESIS Categories**

| Category | NESIS Value | Description |
|---|---|---|
| 1 | 1—2.499 | Notable |
| 2 | 2.5—3.99 | Significant |
| 3 | 4—5.99 | Major |
| 4 | 6—9.99 | Crippling |
| 5 | 10.0+ | Extreme |

Loss of power and internet communication resulting from an ice storm may present a very dangerous situation. Furnaces and pellet stoves require electricity to function and the temperatures following winter nor'easters typically plunge as cold fronts sweep in behind the departing weather system.

The wind chill index attempts to quantify the cooling effect of wind with the actual outside air temperature to determine a wind chill temperature that represents how cold people and animals feel, based on the rate of heat loss from exposed skin. A wind chill index of -5 indicates that the effects of wind and temperature on exposed flesh are the same as if the air temperature alone were five (5) degrees below zero (0) (Fahrenheit), even though the actual temperature could be much higher. The NWS issues a wind chill advisory when wind chill temperatures are potentially hazardous and a wind chill warning when the situation can be life-threatening (Rhode Island Emergency Management Agency, 2014a).

Extreme cold is another dangerous aspect of winter related hazards. The greatest danger from extreme cold is to people. Prolonged exposure to the cold can cause frostbite or hypothermia and become life threatening. The risk of hypothermia due to exposure greatly increases during episodes of extreme cold. Infants and elderly people are most susceptible. Certain medications, medical conditions or the consumption of alcohol can also make people more susceptible to the cold. House fires and carbon monoxide poisoning are also possible as people use supplemental heating devices (Rhode Island Emergency Management Agency, 2014a). Frozen pipes resulting from prolonged or extreme cold conditions increase the exposure of both people and property to these winter hazards.

**Previous Occurrences and Probability of Future Events**

Winter weather events in Rhode Island can be described as unpredictable. Days of frigid, arctic air and below freezing temperatures may be followed by days of mild temperatures in the 40s or 50s. Snowfall and rainfall vary; however, Rhode Island residents can expect to experience several nor'easters, which usually bring coastal erosion and a possibility for blizzard conditions or heavy rainstorms dependent on the temperature (Rhode Island Emergency Management Agency, 2014a).

There have been several damaging nor'easters that have occurred in Rhode Island (Table 3.8), and the worst to strike Rhode Island in the last 100 years was the Blizzard of 1978, which had extreme impacts on Rhode Island. Snow accumulation reached 3 to 4 feet and wind speeds exceeded 60 miles per hour. Abandoned cars caused the interstate highways to shut down and more than 10,000 people were stranded on roads and highways throughout the state. In Rhode Island 26 deaths and 232 injuries were attributed to the storm and damage totaled $15 million (Strauss, NOAA). The Blizzard of 1978 is still regarded as the storm of the century and is the storm to which all subsequent storms are compared. Westerly received 24 inches of snow while areas in the rest of the state got upwards of 40 inches (Town of Westerly, 2012; Weisman, 2012). The storm severely impacted municipal budgets due to the wear and tear it caused on the public works department vehicles (Town of Westerly, 2012).

More recently Rhode Island experienced a powerful nor'easter in January 2015, (unofficially known as Winter Storm Juno). Juno dumped 16 inches of snow in southern Rhode Island and resulted in a presidential disaster declaration being issued in April 2015. The preliminary damage assessment for the state was approximately $5 million. Rhode Island also experienced a powerful nor'easter in February 2013, known unofficially as Winter Storm Nemo. With peak wind gusts at 43 mph, Nemo left 20 inches of snow in Westerly. Governor Lincoln Chafee declared a State of Emergency in Rhode Island and enacted a state travel ban that lasted nearly 24 hours (Rapoza, 2013). National Grid estimated more than 180,000 customers lost power. By Saturday night, 129,000 customers in Rhode Island remained without power, with Bristol and Newport counties suffering the majority of the outages. Rhode Island received $1 million in reimbursements from FEMA for snow removal costs from the storm (Cicilline, 2014).

The NCDC data suggests that Westerly can anticipate between two to six significant winter weather events per winter season, making the probability of one occurring in the next 5 years highly likely. Between the years of 1956-2012, Washington County experienced a relatively small number of significant winter weather events (43) relative to other counties, including Providence (139) and Kent (111) (Rhode Island Emergency Management Agency, 2014a). Westerly, which can typically expect to have two to three significant winter events budgeted a total of $211,350 for the Department of Public Works snow and ice removal for fiscal year 2014, which includes overtime, materials and equipment, and salaries and benefits (Town of Westerly, 2013).

**Table 3.8 Historical Nor'easter Losses for Rhode Island**

| Year | Deaths | Total Losses (Actual) |
|---|---|---|
| 1888 | 400+ | Unknown |
| 1978 | 99 | $202M |
| 1991 | 33 | $200M |
| 1992 | 19 | $1,000-2,000M |
| 1993 | 270 | $3,000-6,000M |
| 1996 | 187 | $3,000M |

#### 3.2.2.6 Flood Related Hazards

**Description**

A flood, which can be slow or fast rising but generally develops over a period of days, is defined by the NFIP as:

- A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from: overflow of inland or tidal waters; unusual and rapid accumulation or runoff of surface waters from any source; or a mudflow; or
- The collapse or subsidence of land along the shore of a lake or similar body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels that result in a flood as defined above.

By their very nature, floodplains are the low, flat, periodically flooded lands adjacent to rivers, lakes, and oceans, and are subject to geomorphic (land-shaping) and hydrologic (water flow) processes. It is only during and after major flood events that the connections between a river and its floodplain become more apparent. These areas form a complex physical and biological system that not only supports a variety of natural resources but also provides natural flood and erosion control. In addition, the floodplain represents a natural filtering system, with water percolating back into the ground and replenishing groundwater. When a river is divorced from its floodplain with levees and other flood control structures, natural benefits are either lost, altered, or significantly reduced (Rhode Island Emergency Management Agency, 2014a).

### Riverine Flooding

Riverine flooding is a function of precipitation levels (both rain and snow) and water runoff volumes within the stream or river. Riverine flooding is defined as the periodic occurrence of overbank flows of rivers or streams resulting in partial or complete inundation of the adjacent floodplain. The recurrence interval of a flood is defined as the average time interval, in years, expected to take place between the occurrences of a flood of a particular magnitude to an equal or larger flood. Flood magnitude increases with increasing recurrence interval. When land next to or within the floodplain is developed, these cyclical floods can become costly and dangerous events (Rhode Island Emergency Management Agency, 2014).

### Flash Flooding

A flash flood is the fastest-moving type of flood. It happens when heavy rain collects in a stream or gully, turning the normally calm area into an instant rushing current. Any flood involves water rising and overflowing its normal path. A flash flood is a specific type of flood that appears and moves quickly across the land with little warning, making it very dangerous (Rhode Island Emergency Management Agency, 2014a).

Flash floods are the result of heavy rainfall concentrated over one area. Most flash flooding is caused by slow-moving thunderstorms, thunderstorms that repeatedly move over the same area, or heavy rains from hurricanes and tropical storms. Dam failures can create the most damaging flash flood events. When a dam or levee breaks, a large quantity of water is suddenly let loose downstream, potentially destroying anything in its path (Rhode Island Emergency Management Agency, 2014a).

Flash flood waters move at very fast speeds. They have the power to move boulders, tear out trees, destroy buildings, and obliterate bridges. Walls of water can reach heights of 10' to 20', and generally carry a huge amount of debris with them. The best response to any signs of flash flooding is to move immediately and quickly to higher ground (Rhode Island Emergency Management Agency, 2016).

### Urban/Stormwater Flooding

Urban flooding occurs where there has been development within stream floodplains. This situation has developed partly as a result of the use of waterways for transportation purposes in earlier times. Sites adjacent to rivers and coastal inlets provided convenient places to ship and receive commodities. Floodways and wetlands, which are the natural storage basins for flood waters, were filled to accommodate development. The price of this accessibility to the rivers was increased flooding of those urban areas. Urbanization increases the magnitude and frequency of floods by increasing impermeable surfaces, increasing the speed of drainage collection, reducing the carrying capacity of the land, and, occasionally, overwhelming sewer systems. The most common result from these flooded areas is poor or insufficient stormwater drainage, high groundwater levels, and high percentage of impervious surfaces which prevent groundwater recharge. More often

than not, when heavy rains occur, Rhode Island's aging sewer systems (or combined sewer overflows – CSOs) are overrun, which results in raw sewage flowing into Narragansett Bay, often creating closures to bay shell fishing and swimming (Rhode Island Emergency Management Agency, 2016).

**Coastal Flooding**

Coastal flooding is typically a result of storm surge and wind-driven waves, which erode the coastline. These conditions are produced by hurricanes (tropical storms) during the summer and fall, and nor'easters and other large coastal storms (extra-tropical storms) during the fall, winter, and spring. Storm surges may overrun barrier islands and push sea water up coastal rivers and inlets, blocking the downstream flow of inland runoff. Thousands of acres of crops and forest lands may be inundated by both saltwater and freshwater. Escape routes, particularly from barrier islands, may be cut off quickly, stranding residents in flooded areas and hampering rescue efforts (Rhode Island Emergency Management Agency, 2016).

**Location**

Within the established flood risk areas in Westerly, certain regions are more susceptible to damaging floods than others. In order to identify such regions, the Westerly flood risk areas can be prioritized based on the flood zones designations.

While riverine flooding in Westerly is a typical by-product of coastal storms and hurricanes, it can also occur during late winter due to melting snow, ice and persistent spring rain. The effect of such flooding includes retaining wall and building foundation damage, road damage, and ice or water-borne debris buildup against bridge structures.

One of the primary freshwater waterbodies in Westerly that is susceptible to flooding is the Pawcatuck River, whose watershed covers an area of 486 square kilometers, or 188 square miles (Dillingham, 1993). The Pawcatuck river is the primary component of the Wood-Pawcatcuck Watershed which encompasses 300 square miles and consists of seven major drainage basins, including the Queen, Wood, Chickasheen, Chipuxet, Shunock, Green falls, and Pawcatuck Rivers and their tributaries (Wood-Pawcatuck Watershed Association, 2017). It extends north into Rhode Island and west into Connecticut, encompassing all or part of twelve different municipalities. Within the limits of Westerly, the Pawcatuck River drains the northern and western portions of the town. Westerly is located at the downstream end of the drainage basin. The watershed is irregular in shape with the longest dimension being 22 miles. The maximum elevation of slightly more than 600 feet is in the northern portion of the basin; however, the average elevation is less than 200 feet (FEMA, 2013b). Approximately 5 miles of the river upstream of the confluence at Little Narragansett Bay are tidally influenced (USACE, 1979).

Existing flood protection along most of the coast of the Town of Westerly is limited to the natural protection offered by the barrier beaches themselves, a stretch of sand fill placed by the State of Rhode Island at Misquamicut Beach in 1959 and 1960, and a few seawalls (FEMA, 2013b). Flood hazard areas in Westerly include the

coastal barrier beaches that separate the Maschaug, Little Maschaug, Winnapaug and Quonochontaug Ponds from Block Island Sound, which are designated V zones, as are lands located immediately north of the northern shorelines of these salt ponds. Other V zone locations include Napatree Point, Watch Hill Point, both sides of Atlantic Avenue in Misquamicut Beach, and portions of Weekapaug to the south of Wawaloam Drive and Ninigret Avenue. FEMA-designated A zones are much more expansive, and include low-lying portions of Watch Hill, portions of Misquamicut Beach located some distance inland from the ocean, and a large number of properties located between the north side of the salt ponds and Shore Road (Route 1A).

**Extent**

Populations and property are extremely exposed to flooding. Homes and business may suffer damage and be susceptible to collapse due to heavy flooding. Floodwaters can carry chemicals, sewage, and toxins from roads, factories, and farms; therefore any property affected by a flood may be contaminated with hazardous materials. Debris from vegetation and manmade structures may also be hazardous following a flood. In addition, floods may threaten water supplies and water quality and initiate power outages (Rhode Island Emergency Management Agency, 2014).

Water damage that homeowners and businesses face after flooding can also be an issue. If water damage is not addressed quickly following flood events, which may be the case after significant floods, the likelihood of mold contamination greatly increases (Brandt et al., 2006). Molds are ubiquitous in nature and grow indoors and outdoors, however, moist environments created post-flooding provide optimal mold growth conditions (Brandt et al., 2006). While undisturbed mold is not a substantial health hazard for most people, it can be hazardous to people with conditions such as impaired host defenses or mold allergies (Brandt et al., 2006).

The extent of a flood hazard varies by location and type of flooding. Since there is no universally accepted scale associated with this hazard, in order to appropriately quantify and given the number of flooding events the Town has experienced, the most severe flood of record occurred in 2010 and is detailed further in the following section. Coastal areas are most at risk from flooding caused by hurricanes, tropical storms, and nor'easters. Low-lying coastal areas in close proximity to the shore, sounds or estuaries are exposed to the threat of flooding from storm surge and wind-driven waves, as well as from intense rainfall. Areas bordering rivers may also be affected by large discharges caused by heavy rainfall over upstream areas. Inland areas are most at risk from flash flooding caused by intense rainfall over short periods of time. Stream flow tends to increase rapidly. Large amounts of impervious surfaces in urban areas increase runoff amounts and decrease the lag time between the onset of rainfall and stream flooding. Manmade channels may also constrict stream flow and increase flow velocities (Rhode Island Emergency Management Agency, 2014).

Flood conditions are exacerbated by constriction of river waters that can occur when large amounts of ice or debris such as fallen trees, tree limbs pile up behind low-lying bridge decks or narrow bridge spans. There are nine bridges located on Westerly's section of the Pawcatuck River, several of which date to a period before structures were designed to pass floodwaters from a 100-year storm event. The collapse of one of these structures could cause a downstream catastrophe, as a flood surge laden with trees or buildings could pile up against a dam or set of bridge abutments.

In the future, more intense rainfall, the result of climate change, is likely to increase peak flooding, particularly in urban environments. The magnitude of this increase is dependent on the level and rate of greenhouse gas emissions through the end of the century.

**Previous Occurrences and Probability of Future Events**

Many inland areas of Westerly subject to riverine flooding are designated "A zones, including low-lying areas along the Pawcatuck River (including portions of Downtown Westerly, the North End neighborhood, White Rock and Bradford), Mastuxet Brook, and Chapman Pond. In 1978, 1982 and again in 2010 heavy rains caused the Pawcatuck River to flood its banks. Between April 1 and April 12, 2010, 5 to 10 inches of rain fell across Washington County, resulting in rises on the Pawcatuck River at Westerly and Wood River Junction. The Pawcatuck River set a record of approximately 15.5 feet at Westerly and just over 11 feet at Wood River Junction (FEMA, 2013). The 2010 floods caused road blockages along Route 91 between Westerly and Bradford, and along Canal Street, which included the complete failure of the National Grid substation that disabled power. Numerous businesses and residential structures were flooded out and one building suffered a partial collapse. The Pawcatuck River reached a new record level, exceeding the previous record which was set by storm surge from the 1938 Hurricane. The Pawcatuck River was so severely impacted that it did not recede below flood stage for 10 days until April 12. In Westerly, a mile of train track was inundated, resulting in a suspension of Amtrak services. In addition, Chapman Pond was flooded so badly that it effectively shut down Route 91 and Pound Road, causing a prolonged blocked access to an entire neighborhood (National Weather Service).

The Great New England Hurricane of 1938 and Hurricane Carol in 1954 were severely damaging hurricanes that caused extensive coastal flooding in southern New England (Vallee and Dion, 1998). Hurricane Carol produced a powerful storm surge of 14.4 feet in Narragansett Bay, which surpassed the surge created by the Hurricane of 1938 (Vallee and Dion, 1998). Flooding hastens coastal erosion, and areas such as Misquamicut Beach suffered significant erosion and sand dune damage after Hurricane Sandy (Goonan, Oct. 20, 2012).

Continuing flood losses during the last 30 years have shifted the federal government's focus from flood "control" to flood "management." The goal of flood management is to prevent loss of life and damage to public and private property by reducing the effects of flood damage and forming effective plans for recovery and

rehabilitation. The change from flood control to flood management resulted in revisions and improvements to federal policies. One major impetus was flood hazard mapping. The development of Special Flood Hazard Area (SFHA) maps was the first comprehensive attempt to identify flood hazard risk in the nation's floodplains.

This effort began in 1968, with the passage of the NFIP Act by Congress. The program's intent is to reduce future damage and to provide protection for property owners from potential losses. Flood insurance is made available in communities participating in the NFIP. Policyholders pay premiums that are based on the level of flood risk at an identified location in the community. To accurately identify the risk, FEMA produces Flood Insurance Rate Maps (FIRMs) that show areas subject to flooding. The flood risk information presented on the FIRMs is based on historic, hydrologic, and hydraulic data, as well as on open-space conditions, flood-control works, and development (Rhode Island Emergency Management Agency, 2014).

A 100-year flood is not a flood that occurs every 100 years. In fact, the 100-year flood has a 26 percent chance of occurring during a 30-year period, the typical length of many mortgages. The 100-year flood is a regulatory standard used by federal agencies, states, and NFIP-participating communities to administer and enforce floodplain management programs and is also used nationwide by the NFIP as the basis for insurance requirements. The main recurrence intervals used on the FIRMS are shown in Table 3.9. In those FEMA SFHAs where there are armored shorelines, or any other manmade structures impeding the beaches' natural process of sediment transport, there is a greater likelihood of coastal flooding as the beaches erode and can no longer protect these areas from flooding.

**Table 3.9 Annual Probability Based on Flood Recurrence Intervals**

| Flood Recurrence Interval | Annual Chance of Occurrence |
|---|---|
| 10-yr | 10.0% |
| 50-yr | 2.0% |
| 100-yr | 1.0% |
| 500-yr | 0.2% |

Flooding is the most prevalent and frequent natural hazard that impacts the state. Although there is no distinct flood season in Rhode Island and major river flooding can occur in any month of the year, NOAA has studied a number of past floods from the 1994 to 2000 and has noted three times of the year of particular importance with regard for the potential of flood activity to occur (Valle and DelliCarpini).

- Late winter/spring melt
- Late summer/early fall
- Early winter

The geography and location of Westerly makes the Town susceptible to some level of flooding every year. In the context of hazard mitigation, the probability of a damaging flood event is considered highly likely.

### 3.2.2.7 Coastal Erosion

#### Description

Coastal zones are dynamic areas that are constantly undergoing change in response to a multitude of factors, including Sea Level Rise (SLR), wave and current patterns, hurricanes, coastal flooding and human influences. High winds and associated marine flooding from storm events such as hurricanes, nor'easters, flooding, and SLR, increase the risk exposure along developed coastal lands. Storm impacts and long-term erosion threatens developed areas with potential loss of life and billions of dollars in property damage. In addition to the natural processes that cause erosion, human alterations are affecting erosion rates (Rhode Island Emergency Management Agency, 2014).

Erosion has been wearing away bluffs and moving beaches and barriers along the U.S. coastal and Great Lakes shores from the powers of flooding, storm surge, rising sea levels, and high surf. As shorelines retreat inland, waterfront homes, public infrastructure, such as roads, bridges, wastewater treatment facilities, and stormwater drainage systems, eventually become severely damaged. The Heinz Center report on the "Evaluation of Erosion Hazards" predicts that over the next 60 years erosion may claim one out of four houses within 500 feet of the U.S. shoreline. Most of the damage will occur in low-lying areas – areas also subject to the highest risk of flooding. Additional damage will also occur along coastal bluffs as waves reach higher on the shoreline and erode the toe of the bluff and gravity takes its course (Rhode Island Emergency Management Agency, 2014).

The beaches, barrier spits and coastal bluffs of Rhode Island are vital economic, environmental, and cultural resources. A healthy, wide sandy beach provides protection against the effects of storm surge, coastal flooding, and high surf impacts. The beach and barrier environment provides habitat for marine and terrestrial organisms with beach dependent life stages and is home to species of indigenous and endemic Rhode Island plants. Beaches, barrier spits, and coastal bluffs are also the basis for the tourism industry, exceeding by a factor of three all other industries combined when providing direct income to the state (Rhode Island Emergency Management Agency, 2014).

Rhode Island's beaches and barriers serve as natural protective buffers between the ocean and the land. During storm events, a beach is able to modify its slope and overall morphology to dissipate the waves. The beach profile is flattened, and the waves coming inshore shoal further out offshore, thus minimizing further erosion. Beaches recover when sand is moved back onto the shore by fair weather waves and then is blown inland to reestablish the frontal dunes. The final stage of recovery of the beach and dunes occurs when vegetation grows back over these new dunes. Hence, the narrowing of healthy beaches in response to a high wave event is often a temporary condition (Rhode Island Emergency Management Agency, 2014).

### Location

The headlands and barriers of the south shore from Watch Hill in Westerly to Point Judith in Narragansett are generally eroding at a higher rate than other shorelines along the Rhode Island coast due to their exposure to ocean forces and geologic setting and composition (Rhode Island Emergency Management Agency, 2014). Continuous erosion of this nature will decrease the coastal buffer making waterfront property more susceptible to storm surge (Rhode Island Emergency Management Agency, 2014).

Of the six shoreline types found in Rhode Island, beaches and barrier spits are the most susceptible to erosion. About seven of Westerly's nine miles of coastline are comprised of these unconsolidated sediments (exceptions are rocky headlands located at Watch Hill Point and Weekapaug Point). The RI CRMC includes shoreline change maps for the Rhode Island south shore that span the time period from 1939 to 2004, based on a chronological sequence of aerial photographs taken after the hundred year storm of record, the 1938 hurricane. These maps will be applied to pertinent sections of the Council's regulatory programs to address issues including setbacks of activities from coastal features. These shoreline change maps detail erosion rates for the shoreline, and are further detailed into shoreline segments for each map. In total there are eight shoreline change maps for Westerly, which can be found in Appendix X. (Hehre and Boothyroyd, 2007).

### Extent

Coastal erosion threatens both waterfront property and fragile shoreline habitats, and can affect Westerly's shoreline even during moderate coastal storms. In addition, the predicted increase in global sea-level rise will exacerbate coastal erosion as lower intensity storms cause greater amounts of damage and flooding than their historic counterparts (RIDEM a). Westerly is composed of headland beaches and barrier beaches, which experience erosion at different rates (Faulkner, Mar. 1 2014). Barrier beaches tend to be more dynamic, losing sand at times and then regaining it through natural processes, while headland beaches tend to only erode, resulting in lost beach area (Faulkner, Mar. 1).

The average coastal erosion rate is 1.6 feet per year in Rhode Island (Sullivan, Aug 30, 2012). Rhode Island's shoreline is naturally eroding and migrating over time (Save the Bay, 2013). Based on measurements of the Watch Hill Cove tide gauge, sea level has risen approximately ten inches since 1930 and a full foot of sea level rise is expected by 2030 (Freedman, Jan. 13, 2013). Most of this erosion occurs during short term storm events such as hurricanes and nor'easters, although factors such as sea level rise and coastal armoring also contribute to erosion (Save the Bay, 2013). The vulnerability of many of Rhode Island's beaches and shoreline areas to coastal erosion and flooding tends to increase dramatically as manmade structures are allowed to be built along the shoreline thus impeding the natural, dynamic system of the beach. Coastal armoring and the construction of jetties and groins may save the beach or one private property owner, but it severely impacts sediment deposits

from occurring down shore of the structure, thus accelerating erosion activity and negatively impacting property owners in these locations (Save the Bay, 2013).

**Previous Occurrences and Probability of Future Events**

Westerly has experienced both gradual shoreline erosion and more dramatic erosion from storms. During the period of October 28-31, 2012, Hurricane Sandy caused significant erosion along Misquamicut beach, in addition to several other areas of Rhode Island shoreline (USACE, Nov. 5 2013). In 2013, with assistance from the United States Army Corps of Engineers (USACE), the town began a project to repair the damage to the beach caused by the hurricane through a sand replacement project (USACE, Nov. 5 2013).

Napatree Point in Westerly is another area especially vulnerable to the effects of coastal erosion. The 1938 hurricane in addition to gradual erosion has caused the beach area of Napatree to recede 200 feet and cause the separation of Sandy Point from the mainland (Seaside Topics, 1938).

SLR contributes to erosion by influencing and worsening on-going coastal processes, making coastal areas ever more vulnerable to extreme events. As sea levels rise, storm surges and waves will extend further inland, flooding homes, businesses and roadways. In some areas of the Northeast, storm surges associated with future hurricanes could be two to four feet higher than present conditions. The potentially large effect of SLR on erosion rates must therefore be considered.

#### 3.2.2.8 Dam Failure

**Description**

Dam failures can result from natural events, human-induced events, or a combination of the two. Failures due to natural events such as prolonged periods of rainfall and flooding can result in overtopping, which is the most common cause of dam failure. Overtopping occurs when a dam's spillway capacity is exceeded and portions of the dam that are not designed to convey flow begin to pass water, erode away, and ultimately fail. Other causes of dam failure include design flaws, foundation failure, internal soil erosion, inadequate maintenance, or misoperation. Complete failure occurs if internal erosion or overtopping results in a complete structural breach, releasing a high-velocity wall of debris-laden water that rushes downstream, damaging or destroying everything in its path. An additional hazard concern is the cascading effect of one dam failure causing multiple dam failures downstream due to the sudden release of flowing water (Rhode Island Emergency Management Agency, 2016).

While dam failures that occur during flood events compound an already tenuous situation and are certainly problematic, the dam failures that occur on dry days are the most dangerous. These "dry day" dam failures typically occur without warning, and downstream property owners and others in the vicinity are more vulnerable to being unexpectedly caught in life threatening situations than in failures during predicted flood events (Rhode Island Emergency Management Agency, 2016).

Dams are classified by size and hazard ratings. The size classification, which provides a relative description of small, medium, or large, is based on the storage capacity and height of the impounded water (RIDEM, 2016). The hazard classification relates to the probable consequences of failure or misoperation of the dam; however, it does not relate to the current condition or the likelihood of failure of the dam. The hazard classifications are defined in the Rhode Island Dam Safety Regulations as follows:

- **High Hazard**: means a dam where failure or misoperation will result in a probable loss of human life.
- **Significant Hazard**: means a dam where failure or misoperation results in no probable loss of human life but can cause major economic loss, disruption of lifeline facilities, or impact other concerns detrimental to the public's health, safety, or welfare.
- **Low Hazard**: means a dam where failure or misoperation results in no probable loss of human life and low economic losses (RIDEM, 2016).

**Location**

The Rhode Island Department of Environmental Management (RIDEM) has the responsibility to inspect dams and determine their condition (RIDEM, 2016). In accordance with Dam Safety Regulations, visual inspections of significant hazard dams are required every five years (RIDEM, 2016). As part of each visual inspection, the condition of the major components of the dam are subjectively rated as good, fair or poor. The major components of a dam are the embankment, the spillway, and the low-level outlet (RIDEM, 2016). Westerly has several dams that were constructed over a century ago to provide hydropower to adjacent textile mills. According to the 2017 Annual Report to the Governor on the Activities of the Dam Safety Program, all of the dams within Westerly and those that are shared between Westerly and neighboring Connecticut are designated as low hazard dams; meaning that if the dam were to fail it would result in no probable loss of human life and low economic losses.

**Table 3.10 Dams within Westerly**

| Dam No. | Dam Name | Hazard Class |
|---|---|---|
| 493 | Olaf Farm Pond | Low |
| 752 | Boiling Spring | Low |
| 454 | Woody Hill Reservoir | Low |
| 547 | Misquamicut County Club Pond | Low |
| 256 | Stillmanville | Low |
| 253 | Bradford | Low |

The White Rock Dam (Dam No. 255) was removed in the fall of 2015.

In 2008, Section Nine of Chapters 46-18 and 46-19 of the Rhode Island General Laws were amended to require that a city or town where a significant or high hazard dam is located complete an Emergency Action Plan (EAP) for the dam (RIDEM, 2016). An

EAP is a formal document that identifies potential emergency conditions and specifies pre-planned actions to be followed to minimize loss of life and property damage (Dam Safety Program Report, 2012). RIEMA is responsible for coordinating development of EAPs and granting final approval of the plans (RIDEM, 2012). Although Westerly's low hazard dams preclude them from developing an EAP, it would be proactive of the Town to write an EAP should they experience more multiple dam failures.

**Extent**

Safety, liability, and environmental hazards of aging dams are issues for every community in Rhode Island (Save the Bay, 2010). Most of the dams in Rhode Island were constructed before 1900 for water supply, industrial mill use, power supply, and recreation purposes (Save the Bay, 2010). This aging infrastructure poses liabilities for cities, towns, the state, and private landowners. Most of these structures do not fulfill their original purpose, but have become a permanent fixture in the landscape (Save the Bay, 2010). Depending on the location and population density around a dammed area, a dam failure can cause loss of life in addition to the inevitable economic damages associated with dam failure. Those who live downstream from a significant or high risk dam should be aware of designated evacuation routes and preplanned actions that can be taken in the event of a dam failure. As low hazard dams, a failure or misoperation of any of the dams in Westerly would result in no probable loss of human life and low economic losses.

**Previous Occurrences and Probability of Future Events**

Rhode Island has experienced many dam failures, mainly resulting from major flood events (Rhode Island Emergency Management Agency, 2014). There have been over 111 dam incidents recorded in Rhode Island from as early as 1889, seven of which have included some degree of dam failure (National Performance of Dams Program). A notable dam failure in Rhode Island is the collapse of California Jim's dam in Peace Dale in 1998 (Town of South Kingstown, 2006). The failure caused a total draining of the 12.8 acre pond and the resultant flooding cost $400,000 in property damages and $250,000 in repairs to the dam (Association of State Dam Safety Officials). This incident highlighted the lack of dam maintenance and emergency preparedness related to dam failure in Rhode Island and created an impetus for the revised dam safety regulation promulgated in 2007 (Save the Bay, 2010).

The spring rains of 2010 breached Blue Pond Dam in Hopkinton. This dam failure caused a surge of water that incapacitated the National Grid substation on Canal Street and flooded the Canal Street manufacturing district and the North End Neighborhood of Westerly. Other dams that were closely monitored during the March 2010 flooding included the Alton Dam on the Wood River in neighboring Hopkinton. The Alton Dam was submerged by swiftly moving waters and the bridge spanning the river on Route 91 was left with a deep crevice (Benson, 2010). Additionally, the dam over the Pawcatuck River in the Bradford section of Westerly overtopped its embankment and flooded Route 216 and the Bradford Dyeing Association plant. Other flooded and damaged dams included dams on the

Pawcatuck on Route 3 and Potter Hill Road (Benson, 2010) and the Hewitt Farm Dam (Souza, 2014). During the flooding, the Alton-Wood River Junction and the Bradford sections of Westerly and Hopkinton downstream of the dams were ordered to evacuate. However, while the flooding did put significant pressure of the dams they did not fail (Benson, 2010).

While the probability of future dam failure events in Westerly is unlikely, there is a correlation to some extent with the probability of future major flood events coupled with preventative measures, including the routine inspection, maintenance, repair, and proper operation of dams by their owners, and as regulated by RIDEM's Dam Safety Program.

#### 3.2.2.9 Wildfire

**Description**

Wildfires are fueled by dead or dying vegetation, including native and non-native species of trees, brush and grasses, and crops along with weather conditions and topography. While available fuel, topography, and weather provide the conditions that allow wildfires to spread, most wildfires are caused by people through criminal or accidental misuse of fire (Rhode Island Emergency Management Agency, 2016).

Wildfires pose serious threats to human safety and property in rural and suburban areas. They can destroy crops, timber resources, recreation areas, and habitat for wildlife. Wildfires are commonly perceived as hazards in the western part of the country; however, wildfires are a growing problem in the wildland/urban interface of the eastern United States, including Rhode Island (Rhode Island Emergency Management Agency, 2016).

Wildfires are dependent upon the quantity and quality of available fuel. Fuel quantity is the mass per unit area. Fuel quality is determined by a number of factors, including fuel density, chemistry, and arrangement. Arrangement influences the availability of oxygen. Another important aspect of fuel quality is the total surface exposed to heat and air. Fuels with large area-to-volume ratios, such as grasses, leaves, bark and twigs, are easily ignited when dry (Rhode Island Emergency Management Agency, 2016)

Climatic and meteorological conditions that influence wildfires include solar insulation, atmospheric humidity, and precipitation, all of which determine the moisture content of wood and leaf litter. Dry spells, heat, low humidity, and wind increase the susceptibility of vegetation to fire. In Rhode Island, common factors leading to large fires include short-term drought, humidity below 20%, and fuel type (Rhode Island Emergency Management Agency, 2016).

**Location**

Westerly is a well-developed coastal town with large areas of open space that are mostly composed of beaches. Fires can occur in these open spaces given the right

conditions. Wildfires that occur in undeveloped, natural areas may be less accessible to fire protection services, thus further increasing the risk of wildfire.

The likelihood of fire varies based on a number of weather-related factors. Drought leads to increasing dryness, which affects how deep in the vegetation the fire will burn. Wind speed influences direction and speed of the spread of wildfire. Both temperature and humidity affect the likelihood of wildfire; warmer and dryer weather can result in increased fire danger. Locations in Westerly most vulnerable to wildfire include the Woody Hill Management Area and the Town Forest that have limited accessibility to motor and/or emergency vehicles. Other critical areas are the coastal grasslands in vicinity of Avondale, Watch Hill and the salt ponds. While these grassland areas are relatively small in size, the real danger associated with wildfire is the potential for its spread to nearby residential structures. While coastal grasslands are generally accessible to fire apparatus, they may be located some distance from hydrants, necessitating the transport of water to burning vegetation.

A specific problem in rural areas faced by fire fighters is inadequate posting of street addresses for residential properties. Without property markers, emergency response personnel may waste valuable time when trying to find direct access to a fire. This is especially true when residential properties are setback some distance from the road and hidden behind vegetation. This is easily remedied by requiring property owners to post address numbers that are visible from the street.

Another pressing fire hazard risk is that of urban fires. A wildland urban interface fire (WUI) is an uncontrolled wildfire in a geographical area where structures and other human development meet or intermingle with vegetative fuels, possibly consuming structures in its path. WUI fires tend to be more damaging than urban structural fires, are often more difficult to control, and behave differently from structural fires. People who live in heavily forested portions of Westerly have little understanding of wildfire cycles and danger since it occurs so infrequently in Rhode Island. Consequently, homes and other structures are often built and maintained in a manner that leaves them and their occupants' vulnerable (Town of Westerly, 2012). The vegetative fuels found in Westerly are classified as Light based on the National Fire Danger Rating Fuel Model. However, severe and prolonged droughts increase the likelihood of wildfires regardless of the area vegetation (Town of Westerly, 2012).

Open air burning, the act of any fire in the outdoors or in a structure not completely enclosed by walls and a roof, require a written permit from the local Fire Department with jurisdiction when risk of wildfires is low. Open air burning can increase the risk of wildfires and if the risk of wildfires is heightened the decisions of permit issuance is superseded by state law (RIDEM b).

**Extent**

Wildfires, commonly called "forest fires" or "brush fires," have the potential to destroy valuable natural resources, damage real estate property, and threaten people's lives and livelihoods (RIDEM b). The accurate prediction of the potential risk of a wildfire and the forewarning of dangerous wildfire conditions can help reduce

the incidence and seriousness of wildfires (RIDEM b). It can also provide firefighters the critical time needed for important preparation and readiness for wildfire suppression, as well as assist decision makers in the appropriate uses and activities for the public at large during times of extreme fire danger to aid in the prevention efforts (RIDEM b). RIDEM's Division of Forestry is responsible for predicting the risk of wildfires using a modified NFDRS to account for local conditions (RIDEM b).

The U.S. Forest Service has established the National Fire Danger Rating System (NFDRS) to determine the daily risk to fire experienced by different regions of the country (Table 3.11). The system uses mathematical formulas including wind speed and fuel type to determine a fire index. The fire indexes are grouped into five groups based on severity, and each group has an associated class rating (Classes 1 through 5) and an associated fire risk level. A fire index of zero occurs when there is snow on the ground or there has been a prolonged period of substantial rain (Rhode Island Emergency Management Agency, 2014).

**Table 3.11 Fire Index Class Ratings**

| Fire Index | Rating | Description |
|---|---|---|
| 0 | Class 1 | No rating |
| 1-30 | Class 2 | Low danger |
| 31-60 | Class 3 | Medium danger |
| 61-80 | Class 4 | High danger |
| 81+ | Class 5 | Extreme |

Source: Rhode Island Department of Environmental Management b

Vulnerability to wildfire is influenced by a variety of factors, such as land cover conditions, weather, and the effectiveness of land management techniques. Highly urbanized areas are less vulnerable to wildfire, however the risk of urban fire is heightened. Suburban neighborhoods located at the state's Wildland Urban Interface (WUI), the area where structures and human development meet and intermingle with undeveloped wild land, are very vulnerable to wildfire. Individual buildings may be more or less vulnerable to damage from wildfire based on factors such as the clear distance around the structure and the structure's construction materials. Wildfire primarily impacts timber and forest ecosystems, although the threat to nearby buildings is always present.

Although not thought of as an urban area, densely populated areas of Westerly are vulnerable to fires if they are adjacent to undeveloped, forested land.

**Previous Occurrences and Probability of Future Events**

While wildfires are not especially common in Rhode Island, and Westerly has not had a significant wildfire in decades. However, they have happened and their effects have been devastating. In 1894, an immense woodland fire burned along Post Road (Route 1) between Wakefield and Westerly and destroyed timber supplies in Charlestown as well as several farmhouses (New York Times, 1894). In 1930 and 1942

major forest fires swept through western Rhode Island burning tens of thousands of acres of timber (University of Rhode Island Cooperative Extension).

Like the rest of Rhode Island, Westerly generally exhibits a humid continental climate, with hot, rainy summers and cold, snowy winters, and thus often has a low or medium (Class 1 or 2) fire class rating (USGS, 1989). However, fires can and do occur at any time of year (RIDEM b). Dry, windy weather does occur, and fire conditions can be exacerbated by drought. The peak fire season in Rhode Island is typically between March and May (RIDEM b). During this time of year there is no leaf canopy so the sun dries out grasses and fallen leaves (considered one hour fuel sources) and dormant brush, dead twigs, and small branches (ten hour fuels) (RIDEM b). Windy conditions and the low humidity of the spring (typically less than 40%) further contribute to increased fire risk (RIDEM b). Although less common, wildfires may be a risk during the summer and fall months particularly if drought conditions occur (RIDEM b). Based on historic analysis and continued education regarding wildfires, the probability of future events is unlikely.

#### 3.2.2.10 Earthquakes

**Description**

An earthquake is caused by a sudden displacement within the earth. Strong and destructive earthquakes usually result from the rupturing or breaking of great masses of rocks far beneath the surface of the earth. The ultimate cause of these deep ruptures has not been established. All earthquakes produce both vertical and horizontal ground shaking. This ground movement begins at the focus or hypocenter, deep in the earth, and spreads in all directions. The felt motion is the result of several kinds of seismic vibrations. The primary, or P, waves are compressional. The secondary, or S, waves have a shear motion. These body waves radiate outward from the fault to the ground surfaces where they cause ground shaking (Rhode Island Emergency Management Agency, 2016).

Geologists have found that earthquakes tend to reoccur along faults, which reflect zones of weakness in the Earth's crust, a theory known as plate tectonics (Kafka, 2014). A fault is a fracture in the Earth's crust along which two blocks of the crust have slipped with respect to each other. Faults are divided into three main groups, depending on how they move. Normal faults occur in response to pulling or tension; the overlying block moves down the dip of the fault plane. Thrust (reverse) faults occur in response to squeezing or compression; the overlying block moves up the dip of the fault plane. Strike-slip (lateral) faults occur in response to either type of stress; the blocks move horizontally past one another. Most faulting along spreading zones is normal, along subduction zones is thrust, and along transform faults is strike-slip. Even if a fault zone has recently experienced an earthquake there is no guarantee that all the stress has been relieved (Kafka, 2014).

The focal depth of an earthquake is the depth from the Earth's surface to the region where an earthquake's energy originates (the focus). Earthquakes with focal depths from the surface to about 70 kilometers (43.5miles) are classified as shallow.

Earthquakes with focal depths from 70 to 300 kilometers (43.5 to 186 miles) are classified as intermediate. The focus of deep earthquakes may reach depths of more than 700 kilometers (435 miles). The focuses of most earthquakes are concentrated in the crust and upper mantle. The depth to the center of the Earth's core is about 6,370 kilometers (3,960 miles), so even the deepest earthquakes originate in relatively shallow parts of the Earth's interior. The epicenter of an earthquake is the point on the Earth's surface directly above the focus. The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth (Rhode Island Emergency Management Agency, 2014).

Earthquakes beneath the ocean floor sometimes generate immense sea waves or tsunamis. These waves travel across the ocean at speeds as great as 960 kilometers per hour (597 miles per hour) and may be 15 meters (49 feet) high or higher by the time they reach the shore (Rhode Island Emergency Management Agency, 2016).

Liquefaction, which happens when loosely packed, water-logged sediments lose their strength in response to strong shaking, causes major damage during earthquakes (Rhode Island Emergency Management Agency, 2016).

**Location**

Rhode Island is located in a region of the North American plate and falls within seismic zone 2A with 8-16% ground acceleration, which translates to a "moderate" seismic hazard (Petersen et al. 2008; US Seismic Zone Map). This means that people may experience moderate intensity shaking that can lead to slight damage during an earthquake event (FEMA Earthquake Hazard maps). There are no significant geologic fault lines in Rhode Island or New England, and the USGS Earthquake Hazards Program identifies all of Rhode Island as occurring in a low seismic risk area (<2%g peak acceleration). Earthquakes that occur in the northeast, which is considered an intraplate area, do not meet the assumptions of the plate tectonic theory since there is no obvious relationship between earthquake occurrence and fault lines in intraplate areas (Kafka, 2014).

A commonly accepted explanation for the occurrence of earthquakes in the northeast is that "ancient zones of weakness" are being reactivated by the present stress field (Kafka, 2014). This theory hypothesizes that pre-existing faults and other geologic features formed during ancient geological episodes persist today and that earthquakes occur when present-day stress is released along these zones of weakness (Kafka, 2014). Earthquakes occur infrequently in Rhode Island and surrounding New England, but historically earthquakes originating in other states have been felt in various parts of Rhode Island.

**Extent**

The severity of an earthquake can be expressed in terms of both intensity and magnitude. Intensity is based on the observed effects of ground shaking on people, buildings, and natural features. It varies from place to place within the disturbed region depending on the location of the observer with respect to the earthquake epicenter. Although numerous intensity scales have been developed over the last

several hundred years to evaluate the effects of earthquakes, the one currently used in the United States is the Modified Mercalli Intensity (MMI) Scale. This scale, composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, is designated by Roman numerals. It does not have a mathematical basis; instead it is an arbitrary ranking based on observed effects.

Magnitude is related to the amount of seismic energy released at the hypocenter of the earthquake. It is based on the amplitude of the earthquake waves recorded on instruments which have a common calibration. The magnitude of an earthquake is thus represented by a single, instrumentally determined value. The magnitudes of seismic waves are recorded on instruments called seismographs, using the Richter Magnitude Scale. The Richter Scale is not used to express damage. An earthquake in a densely populated area that results in many deaths and considerable damage may have the same magnitude as a shock in a remote area that does nothing more than frightens the wildlife. Large magnitude earthquakes that occur beneath the oceans may not even be felt by humans (Rhode Island Emergency Management Agency, 2014).

Earthquakes with magnitude of 2.0 or less are usually called micro earthquakes. They are not commonly felt by people and are generally recorded only on local seismographs. Events with magnitudes of 4.5 or greater are strong enough to be recorded by sensitive seismographs all over the world. Great earthquakes, such as the 1964 Good Friday earthquake in Alaska, have magnitudes of 8.0 or higher. On the average, one earthquake of such size occurs somewhere in the world each year. Although the Richter scale has no upper limit, the largest known shocks have had magnitudes in the 8.8 to 8.9 range. Recently, another scale called the moment magnitude scale has been devised for more precise study of great earthquakes. Only a couple earthquakes of MMI Scale V or greater have been centered in Rhode Island, including the 1951 South Kingstown earthquake of magnitude 4.6 on the Richter scale (Rhode Island Emergency Management Agency, 2014).

Impacts from earthquakes can be severe and cause significant damage. Ground shaking can lead to the collapse of buildings and bridges and disruption of gas and electric lines, phone service, and other critical utilities. Death, injuries, and extensive property damage are possible vulnerabilities from earthquakes. Some secondary hazards caused by earthquakes may include fire, hazardous material release, landslides, flash flooding, avalanches, tsunamis, and dam failure (Rhode Island Emergency Management Agency, 2014).

Earthquakes can cause flooding due to the tilting of the valley floor, dam failure, and seiches in lakes and reservoirs. Flooding can also result from the disruption of the rivers and streams. Water tanks, pipelines, and aqueducts may be ruptured or canal and streams altered by ground shaking surface faulting, ground tilting, and land sliding (Rhode Island Emergency Management Agency, 2014).

Earthquake-caused fires are generally the result of broken natural gas lines. These types of fires were very evident in the 1906 and 1989 San Francisco earthquakes. Other types of fires may include oil refineries, electrical, gasoline stations and

chemical spills. Earthquakes may also result in a hazardous materials spill (Rhode Island Emergency Management Agency, 2014).

**Table 3.12 Richter Magnitude Scale**

| Richter Magnitude Scale | Modified Mercalli Intensity Scale |
|---|---|
| 1.0 - 3.0 | I |
| 3.0 - 3.9 | II – III |
| 4.0 - 4.9 | IV – V |
| 5.0 - 5.9 | VI - VII |
| 6.0 - 6.9 | VIII - IX |
| 7.0 and higher | X and higher |

**Table 3.13 Modified Mercalli Intensity Scale**

| Defined MMI Rating | Description |
|---|---|
| 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. |
| 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. Vibrations similar to the passing of a truck. |
| 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, 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. |

| Defined MMI Rating | Description |
|---|---|
| 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 into the air. |

**Previous Occurrences and Probability of Future Events**

European settlers in Rhode Island noted the effects of a number of earthquakes beginning in the mid-17th century. Between 1776 and 2007, thirty-eight (38) earthquakes were recorded in Rhode Island, far fewer than any New England state. Most of these earthquakes measured low on the intensity scale, and are believed to have originated elsewhere, some as far away as Quebec. In 1883 an earthquake believed to have been centered on Rhode Island was felt (Intensity V effects) from Bristol to Block Island. On December 20 and 24 in 1940 there were strong earthquakes centered around Lake Ossipee, New Hampshire that caused some damage in the epicentral area and caused Intensity V effects on the MMI scale in Newport, Rhode Island (von Hake, 1976). The largest earthquake recorded in Rhode Island occurred on June 10, 1951 and was centered in Kingston with a 4.6 Richter Magnitude Scale rating (Rhode Island Emergency Management Agency, 2014). The most recent earthquake to affect a portion of Connecticut and Rhode Island was a 3.3 magnitude quake that occurred on January 12, 2015 with an epicenter in Wauregan, Connecticut (USGS, 1/12/15). Effects of the quake were mostly felt along the Rhode Island and Connecticut border shared between Plainfield and Foster, although weak intensity effects were also reported in Westerly (USGS, 1/12/15; Algier, 1/12/15).

A primary goal of earthquake research it to increase the reliability of earthquake probability estimates (Shedlock and Pakiser, 1995). However, while there have been some tools developed to predict large earthquakes within a certain radius, to date there have not been any conclusive methodologies with high degrees of accuracy developed for earthquake prediction. Rhode Island is located in an area of "moderate" seismicity and "high" risk. Seismic risk applies to the seismic hazard, location demographics, and regional economics to the vulnerabilities of the structure or lifeline on the site. Seismologists have estimated that there is about a 50% probability of a very damaging magnitude 5.0 earthquake occurring anywhere in New England, in a 50-year period. Using the hazard ranking criteria, probability of future occurrence has been related to aa unlikely probability of occurrence based on previous occurrences of earthquakes in Rhode Island. Vulnerability of property to seismic hazards is determined by the prevalence of earthquake-resistant construction (FEMA, 2014).

Despite the low probability of a high impact earthquake, physical characteristics in Rhode Island may increase earthquake vulnerability:

1. **Hard Rock**: Due to the geological makeup of New England's base rock, seismic energy is conducted on a greater scale (four (4)-10 times that of an equivalent Richter magnitude earthquake in California)
2. **Soft Soil**: Many coastal regions of New England are made up of soft soils. These soils can magnify an earthquake as much as two times.
3. **Structures**: The New England region, being one (1) of the first settled areas of the United States, has an abundance of older, unreinforced masonry structures that are inherently brittle and very vulnerable to seismic forces.
4. **Low Public Awareness of Vulnerability**: Little public recognition of earthquake threat, and no established system of educating or informing the public of the threat or how to prepare for or respond during an earthquake. Therefore, higher losses will occur here than in other regions of the country.

### 3.2.3 Climate Change

Based on the NOAA Technical Report NESDIS 142-1, Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Climate of the Northeast, two climate model simulations have been developed that project the effects of high and low greenhouse gas emission scenarios. Analyses of the simulated future climate are provided for the periods of 2021-2050, 2041-2070, and 2070-2099, with changes calculated with respect to a historical climate reference period (1971-1999, 1971-2000, or 1980-2000) (NOAA 142-1, 2013). The resulting climate change conditions are to be viewed as scenarios, not forecasts, and there no explicit or implicit assumptions about the probability of either scenario (NOAA 142-1, 2013).

Key findings of the simulated climate models are as follows:

- Models indicate an increase in temperature for all three future periods, with little spatial variation. Changes along coastal areas, such as Westerly, are slightly smaller than inland areas.
- Simulated temperature changes are similar in value for the high and low emissions scenarios for the near future, whereas late in the 21st century the high emissions scenario indicates nearly twice the amount of warming.
- The range of model-simulated temperature changes is substantial, indicating substantial uncertainty in the magnitude of warming associated with each scenario. However, in each scenario, the modeling is unequivocal and large compared to historic variations.
- Increases in the number of days with a maximum temperature above 95ºF are simulated to occur throughout the northeast, with the largest increases occurring in the southern and western areas.
- Simulated decreases in the average annual number of days with a minimum temperature below 10ºF are largest (21 days or more) in northern areas. Decreases in the number of days with a minimum temperature below 32ºF are 20-23 days across most of the region.

- The freeze-free season is simulated to lengthen by at least 19 days across the region by mid-21st century. Simulated increases in most areas are 3-4 weeks.
- The far northern regions show the largest simulated increases in average annual precipitation, while southern and coastal areas show less of an increase. Models are mostly in agreement that precipitation will increase over the entire region under these scenarios. Simulated seasonal changes are mostly upward in winter, spring, and fall, and downward in summer.
- All areas see simulated increases in the number of days with precipitation totals exceeding 1 inch, with the greatest increases (up to 30%) occurring in parts of New York. The simulated increases are statistically significant in most northern areas.
- Most models do not indicate a statistically significant change in temperature (with respect to 2001-2010) for the near future; however, as the time period increases a greater number of models simulate statistically significant temperature changes, with all being significant at the 95% confidence level by 2055 (for the high emission scenario).

These modeled scenarios of hotter weather and increased precipitation, along with current climate trends such as increased sea level rise may affect Westerly in the long term. Increased precipitation may lead to inland flooding and potentially cause issues, such as dam breach of the drinking water reservoir, which already is deemed a high hazard. Conversely, hotter weather can lead to drought-like conditions and strain Westerly's drinking water supply. The rise in sea level may intensify coastal erosion and damage vulnerable areas. Based on the actions outlined in this natural hazard mitigation plan, Westerly may be better prepared to respond to and mitigate the effects of climate change.

### Sea Level Rise and Salt Marshes

Salt marshes are a valuable natural resource. In terms of offering protection from natural hazards, salt marshes help to reduce the damage from coastal storms and erosion by absorbing wave energy. Salt marshes also provide nursery and foraging grounds for many marine fish, invertebrates, and birds as well as providing critical water quality functions. Today, salt marshes are being threatened from SLR. Based on local marsh elevation data and ongoing regional SLR trends indicate that Rhode Island's marshes are not gaining elevation fast enough on an annual basis to keep pace with the present rates of SLR (CRMC, 2015).

In March 2015, the CRMC, in conjunction with local environmental organizations, developed a report that analyzed the impacts of SLR on coastal wetlands and the landward migration potential of coastal wetlands in Rhode Island. The modeling effort, named the Sea Level Affecting Marshes Model (SLAMM) used SLR projections of 1, 3 and 5 feet (above 1990 levels) to simulate short- and long-term impacts on coastal wetlands by the end of the century and to assess potential wetland migration pathways on both developed and undeveloped upland parcels (CMRC, 2015). In the near and long-term time frames,

Rhode Island may face substantial loss of coastal wetlands and some freshwater wetlands in close proximity to the coast. Total statewide losses of existing coastal wetlands are projected to be 13%, 52% and 87% under 1, 3 and 5 feet SLR, respectively (CRMC, 2015). However, under the assumption that there may be successful marsh migration onto adjacent upland areas, the model is projecting that the state will have an overall net gain of coastal wetlands under all three SLR scenarios (CRMC, 2015).

The model was run in two application scenarios: one scenario prevents the migration of salt march upon currently developed land and is known as "protected development" and the other scenario allows for the establishment of marsh over paved or otherwise developed areas provided that all other factors are favorable for marsh migration and development and is known as "unprotected development." The unprotected development scenario results in a likely overestimation of the acreage of newly created wetland, but was used to show the complete picture of potential future salt marsh migration (CRMC, 2015). Another aspect of the modeling scenario is that it has a lower degree of confidence for coastal barrier beach systems, a common feature in Westerly, due to the model's overwash component (CRMC, 2015). Despite this limitation, the model still provides a valuable tool to identify areas that are vulnerable to salt marsh loss and migration.

Based on the 2010 National Wetlands Inventory, Westerly currently has 26.2 acres of irregularly flooded salt marsh, 237.2 acres of regularly flooded salt march, and 6.2 acres of transitional marsh/scrub shrub, for a grand total of 269.6 coastal wetland. Tables 3.14 and 3.15 show the predicted salt marsh gain and loss results based on the SLAMM protected and unprotected scenarios, respectively. New marsh habitat is the acreage of coastal wetlands that are projected by SLAMM to develop under the selected SLR scenario. Persistent marsh is existing marsh that will continue to survive under the specified SLR elevation, while marsh habitat loss is the acreage that will drown in place or will not continue to persist at the specified SLR elevation.

**Table 3.14 Status of Coastal Wetlands in Westerly based on 2010 National Wetlands Inventory (acres)**

| Salt marsh (irregularly flooded) | Salt marsh (regularly flooded) | Transitional marsh/ scrub shrub | Grand total |
|---|---|---|---|
| 26.2 | 237.2 | 6.2 | 269.6 |

**Table 3.15 Salt Marsh Loss and Gain in Acres Under Specified Sea Level Rise In Westerly: Protected Development Scenario**

| 1 ft. Sea-Level Rise | | | 3 ft. Sea-Level Rise | | | 5 ft. Sea-Level Rise | | |
|---|---|---|---|---|---|---|---|---|
| New marsh habitat | Persistent marsh habitat | Marsh habitat loss | New marsh habitat | Persistent marsh habitat | Marsh habitat loss | New marsh habitat | Persistent marsh habitat | Marsh habitat loss |
| 89.4 | 240.4 | 29.1 | 136.2 | 62.0 | 207.6 | 111.6 | 18.4 | 251.2 |

Note: The SLAMM protected scenario does not allow coastal wetlands to migrate onto currently developed areas.

**Table 3.16 Salt Marsh Loss and Gain in Acres Under Specified Sea Level Rise In Westerly: Unprotected Development Scenario**

| 1 ft. Sea-Level Rise | | | 3. ft. Sea-Level Rise | | | 5 ft. Sea-Level Rise | | |
|---|---|---|---|---|---|---|---|---|
| New marsh habitat | Persistent marsh habitat | Marsh habitat loss | New marsh habitat | Persistent marsh habitat | Marsh habitat loss | New marsh habitat | Persistent marsh habitat | Marsh habitat loss |
| 112.7 | 224.4 | 45.1 | 237.0 | 54.0 | 215.6 | 250.1 | 18.4 | 251.2 |

Note: The SLAMM unprotected scenario allows coastal wetlands to migrate onto currently developed areas provided all other model parameters are favorable for marsh development.

Although statewide the SLAMM results show that Rhode Island as a whole will see net overall gains of coastal wetlands under all SLR scenarios, Westerly is one of four towns that is projected to see a net loss under 3 and 5 feet SLR, as shown in Table 3.17.

**Table 3.17 Net change of coastal wetlands in acres in Westerly for Protected and Unprotected scenarios**

| Protected development | | | Unprotected development | | |
|---|---|---|---|---|---|
| 1 ft. SLR | 3 ft. SLR | 5 ft. SLR | 1 ft. SLR | 3 ft. SLR | 5 ft. SLR |
| 60.3 | -71.4 | -139.6 | 67.6 | 21.4 | -1.1 |

Although the model predicts that there will be statewide net gains of coastal wetlands under the majority of SLR scenarios, however the future condition of new tidally influenced areas is not well understood (CRMC, 2015). Despite the SLAMM predictions, it's likely that many upland areas inundated by SLR in the future may not result in the establishment of new salt marsh (CRMC, 2015). Rather, these upland areas may be converted to regularly-flooded tidal flats and may not establish salt marsh vegetation for long periods of time, if ever (CRMC, 2015).

In addition to the losses and gains for coastal wetlands, the SLAMM results also show that some freshwater wetlands located near the shoreline at lower elevations will become submerged by tidal waters in the future. In Westerly, it is predicted that with a 1 ft. SLR 15.6 acres of freshwater wetland will be lost, with 3 ft. SLR 50 acres will be lost and with 5 ft. SLR 75 acres will be lost.

## 3.3 Vulnerability

Vulnerability includes all populations and assets (environmental, economic and critical facilities) that may be at risk from the natural hazards. Vulnerability analysis measures the level of assets, populations, and resources within Westerly. The vulnerability is a function of the built environment, local economy, demographics, and environmental uses of a given region (Rhode Island Emergency Management Agency, 2014).

A critical first step in assessing the risk and vulnerability of Westerly to natural hazards is to identify the links between the built environment vulnerability and the community's vulnerability to hazard-related business interruptions, disruptions of social structure and institutions, and damage to the natural environment and the flow of economic goods and services (Rhode Island Emergency Management Agency, 2014).

The Town of Westerly has updated their Natural Hazard Mitigation Plan to outline resources that address vulnerabilities and pressures the town faces: economic stability, historic and cultural preservation, public infrastructure and public facilities. Updating the plan will help reduce the actual or potential loss of life or property from a natural disaster. The Town of Westerly acknowledges that incorporating this plan and its mitigation initiatives (both pre-and post-disaster) into the Comprehensive Plan would not only benefit the community by reducing human suffering, damages, and the costs of recovery, but will also help build and maintain the sustainability and economic health of the city over the long run.

## 3.3.1 Community Assets

Westerly's community assets include its population, natural and cultural resources, its historic architecture, the local economy, public infrastructure, its environmental assets such as the barrier beaches and salt marshes, and public services and facilities. By examining and outlining the vulnerabilities of each of these assets, the town will be better prepared to respond to natural hazards that may affect them and therefore better protect their community assets.

### 3.3.1.1 People

As of the 2010 census the population of Westerly was 22,787. This represents a 0.8% decline in the population since 2000 (Rhode Island Department of Labor and Training, 2010). There were 9,666 total occupied households with an average household size of 2.33 people. The racial makeup of the town was 92.9% White, 1.0% African American, 0.7% Native American, 2.5% Asian, 0.9% from other races, and 2.0% from two or more races. Hispanic or Latino of any race made up 2.9% of the population (United States Census Bureau, 2010). Westerly's total population grew by 6.3% during the 1990s, but between 2000 and 2013 Westerly's population reduced by 1.4% (319 individuals; Rhode Island Department of Labor and Training, 2014). Despite this recent decline, Westerly's population is projected to grow slightly over the next 25 years, with a 2040 population estimate of 23,466 (Rhode Island Statewide Planning Program, 2013).

Westerly has a significant seasonal population, with 15.3% of homes in the town being used seasonally (United States Census Bureau, 2010). The age of Westerly's population has continued to rise since 1990 and as of 2010 40.7% of the population was comprised of residents at age 50 or over (United States Census Bureau, 2010). In contrast, the town's school-aged population has declined with public school enrollment declining by 15% between 2009 and 2004 (Westerly, 2012). These

demographic characteristics influence the housing climate in the town in terms of ownership and affordability.

As of 2010 there were 12,320 housing units in Westerly, with 65.4% as owner occupied and 34.6% as renter occupied. The median assessed value of single-family homes was $336,800 and the average assessed value as $506,791. The local government is in the process of refining strategies to develop affordable housing that maintain consistency with town's character and environmental constraints.

To expedite assistance response, persons requiring assistance due to an access or functional need, which includes those with disabilities, chronic conditions, and special healthcare needs, are encouraged to enroll in the Rhode Island Special Needs Emergency Registry (Rhode Island Department of Health, 2014). This registry provides a reliable system for the identification of Rhode Islanders who may require special assistance during emergencies (Rhode Island Department of Health, 2014). It is important to know the number of people that are considered to be at a higher risk in a natural hazard event in order to plan for their needs and safety.

#### 3.3.1.2 Economy

As of April 2015, Westerly's credit rating on the General Obligation debt was affirmed Aa2 by Moody's bond rating agency (Moody's, 2016). Standard and Poor's, another prominent bond rating agency, issued a AA rating for the town's new bonds and characterized the town's debt worthiness as stable (Standard and Poor's, 2016). The agencies noted that the town has a good financial position, reserves, modest existing debt burden and property appreciation that resulted in an expanded tax base and market value of homes.

Due to its location, Westerly's economy is closely linked to both Rhode Island and southeastern Connecticut. According to the 2013 Rhode Island Market Information Report, 44.9% of Westerly residents work in Westerly, while 34.1% work outside of Rhode Island, mostly in Connecticut. The entertainment and tourism industry is a significant employment and revenue source in Westerly and southeastern Connecticut. Tourism venues in southeastern Connecticut include Mystic Seaport and Mystic Aquarium and the two Native-American owned casinos, Foxwoods and Mohegan Sun (Westerly, 2010). Travel and tourism is also a significant economic sector in Westerly itself. In 2002, the tourism industry in Westerly generated $27.88 million in wages and $101.54 million in economic activity (Town of Westerly, 2010).

Other significant Connecticut employers include U.S. Naval Submarine Base located in Groton, Connecticut and the Electric Boat Division of General Dynamics also located in Groton. Pfizer, a large pharmaceutical company, is also a major employer in the region and is also located in Groton. Dependence on these three major industries leaves the regional economy somewhat vulnerable to shifts in the pharmaceutical, defense, hospitality and tourism industries (Town of Westerly, 2010).

There are also local employers within Westerly that are important to the economy. Two of the largest employers are the Westerly Hospital and the Washington Trust

Company. Westerly Hospital is a 125-bed acute care facility and is Westerly's largest single private sector employer with 400 total employers. Washington Trust Company is the largest independent bank in Rhode Island and employs approximately 190 people in Westerly (Town of Westerly, 2010).

Although private industry employment as of 2008 was the primary means of employment for Westerly's residents at 88.5%, it should be noted that the local government is also an important employer through its various municipal departments and it school department. The Town budget approved in fiscal year 2015-2016 provided for 717.2 full-time equivalent positions, 188.6 in municipal departments and 528.6 in the school department. The Town also provides part-time seasonal employment in support of its parks and recreation activities, beaches and other summer programs (Town of Westerly, 2015).

Based on 2015 employment numbers, 50% of Westerly's total population make up the Town's labor force. In the same year Westerly's unemployment rate averaged 7.4%, slightly above the state average of 6%. Employment growth was strong between 2009 and 2013 in Westerly; employment in Westerly increased by 231 (+2.5%) jobs. Private sector employers reported a gain of 221 (+2.6%) jobs, while public sector employment grew by 9 (+0.9%) jobs. In comparison, statewide total employment grew by 7,633 (+1.7%) jobs (Rhode Island Department of Labor, 2014). Approximately 43 percent of Westerly residents 25 years and older had a college degree (Associate or higher) in 2013. The share of local residents without a high school diploma or GED decreased between 2000 and 2013, falling from 18.3 percent to 11.3 percent (Rhode Island Department of Labor, 2014).

#### 3.3.1.3 Built Environment

The damage to and destruction of the built environment, particularly in the critical lifeline sectors (communications, emergency services, energy, information technology, transportation systems, water and wastewater systems) represents enormous economic, social, and general functional costs to a community, while also impeding emergency response and recovery activities. Since Westerly is a coastal community, it has increased vulnerability to extreme weather events like hurricanes. To better prepare for natural hazard events this report examines elements of Westerly's built environment and addresses vulnerabilities in the action section

**Existing structures**

Westerly is an old town that was largely built around its shoreline communities and booming granite industry. Along with its beautiful natural resources, Westerly's historic and architectural resources are the town's greatest assets.

**Infrastructure**

Damage or destruction of public infrastructure such as transportation, water and wastewater systems or communications facilities can result in enormous economic, social, and general functional disruptions to Westerly. A flooded road or collapsed bridge can have major implications including general loss of productivity; disruption

of physical access preventing residents from getting to work or back to their homes, prevent emergency vehicles from reaching their destinations, and pose difficulties in obtaining important lifeline supplies such as food and other deliveries to the community (Town of Westerly, 2012).

Wastewater Treatment

The Westerly Wastewater Treatment facility is operated by United Water. The system that services approximately 45% of the parcels in the town (Town of Westerly, 2010). In terms of residential parcels, only 39% have public sewers and 61% use individual sewage disposal systems (ISDS). The Town has not extended sewer service in several years. Developers of some projects have extended sewers in conjunction with completing the projects. The wastewater in areas not serviced by sewers has been accommodated in many ways including cesspools and septic systems installed during time periods where no regulations existed or where there were minimal local regulations. Later systems were installed under regulations of the RIDEM relating to Individual Septic Disposal Systems including, effective January 1, 2008, the new RIDEM "Rules Establishing Minimum Standards Relating to Location, Design, Construction and Maintenance of Onsite Wastewater Treatment Systems" (Town of Westerly 2010).

There are conditions that can limit the effectiveness of ISDSs in Westerly and potentially cause environmental degradation of water resources and consequently threaten the health of residents. Improper operation, old age, and poor site conditions are all factors that lead to failing ISDSs which can leach nitrates, excessive nutrients, and fecal coliform bacteria into groundwater and surface water. These existing vulnerabilities are exacerbated in extreme weather events. For example, flooding can lead to saturated soil conditions that are unfit for treating and dispersing wastewater. Furthermore, flood conditions can cause wastewater to back up into homes and contaminate drinking water (Lee and Jones, 2005). In general, the areas that are most at risk to failing ISDSs are the residential areas near the salt ponds. These areas are densely developed and have experienced chronic problems with ISDS failures (Town of Westerly, 1998).

Despite the challenges posed by ISDSs in Westerly, onsite wastewater treatment will continue to be the primary source of wastewater disposal for areas outside the current sewer district (Town of Westerly, 2010). In an effort to minimize the risk of groundwater and surface water contamination from failing ISDSs, Westerly has taken several initiatives to improve ISDSs. Westerly has an approved Onsite Wastewater Management Plan which calls for the creation of a wastewater management district for areas not currently served by sewers an where the Wastewater Facilities Plan indicates sewers are not planned (RIDEM, 2014). Within this district the Town will create a homeowner education and outreach program and created a computerized inventory containing results of voluntary inspections (RIDEM, 2014). Westerly also participates in Rhode Island's Community Septic System Loan Program (CSSLP) which allows towns to assist citizens with the replacement of older and failing systems through low-interest loans (RIDEM, 2014).

Westerly has one wastewater treatment plant located at 87 Margin Street that discharges treated effluent through a 24-inch diameter outfall pipe into the Pawcatuck River. The plant's discharge is regulated by the RIDEM through its Rhode Island Pollutant Discharge Elimination System (RIPDES) program. Effluent standards are based on the water quality classification of the receiving water body (i.e., Pawcatuck River) and are regulated by RIDEM's Water Quality Regulations. A "Wastewater Facilities Plan" was prepared for the Town in November of 1998 (revised December 1999) by BETA Engineering, Inc. The plan addresses deficiencies with the existing sewer collection system and sewage treatment plant as well as any deficiencies or problems with the unsewered areas of the community.

The plant, which is operated by United Water, is now designed to treat an average flow of 3.3 million gallons per day and a peak hourly flow of 7.8 million gallons per day (Town of Westerly, 2010). The plant currently has capacity for all currently proposed and approved subdivisions within the sewer district, normal build-out within the district and the Misquamicut section of the sewer district between Winnapaug Pond and Maplewood. The Town is also trying to limit the amount of groundwater that infiltrates the system. Town staff have been using video cameras that are inserted into sewer pipes to look for broken pipe, and these pipes are lined, sealed or replaced to seal off inflow.

In 2012 the USEPA awarded United Water with the Regional EPA Wastewater Treatment Plant Excellence Award for its "outstanding operations and management of the Westerly Wastewater Treatment Plant (USEPA, 2013). The EPA Regional Wastewater Treatment Plant Excellence Award was established to recognize and honor the employees of publicly owned wastewater treatment plants for its commitment to improving water quality with outstanding plant operations and maintenance (USEPA, 2013).

The FEMA FIRM for the Town of Westerly (Map No. 44009C0252J, Panel 252 of 368, Revised October 16, 2013) indicates that the Westerly Wastewater Treatment Plant is located within a Zone X flood area. Zone X denotes areas of 0.2 percent annual chance flood. The effluent outfall is located within Zone AE, which is the one percent annual chance SFHA at elevation 13 feet above the North American Vertical Datum of 1988 (NAVD88). The location of the wastewater treatment plant and its effluent exit in flood zones AE and X puts the treatment plant's operation at risk in the event of major flooding events. There are also nine active wastewater pumping stations in the town and the four major ones have been rebuilt since 2003. There are nine active wastewater pumping stations in the town. All four major sewer pump stations have rebuilt since 2003. The nine wastewater pumping stations (five of which are in the SFHA) are located on the following streets: Apache Drive, Beach Street, Bradford Road, Cimalore Field, Margin Street, New Canal Street, Old Canal Street, Riverdale Gardens, and Branch Street (Town of Westerly, 1998). All of the pumping stations discharge into the wastewater treatment plant for processing.

Stormwater System

The Town of Westerly owns and maintains a stormwater sewer system. Most of the system flows into the Pawcatuck River or wetlands rather than into the ocean (Town of Westerly, 2010). There are no combined sewer overflow (CSO) connections between the sanitary sewer and storm sewer which is beneficial because wastewater will not enter the stormwater system during large rain or flooding events. Most of the system flows by gravity with only a single pump station (Town of Westerly, 2010). With the implementation of the 2010 RIDEM Stormwater Regulations, most developments proposed in Town handle stormwater via underground injection systems or stormwater retention basins or ponds. The Town ensures that these types of private infrastructure elements are sized appropriately and will operate effectively. When needed, the Town may require maintenance easements and/or bonding on projects to ensure the viability of these drainage systems into the future. The Town employs an ongoing maintenance program for the publicly owned storm system that includes cleaning catch basins and pipes and replacing aging pipes and structures (Town of Westerly, 2010).

Drinking Water

Westerly's water system is owned by the Town and operated by the Water Department which is part of the Department of Public Works. The budget for the Town's Water Department is prepared to incorporate all of the costs of operating the department and the water rates are established so that the users pay for all of the activities of the department. There is a small portion of town (approximately 6 percent) that depends on private wells. The area of town served by public water and by both public water and sewers is illustrated in Figure 7

The Pawcatuck River Aquifer Region, which is comprised of the Westerly, Bradford, and Ashaway aquifers, serves as the drinking water supply for the town. The Pawcatuck River Aquifer was designated as the sole source aquifer for the region in 1988 meaning that it is the sole or principle drinking water source for the town. The quality of the water is very good and the town has recently implemented a new and improved disinfection system. The Town has undertaken a comprehensive assessment of its groundwater resources. The conclusion is that its existing White Rock sites, combined with its Bradford II and III sites and the Crandall well sites provide sufficient capacity. However, to enhance the town's reserves, a new well is being developed (Bradford IV). The Town continues to actively acquire land for aquifer protection. As required by the state of Rhode Island, Westerly has prepared a plan for drought management that includes procedures for addressing drought.

Waste Removal

Westerly owns and operates a solid waste transfer station located at 39 Larry Hirsh Way, west of Chapman Pond. This facility is also available to residents of Hopkinton under an agreement between the two municipalities. The Town does not provide curbside pickup but rather sells orange trash bags that residents fill and return to the transfer station on their own. The Town compacts the trash at the transfer

station, loads and trucks it to the RI Resource and Recovery Corporation (RIRRC) facility in Johnston, Rhode Island where it is landfilled. There is also a recycling facility directly adjacent to the transfer station where residents bring recyclables at no charge.

According to the FEMA FIRM for the area (Map No. 44009C0143H, Panel 143 of 368, Effective October 19, 2010) portions of the waste transfer station are located within SFHA Zone A associated with Chapman Pond. Zone A is the one percent annual chance flood area with no base flood elevation determined. During the spring 2010 floods portions of the transfer station were inundated with flood waters. The transfer station's proximity to Chapman Pond's flood zone leaves it vulnerable during extreme flooding events. This presents a hazard in terms of the necessity temporary waste storage and in terms of water quality degradation.

Natural Gas and Electric

Westerly's gas and electric service is provided by National Grid. The utility also owns and maintains the Town's utility poles and electric lines. Gas service is available in some areas of town; however, the main transmission line is not adequate to provide broad town-wide service. There are reported to be approximately 4,000 gas service connections in Westerly. National Grid owns and maintains the gas lines in Westerly. Lines run along many of the major roads and can be extended to meet demand. There is a major gate station along a large gas pipeline in Westerly that can supply a significant number of new services as the need arises (Westerly, 2010). There are two substations located within Westerly: 1.) Langworthy Corner 86 located at 55 Langworthy Drive and 2.) Westerly 16 located at 69 Canal Street. According to the FEMA FIRM for the Town of Westerly (Map No. 44009C0139J, Panel 139 of 368, Revised October 16, 2013), nearly the entire substation on Canal Street is located within the SFHA Zone AE at elevation 10 feet above the NAVD88. The areas of the substation yard not included in the Zone AE are located within Zone X, the 0.2% annual chance flood area. The substation on Langworthy Road is not located within any flood areas (FIRM Map No. 44009C0259J, Panel 259 of 368, Revised October 16, 2013).

**Critical Facilities**

Each jurisdiction classifies "critical facilities" based on the relative importance of that facility's assets for the delivery of vital services, the protection of special populations, and other important functions. If damaged, the loss of that critical facility would present an immediate threat to life, public health, and safety (Rhode Island Emergency Management Agency, 2014). Protection of critical facilities is also important for rapid response and recovery of a community, its neighborhoods, and its businesses. Damaged or destroyed utility lines and facilities – electricity, computer and satellite links, natural gas, sewer, and water services – can cripple a region after a disaster. High winds or an ice storm can down power lines, resulting in the loss of power for days or weeks. In the Town of Westerly, critical facilities are classified under the following subsections:

Critical Infrastructure:

- Westerly Town Hall: 45 Broad Street
- Westerly Police Department: 60 Airport Road
- Bradford Fire Department: 5 North Main Street/460 Bradford Road
- Dunn's Corners Fire Department: 1 Langworthy Road, Westerly/5664 Post Road, Charlestown
- Misquamicut Fire Department: 65 Crandall Avenue
- Watch Hill Fire Department: 222 Watch Hill Road
- Westerly Fire Department: 7 Union Street/180 Beach Street
- Westerly Ambulance Corps: 30 Chestnut Street
- Westerly Hospital: 25 Wells Street
- Bradford Elementary School: 15 Church Street
- Dunn's Corners School: 8 ½ Plateau Road
- Springbrook Elementary School: 39 Springbrook Road
- State Street School: 35 State Street
- Tower Street School: 93 Tower Street
- Westerly Middle School: 23 Ward Avenue
- Westerly High School: 10 Sandy Hill Road

Public Utilities

- Waste transfer station: 39 Larry Hirsh Way
- Westerly wastewater treatment center: 87 Margin Street
- Langworthy Corner 86 Substation: 55 Langworthy Drive
- Westerly 16 Substation: 69 Canal Street

Critical Bridges that Cross Water Features

A flooded road or collapsed bridge can have major implications including general loss of productivity; disruption of physical access preventing residents from getting to work or back to their homes, prevent emergency vehicles from reaching their destinations, and pose difficulties in obtaining important lifeline supplies such as food and other deliveries to the community. Westerly's bridges, particularly those crossing the Pawcatuck River or the Winnapaug Pond breach way, are also at risk due to flooding or storm surge.

Westerly State Airport

The Westerly State Airport is located south of Route 1 at Westerly Bypass Road. The airport offers scheduled flights to and from Block Island via New England Airlines. No other regular commercial passenger service is available, but the airport tenants include charter companies as well as aviation maintenance companies. There is

substantial private aircraft traffic which complements both the local tourism and resident economies (Town of Westerly, 2010).

Nursing Homes and Retirement/Assisted Living Facilities

- Westerly Nursing Home: 79 Beach Street
- Watch Hill Care and Rehab: 79 Watch Hill Road
- Westerly Health Center: 280 High Street
- The Clipper Home: 161 Post Road
- Elms Retirement Residence: 22 Elm Street

Emergency Notification

The Town of Westerly has signed a Memorandum of Understanding (MOU) with RIEMA for a town-wide emergency notification system known as "CodeRED®." The CodeRED® Emergency Telephone Calling System is an extremely high-speed telephone communication service available for emergency notifications. CodeRED® employs a one-of-a-kind Internet mapping capability for geographic targeting of calls, coupled with a high-speed telephone calling system capable of delivering customized pre-recorded emergency messages directly to homes and businesses at the rate of up to 60,000 calls per hour. Residents and businesses in Westerly are encouraged to sign up for this notification system via http://www.westerlypolice.org/emergency/.

Emergency Shelters

Emergency shelters play an important role during hazard response and recovery. They provide temporary shelter, sanitary facilities and food service during a local emergency. They can also serve as a focal point for distribution of food and clothing for people who choose not to use the shelter for temporary accommodation. Short-term occupancy of two to three days duration is typically adequate for hurricane conditions. To establish a sense of community normalcy after a disaster, it is important that the schools be used for shelter only for a very short period, enabling them to revert to educational activities as quickly as possible. The Westerly Armory would be used as a staging area for emergency volunteers and National Guard troops. Table 3.18 lists the shelters and their locations and individual occupancies.

Shelters approved by the American Red Cross (ARC) must meet the following criteria: control by the Town of Westerly, have adequate parking, not be located in a flood zone or storm surge area, by ADA compliant, and be structurally sound. The decision to open a shelter is not made by ARC; rather, it is made by local officials who then notify the ARC. The Red Cross will provide meals, basic first aid and counseling as needed, provided that the Town provide security, consisting of one policeman and one firefighter at each shelter.

**Table 3.18 Emergency Shelters Serving Westerly**

| Shelter Name | Location | Available Space (SF) | Short-term Occupancy | Long-term Occupancy |
|---|---|---|---|---|
| Springbrook Elementary School | 43-45 Springbrook Road | 8,760 | 437 | 219 |
| Westerly Armory | 6 Dixon Street | 6,000 | 300 | 150 |
| Westerly Senior Citizens Center | 39 State Street | 7,000 | 350 | 175 |
| *Total Shelter Occupancy* | | | 1,087 | 544 |

Pet/Animal Emergency Shelter and Care

As stated by RIEMA, disaster shelters cannot accept pets because of health and safety regulations and other considerations. The only animals allowed in shelters are service animals that assist people with disabilities. The Westerly Animal Shelter, located at 33 Larry Hirsch Lane, is listed by RIDEM as a Rhode Island State Emergency Pet Shelter. RIDEM recommends that pet owners create a "Pet ID Pack" which contains identification and supplies for each pet in the event that a pet must be temporarily placed in an emergency animal shelter (RIDEM, 2013).

**Historic and Cultural Resources**

Westerly was incorporated as a town in 1669 and over the years it has remained a hub of commerce and recreation in southern Rhode Island (Town of Westerly, 2010). Westerly also has a collection of distinct villages which provides a glimpse into the town's historic past whether they are commercial centers, coastal communities, or mill towns. The Rhode Island Historical Preservation and Heritage Commission (RIHPHC) provides municipalities within the state with a variety of information on historic resources. In 1978, the Commission developed the Preliminary Report on Historic and Architectural Resources of Westerly, Rhode Island as a tool to identify and record properties of historic and architectural significance in the town. Within each of the listed historic districts are structures and sites which are deemed to be "contributing" to the historic character of the particular district.

Many of Westerly's historic buildings are potentially at risk from natural hazards and it is important to protect this crucial aspect of Westerly's character. The following is a list of historic districts and sites in Westerly that have been placed on the National and State Register of Historic Places. These properties are recognized as significant features of American history and are worthy of preservation. Table 3.19 below provides a list of historic properties in Westerly and their locations.

**Table 3.19 National Register of Historic Places in Westerly, Rhode Island**

| Property | Location | Flood zone |
|---|---|---|
| Bradford Village Historic District | Bounded roughly by Bowling Lane, Bradford Road, Church Street, Dorr Street, Douglas Park, Joseph Lane, Knowles Street, Niantic Avenue, North Main Street, Railroad Avenue, South Main Street, and Vars Lane | N/A |
| Main Street Historic District | Short sections of Main and School Streets and adjacent Maple Street | A |
| North End Historic District | Bounded roughly by Pierce, Pond, Pearl, High, Friendship, Pleasant, and Canal streets | A |
| Watch Hill Historic District | Bounded roughly by Breen, Watch Hill and East Hill Roads; Block Island sound; Little Narragansett Bay; and Pawcatuck River | A+V |
| Westerly Downtown Historic District | Portions of High, Canal, Broad, Union, and Main Streets, and Railroad Avenue (7/19/84) with boundary increase to include 7 Union Street | A |
| Wilcox Park Historic District | 71 ½ High Street | N/A |
| Flying Horse Carousel | Bay Street | AE |
| Dr. Joshua Babcock House | 124 Granite Street | N/A |
| U.S. Post Office | High and Broad Streets | N/A |
| Immaculate Conception Church | 119 High Street | AE |
| Lewis-Card-Perry House | 12 Margin Street | AE |
| Westerly Armory | Railroad Avenue | N/A |
| Weekapaug Inn | 25 Spray Rock Road | AE |
| Perry Homestead Historic District | 2,4,8,12, &16 Margin St., 15 & 17 Beach St. | A |
| Ram Point | 77 Watch Hill | A |

**Future Development**

Westerly's Comprehensive Plan envisions maintaining the distinctive neighborhoods, history and beautiful natural resources while also revitalizing the commercial and industrial sectors of the town. The Town of Westerly also envisions building a greenspace and greenways system that will be realized through a combination of efforts. Traditional open space protection techniques include acquiring land for preservation and recreation, but the town also intends to employ conservation development strategies to maximize open space and habitat while also providing for new housing demands in the community.

The plan does not propose any changes to the current zoning districts but it does make recommendations for changes in land use regulations and land use. For example, all applications for major subdivisions would be required to include cluster development, conservation development, and conventional subdivision as alternatives for consideration by the Planning Board. Increased use of conservation development approaches would help to preserve open space and natural resources.

Regarding commercial development, the Plan prohibits the expansion of the existing highway commercial district and encourages redevelopment of existing under-utilized commercial space, particularly in the Route 1 corridor. The Plan also calls for the town to work with existing commercial property owners in the Route 1 corridor to enhance landscaping and green space through incentives such as reduction in required parking area. To support these community goals, Westerly also plans to improve and expand its infrastructure systems with regards to stormwater, drinking water, and sewer systems to better serve its residents.

#### 3.3.1.4 Natural Environment

**Water Resources, Watershed**

The majority of Westerly's water supply comes from the Wood-Pawcatuck Watershed. The Salt Pond Region in the southern section of Westerly contains three additional watersheds, one for each of the three salt ponds in Westerly. The Wood-Pawcatuck Watershed encompasses approximately 300 square miles in southeastern Connecticut and southwestern Rhode Island. Within the watershed, seven major rivers and their tributaries drain to a common outlet: the Pawcatuck River and Little Narragansett Bay. These rivers, along with lakes, ponds, wetlands and streams, serve as important wildlife habitat, recreational resources, and water supply for agricultural production. Significant groundwater resources underlie the watershed and are the sole source of drinking water for people within the watershed. Groundwater and surface waters are interconnected and the watershed is noted for having some of the highest quality groundwater and surface water in the area (Town of Westerly, 2010).

The Pawcatuck River flows along the entire northern and western boundaries of the town. Other named streams include Aguntaug Brook, Mastuxet Brook, McGowen Brook and Perry Healy Brook. Chapman Pond, in the north central section of Westerly, is the town's largest freshwater pond; other named freshwater ponds include Dr. Lewis Pond, Long Pond, Spring Pond, No Bottom Pond and Mickill Pond. Freshwater wetlands are scattered throughout the town (a result of the area's glacial past and resultant soils and topography) and along the Pawcatuck River. Crandall Swamp (also known as Chapman or Aguntaug Swamp) is one of the largest freshwater wetland systems in the state. Coastal wetlands include salt marshes and any contiguous freshwater or brackish wetlands. Coastal waters border the entire southern shoreline of the town and include the tidal portion of the Pawcatuck River. The salt ponds include Maschaug Pond, Winnapaug Pond and Quonochontaug Pond (Town of Westerly, 2010).

**Protected Natural Areas**

<u>Pawcatuck River</u>

The Pawcatuck River and its tributaries support 40 species of fish including freshwater, anadromous (live in salt water and return to fresh water to spawn) and catadromous (live in fresh water and enter salt water to spawn) species. These

species include striped bass, white perch, bluefish, smelt, alewives, shad and salmon, and wild and stocked populations of brook trout. The anadromous Atlantic salmon is listed as a federal endangered species. Fish passage restoration projects have restored anadromous alewife, American shad, sea-run brown trout and rainbow smelt to the river. Small returns of adult Atlantic salmon have also been achieved (Dillingham et al. 1993). Phantom Bog, located along the north shore of the Pawcatuck River at the northeast corner of Westerly, is the site of several rare species and communities of special emphasis or concern in the region.

Crandall Swamp

Crandall Swamp is a major wetland complex dominated by Atlantic white cedar and red maple swamps, but also containing a number of marsh, bog and open water habitats. The boundary of Crandall Swamp includes Chapman Pond and adjacent wetlands, Phantom Bog, and adjoining portions of the Pawcatuck River. It is one of the largest freshwater wetlands in Rhode Island, about 2,000 acres in size, and contains one of the most extensive stands of Atlantic white cedar in the state, along with a great diversity of wetland vegetation.

Crandall Swamp is also important as a groundwater resource and flood control area for the Pawcatuck River. A variety of mammals, amphibians, waterfowl and other water birds frequently utilize this pond and swamp complex including several rare species. Bird species nesting here include osprey, bitterns (state endangered and state threatened) and herons (state species of concern). The osprey population is of special significance (Dillingham et al., 1993).

Salt Ponds

The Salt Ponds provide important ecosystem and habitat functions. These include: prime habitat for commercial and recreational fin and shellfish; resting and feeding stops for waterfowl migrating along the Atlantic flyway; and nursery areas for fish that spend the remainder of their life cycle at sea or in fresh waters. Many wildlife species found elsewhere in the state are present in the salt ponds region, in addition to the many species that are dependent upon the salt ponds specialized habitats, such as salt marsh or brackish wetlands.50 Habitat fragmentation occurs within the salt pond watersheds and is impacting wildlife species (Ernst et al., 1999).

There are over 100 species of finfish and shellfish that utilize the salt ponds at some stage of their life cycle. The most popular species, the quahogs, oysters and flounder, are all declining. The available information suggests that the habitat on which these fish and shellfish species depend is also declining (Ernst et al., 1999).

The diversity of habitats found within the salt pond watersheds supports a variety of birds, both year round residents and migratory species. Shorebirds are one group that depends significantly on the salt ponds habitats. The piping plover, which nests along the south shore barriers, is a federally threatened species. Documented nesting occurs at several sites along the south shore, including Maschaug Pond and Napatree Point. The U.S. Fish and Wildlife Service maintains lists of bird species classified as Nongame Migratory Bird Species of Management Concern in the

Continental United States. Species from this list that occur in the Salt Ponds Region include the Seaside Sparrow, Northern Harrier, American Bittern and Black Rail. The first three species are state listed rare species. Waterfowl (ducks and geese) are common inhabitants of the salt ponds but use the area most heavily during migration and wintering periods. The American Black Duck is considered a species of concern by the U.S. Fish and Wildlife Service. Numbers of waterfowl recorded during counts made within the past five years pale when compared to historical accounts made prior to man-made impacts, such as breachways, that have affected the food source for many of these birds (Ernst et al., 1999).

## 3.4 Risk Analysis & Assessment

The HMC reviewed and discussed the 2012 Risk Assessment Matrix of vulnerable areas; the Committee agreed the general areas of vulnerability have expanded while the mitigation priorities have adjusted slightly. Organization of projects and actions was accomplished by thoroughly reviewing the hazards, identifying areas in Westerly which are at risk, and identifying present dangerous situations to the population which are susceptible to costly damage. The result of these efforts was the Risk Assessment Matrix that follows. Vulnerable areas have been prioritized and ordered as such.

This assessment reviewed the town's risks to natural disasters in terms of population, property, economic resources, and probability of occurrence. The committee considered public health/safety, structural damage, area or town-wide evacuation, and structures that house people with special needs. The committee began by identifying specific areas and structures that are vulnerable to natural hazards.

Vulnerable areas were determined by considering past and potential natural hazards that pose a threat to the population, property, and economic resources of the town. For example, the town's population, residential/commercial properties, schools, bridges and historical buildings were identified as vulnerable areas to natural hazardous events.

The committee also determined the objective or benefit that would be realized by implementing an appropriate mitigation action. Objectives or benefits included protection of the public, economic stability, historical preservation, and areas were identified and assigned: a natural hazard, primary problem, and mitigation benefit. A Risk Assessment Matrix was constructed that ranked the vulnerable areas.

The rankings were determined by considering the historical or potential occurrence of natural disasters, the primary threat to the town, and the mitigation benefit that would be received if an appropriate mitigation action was implemented. A growing population and growing value of insured property increases Westerly’s vulnerability to natural hazards. Since the highest ranked hazard – a hurricane – cannot be prevented from occurring, the forces accompanying this hazard such as storm surge, wind, coastal erosion, and flooding, can result in significant damage and destruction. However, much of the built environment’s vulnerability can be attributed to

inappropriately designed, built, and/or located structures that result from not using the best available construction knowledge and practices. Almost every planning and development decision made at the local level has implications for the vulnerability to, and impact of, a natural hazard event.

### 3.4.1 Methodology

Evaluating the number of times that the natural hazard has impacted Westerly in the past provides a measure of the likelihood of the event occurring again in the future. This rating is derived from an investigation of trends in the long-term (30 years at least) data (Table 3.20). Examination of past events helps to determine the probability of similar events occurring in the future. This evaluation also considered the effects of changes in the regional climate.

**Table 3.20 Risk Frequency Score**

| Approximate Annual Probability | Subjective Description | Frequency Score |
|---|---|---|
| 90-100% | Frequently recurring hazards, multiple recurrences in one lifetime | Highly Likely |
| 10-90% | Probability of occurrence in the next year or a recurrence interval of 1 to 10 years | Likely |
| 1-10% | Probability of occurrence in the next year or a recurrence interval of 11 to 100 years. | Occasional |
| <1% | Less than 1% probability occurring in the next year or recurrence interval greater than 100 years | Unlikely |

### 3.4.2 Exposure Analysis

A second criteria used in evaluating the risk of Westerly to natural hazards is to determine the area of impact. Some hazard events impact only a small region, while others can affect the entire area. The area of impact determination, shown in Table 19, indicates how much of the immediate area may be effected by a single event. Again, historical and predictive data were used to investigate/predict damage and loss. Records of previous hazard events helped to develop an estimate of the amount of property damage that may occur from future events.

**Table 3.21 Exposure Analysis (Location)**

| Subjective Description | Area Score Impact |
|---|---|
| Less than 10 percent of planning area or isolated single-point occurrences | Negligible |
| 10 to 25 percent of the planning area or limited single-point occurrences | Limited |
| 25 to 75 percent of planning area or frequent single-point occurrences | Significant |

| | |
|---|---|
| 75 to 100 percent of planning area or consistent single-point occurrences | Extensive |

### 3.4.3 Historical Analysis

Intensity or magnitude criteria are used to determine the range of the severity of damage (from minor to devastating) expected from a single event. Previous damage reports and other historical data (e.g. newspaper articles, personal accountings, video clips, etc.) are used in assigning this score, which is shown in Table 3.22.

**Table 3.22 Extent**

| Subjective Description | Extent Score |
|---|---|
| Limited classification on scientific scale, slow speed of onset or short duration of event, resulting in little to no damage | Weak |
| Moderate classification on scientific scale, moderate speed of onset or moderate duration of event, resulting in some damage and loss of services for days | Moderate |
| Severe classification on scientific scale, fast speed of onset or long duration of event, resulting in devastating damage and loss of services for weeks or months | Severe |
| Extreme classification on scientific scale, immediate onset or extended duration of event, resulting in catastrophic damage and uninhabitable conditions | Extreme |

**Table 3.23 Risk Matrix**

| Hazard | Location (Geographic Area Affected) (Table 3.21) | Maximum Probable Extent (Magnitude/Strength) (Table 3.22) | Probability of Future Events (Table 3.20) | Overall Significance Ranking |
|---|---|---|---|---|
| High Wind | Significant | Severe | Likely | Medium |
| Hurricane | Significant | Severe | Likely | Medium |
| Tornado | Limited | Moderate | Unlikely | Low |
| Winter Weather | Extensive | Extensive | Highly Likely | High |
| Flooding | Extensive | Severe | Highly Likely | High |
| Coastal Erosion | Significant | Extreme | Highly Likely | High |
| Dam Failure | Limited | Extreme | Unlikely | Low |
| Wildfire | Negligible | Weak | Unlikely | Low |
| Extreme Cold | Extensive | Moderate | Occasional | Medium |
| Storm Surge | Extensive | Extensive | Highly Likely | High |
| Climate Change | Extensive | Extensive | Highly Likely | High |

# 4

# Capability Assessment

## 4.1 Purpose

Reviewing the capabilities that currently exist in Westerly enables the HMC and the community at large to identify those that have been successfully used to reduce vulnerability and loss, and which capabilities should be leveraged to address hazard mitigation activities in the future. This review also provides an opportunity to identify community capabilities that inadvertently increase risk or exposure to natural hazards. Westerly has the capability to implement and institutionalize hazard mitigation through its human, legal, and fiscal resources, the effectiveness of intergovernmental coordination and communication, and with the knowledge and tools at hand to analyze and cope with hazard risks and the outcomes of mitigation planning. The capabilities outlined in this section reflect the 'as is' condition. The town has the capacity to expand on certain capabilities through the passage and enforcement of additional codes and regulations. By coordinating with the many groups active in addressing the impacts of current and future weather on the Westerly environment, the town also has the capacity to continually grow the stakeholders involved in the HMC to reflect growth and change in the community.

## 4.2 Types and Evaluation of Capabilities

The capabilities of the Town of Westerly are drawn from the town's network of town agencies, private organizations, and active community members. A collaborative and engaged local governance and community are necessary to ensure Westerly's

preparedness for natural hazards. The following sections provide an overview of the critical capabilities within the Town of Westerly and how they play a role in the mitigation effort.

### 4.2.1 Local Government and Program Areas

Local plans and policies were consulted for the creation of this Hazard Mitigation Plan, including those prepared by or on behalf of the town as well as those prepared by citizen driven groups and committees. Additionally, the public services and facilities provided by the town are crucial resources for the preparation of natural hazard events, as well as the response to and mitigation of such events.

#### 4.2.1.1 Form of Government

The Town of Westerly, established in 1669, operates under a Home Rule Charter adopted in 1968, which provides for a council/manager form of government. The Town Council, comprised of seven members elected at large who each serve two year terms, is vested by the Charter with all legislative powers of the Town (Westerly Finance Department, 2013). The Council also has the power relating to the Town's property, affairs, and government. The Council also has the power to authorize the issuance of bonds or notes by resolution, subject to approval by a majority of electors voting who are qualified to vote on financial matters of the Town (Westerly Finance Department, 2013).

The Town Council appoints the Town Manager for a definite term solely on the basis of their executive and administrative qualifications and experience. The Town Manager is the chief executive officer and the head of the administrative branch of the Town government. The Town Manager is responsible for carrying out the policies of the Town Council, for overseeing the day to day operations of the Town, and for appointing all other employees, except for School Department personnel (Westerly Town Charter 2016).

The Town provides a full range of municipal services including public safety protection, the construction and maintenance of highways, streets and other infrastructure, libraries, recreational activities, planning and zoning, education and administrative services. In addition, the Town operates water, sewer and solid waste utility systems.

The Town of Westerly's local government will be the lead agency in both disaster preparedness and response. Local government employees and officials' participation in and familiarity with this Natural Hazard Mitigation Plan will ensure that they are prepared to enact mitigation and recovery efforts safely and efficiently. To establish the authority and accountability for this plan's implementation, amendments will be made to Westerly's Comprehensive Plan that appropriately address the theme of natural hazard mitigation.

#### 4.2.1.2 Planning, Building, Housing - Community Development

The Westerly Department of Development Services (Planning, Zoning, Code Enforcement, Building Official, Community Development, Minimum housing, Architectural Review and Economic Development) is responsible for approval of many types of new development. These include divisions of land to create new buildable lots and site plans for new commercial and multi-family development. The town development review process works to ensure that residential, commercial, and industrial developments have minimal impact on surrounding land uses and the environment. The plan review process includes technical review by staff members of the zoning, planning, building, and public works.

Westerly implements and enforces the state building code, International Residential Code and International Building Code. The Rhode Island amendments (blue pages) to the International Code Council (ICC) Building Code Base Volume were last updated in 2014. In addition, Westerly has implemented several zoning ordinances which place even greater restrictions on certain types and locations of development.

The Planning section also oversees or maintains a number of the strategic planning efforts that are instrumental to decision making and mitigation planning including the ongoing update of the Comprehensive Plan which addresses open space and recreation planning, economic development, and the impacts of sea level rise.

The Westerly Municipal Land Trust supports the implementation of the town's comprehensive plan and lends assistance to town departments and commissions in regard to the execution of policies related to land use and preservation. The Land Trust manages 38 properties throughout the town.

#### 4.2.1.3 Transportation, Public Works, and Utilities

**Roadway**

The Town Engineering Department is responsible for designing and implementing a maintenance and rehabilitation program for local roads and bridges. Westerly's densely settled downtown center and busy coastal roadway network are vulnerable to traffic congestion particularly during morning and afternoon commutes throughout the year and on summer weekends. At times traffic volume approaches gridlock in the Route 78-Airport Road-Winnapaug Road area and at the roads that feed into Route 1A (Town of Westerly, 2010). In the event of a natural disaster, Westerly must coordinate interstate response and recovery efforts with the bordering Connecticut towns of Stonington and North Stonington, with a particular focus on maintaining these critical transportation links. Of particular concern are bridges that span the Pawcatuck River that are located in a FEMA-designated flood hazard zone that connect Westerly with these two towns. Below is an excerpt from Table 4.1 detailing bridges that span the Pawcatuck River:

**Table 4.1 Bridges that span the Pawcatuck River within or on the boarder of Westerly**

| Bridge | Year built | NBI Safety Rating* | Structural Evaluation* |
|---|---|---|---|
| Boom Bridge Road (North Stonington Town Line) | 1968 | 18.0% | Structurally Deficient |
| Potter Hill Road (Hopkinton Town Line) | 2002 | 85.5% | Better than present minimum criteria |
| U.S. 1 Broad Street | 1932 | 75.5% | Somewhat better than minimum adequacy to tolerate being left in place. |
| Route 3 (Hopkinton Town Line) | 1924 | 67.9% | Functionally obsolete |
| Route 91 Alton Bradford Road (Hopkinton Town Line) | 1930 | 81.5% | Somewhat better than minimum adequacy to tolerate being left in place. |
| Stillman Avenue (Stonington Town Line) | 1953 | 58.8% | Structurally deficient |
| White Rock Road (Stonington Town Line) | 1996 | 72.1% | Equal to present minimum criteria |
| RI 78 West By-Pass | 1974 | 84.5% | Somewhat better than minimum adequacy to tolerate being left in place. |

*Source: National Bridge Inventory Database, 2012
Available at: http://nationalbridges.com/

### Public Transit

The Rhode Island Public Transit Authority (RIPTA) provides public transportation service for the state of Rhode Island. Within Westerly, RIPTA offers the 95 express route between Westerly and Providence during commute times on weekdays. Additionally, RIPTA offers public transportation via FlexService, which allows passengers to reserve curb-to-curb van transportation within Westerly on week days.

The Rhode Island Department of Elderly Affairs provides van transportation (for a fee) for those age 60 and over to the Senior Center Meal Site and to medical appointments through the State RIDE program. The State-run RIDE program offers paratransit services to those protected under the Americans with Disabilities Act (ADA) and Medicaid recipients (Hogan, 2014). The Town of Westerly, in conjunction with the Senior Center, offers free van transportation for Westerly residents age 60 and older to Westerly grocery stores, department stores, banks, hairdressers, drug stores, Center activities, the library, nursing home visits, and other personal needs not covered by the State RIDE program.

**Rail Service**

The Westerly Train Station, renovated in 1999, provides Amtrak service. In 2009 the station was evaluated for potential commuter rail service to New London, CT (17 miles away) and to Providence (44 miles away). Rhode Island Department of Transportation (RIDOT) has determined that the location of the Westerly station is within a ten minute walk of the surrounding downtown area and is, therefore, suitable as a commuter rail station. One potential problem with expanded service is the lack of parking; there are only 37 parking spaces at the station (Town of Westerly, 2010). This option of expanding commuter rail service is still being evaluated.

**Westerly State Airport**

The Westerly State Airport is state-owned and operated by the Rhode Island Airport Corporation to serve the aviation needs of Westerly and nearby communities. The airport serves private and corporate aircraft and New England Airlines which provides important commercial passenger and cargo service between Westerly and Block Island. Recreational flying is the most frequent activity at the airport. In the summer, the airport serves seasonal residents and vacationing visitors in addition to its regular year-round commercial and general aviation traffic. The Rhode Island State Airport System Plan (2011) estimates that Westerly State Airport in 2009 had 5,199 enplanements and 20,528 operations. Enplanements are defined as the number of passengers boarding departing flights and operations are defined as the total number of takeoffs and landings.

**Boat Access**

Boats can be launched during the operating season at the Westerly marina, which is free to all Westerly residents and is operated under a lease agreement between the owners of the marina and the town. Another free boat launch area with parking for boat trailers is the Rhode Island Department of Environmental Management facility located on Main Street. There are several other marinas on the Pawcatuck River where boat ramps are available for a fee. Westerly has had a Harbor Management Plan under development for some time and its successful completion should help manage the growing activity within the Pawcatuck River and Little Narragansett Bay.

#### 4.2.1.4 Floodplain Management

Westerly has been a participant in the National Flood Insurance Program since 1973. NFIP, established by Congress in 1968, provides flood insurance to property owners in participating communities. This program is a direct agreement between the federal government and the local community that flood insurance will be available to residents in exchange for the community's compliance with minimum floodplain management requirements such as the adoption of a floodplain management or flood damage prevention ordinance. Since homeowners' insurance policies do not cover flooding, a community's participation in the NFIP is vital to protecting property in the floodplain and ensuring that federally backed mortgages and loans

can be used to finance property and improvements within the SFHA (Rhode Island Emergency Management Agency, 2014). A major objective for the Westerly floodplain management program is to continue participation in the NFIP and the Community Rating System (CRS).

Pursuant to the Flood Disaster Protection Act of 1973, many forms of federal financial assistance, including disaster assistance and federally-insured loans, related to structures located in the SFHA are contingent on the purchase of flood insurance. Such federal assistance includes not only direct aid from agencies, but also products and assistance from federally insured institutions (Rhode Island Emergency Management Agency, 2014).

**Table 4.2 NFIP Claims as of September 30, 2017**

| | |
|---|---|
| Flood insurance policies in force | 1,016 |
| Coverage amount of flood insurance policies | $271,281,500 |
| Premiums paid | $2,190,132 |
| Total losses (all losses submitted regardless of the status) | 865 |
| Closed losses (Losses that have been paid) | 706 |
| Open losses (Losses that have not been paid in full) | 0 |
| CWOP losses (Losses that have been closed without payment) | 159 |
| Total payments (Total amount paid on losses) | $27,358,388 |

### 4.2.2 National Flood Insurance Program, Community Rating System (CRS)

Floodplain management begins at the community level with operation of a community program of corrective and preventative measures for reducing flood damage. These measures take a variety of forms; for inclusion in the NFIP, communities adopt their flood hazards maps and the community FIS. In addition, a FEMA-compliant floodplain management ordinance that regulates activity in the floodplain is adopted and enforced (Westerly Code of Ordinances, Article X, Chapter 260-51, Flood Hazard Overlay District) (Rhode Island Emergency Management Agency, 2007). In exchange for participating in the NFIP, the NFIP makes federally backed flood insurance available to homeowners, renters, and business owners (Town of Westerly, 2010).

As an NFIP participant, Westerly maintains and enforces floodplain regulations conforming to NFIP requirements as part of the Town's zoning ordinance. For example, in the Westerly Code of Ordinances, Chapter 260-51, Section 3 states that all proposed construction or other development within a Flood Hazard Overlay District shall require a flood hazard permit. Additionally, the ordinance includes regulations on activities that alter a watercourse and requirements for elevation or dry floodproofing of structures and accessory structures. The NFIP affords homeowners, renters or business owners in Westerly the opportunity to purchase flood insurance as long as Westerly maintains NFIP participation status and agrees

to enact and enforce regulations that meet or exceed FEMA's floodplain requirements (Rhode Island Emergency Management Agency, 2007).

The Town of Westerly uses the FEMA FIRMS to determine the location of flood zones and flood prone areas. These maps were last updated in 2013 by FEMA. Within Westerly, there are two SFHA areas of high flood danger: Zone A areas are within the one percent annual chance floodplain (100-year flood); and zone V areas are also within the 1 percent chance floodplain but have additional hazards associated with wave action. Mandatory flood insurance purchases apply for properties within zones A and V. Quonochontaug, Winnapaug and Maschaug Ponds and the low lands around them, Napatree Beach, Sandy Point Island and the coves in Little Narragansett Bay are particularly vulnerable to storm-surge flooding. RIEMA and FEMA also recommend that property-owners in low or moderate risk areas also purchase flood insurance. Almost 25 percent of all flood insurance claims come from areas with minimal flood risk (Rhode Island Emergency Management Agency, 2015).

Flood damage is reduced by nearly $1 billion a year through partnerships with communities, the insurance industry, and the lending industry. Further, buildings constructed in compliance with NFIP building standards suffer approximately 80 percent less damage annually than those not built in compliance. Additionally, every $3 paid in flood insurance claims saves $1 in disaster assistance payments (Rhode Island Emergency Management Agency, 2014).

The NFIP is self-supporting for the average historical loss year, which means that operating expenses and flood insurance claims are not paid by the taxpayer, but through premiums collected for flood insurance policies. The program has borrowing authority from the U.S. Treasury for times when losses are heavy; however, these loans are paid back with interest. Westerly has been a participant in the National Flood Insurance Program since 1973. As of September 30, 2017 there are 1,016 NFIP policies in force in Westerly valued at $271,218,500 in-force insurance and $2,109,132 in-force premiums (FEMA, 2017).

As of November 2017, Westerly has 52 repetitive and one severe repetitive loss property (residential). Of those, 49 have not been mitigated (28 residential and 21 commercial). A repetitive loss property (RL) is defined as a property that is currently insured for which two or more NFIP losses (occurring more than 10 days apart) of at least $1,000 each have been paid within any 10-year period since 1978 by the NFIP program (FEMA, Definitions). A severe repetitive loss property (SRL) is defined as a property that has four or more separate claim payments of more than $5,000 each since 1978 or a property with two or more separate claim payments where the total of the payments exceeds the current value of the property. FEMA has developed a SRL properties strategy to eliminate or reduce the damage to property and disruption to life caused by repeated flooding (FEMA, 2014). The strategy authorizes scheduled increases in flood insurance premium rates to actuarial rates for SRL property owners who refuse a formal and complete mitigation grant offer through the SRL grant program to mitigate an SRL structure (Rhode Island Emergency Management Agency, 2014). Mitigation actions include elevating structures about

the base flood elevation, localized flood reduction projects, dry floodproofing in the case of historic properties, or the demolition or relocation of structures (FEMA, 2014). The Town of Westerly has been very successful in obtaining funding to implement flood mitigation projects. In addition to CDBG and EDA monies, the table below summarizes FEMA grant funded projects.

**Table 4.3 Recent FEMA Grant Awards**

| Date | Grant Source | Project |
|---|---|---|
| 2011 | FEMA HMGP (DR 1894, Floods of 2010) | Acquire several properties along Canal Street. The buildings were removed, the lots were remediated, and will remain as open space. |
| 2013 | FEMA HMGP (DR 4027, tropical Storm Irene) | Assist various property owners in raising their houses or commercial structures one to three feet above the base flood elevation level |
| 2015 | FEMA HMGP (DR 4089, Hurricane Sandy) | Elevate properties along Misquamicut beach |

It is in Westerly's best interest to continue to assist with mitigating repetitive loss and other flood prone properties so as to minimize the expense and disruption of human life associated with such properties.

The CRS is a voluntary program that recognizes and encourages a community's efforts that exceed the NFIP minimum requirements for floodplain management. Westerly has been part of the CRS since May 1, 2013 and has a Class 8 rating where its residents are eligible for a ten percent discount on their flood insurance discount (RIEMA, 2015). The CRS program emphasizes three goals: the reduction of flood losses, facilitating accurate insurance rating, and promoting the awareness of flood insurance. By participating in the CRS program, communities can earn a 5-45% discount for flood insurance premiums based upon the activities that reduce the risk of flooding within the community. Currently, ten Rhode Island communities, one of which is Westerly, participate in the CRS and receive flood insurance premium discounts.

There are many categories for which a community may gain credit for public education and awareness activities regarding floodplain management and mitigation. The maintenance of non-federally-owned open space land in floodplains can also help a municipality gain credit points under the CRS program. In addition, vegetated open-space land enhances the natural beauty and the beneficial functions that floodplains serve while helping to prevent flood damage.

Participating in the CRS can help communities save money, protect the environment, and improve the overall quality of life. If there is a flood, participating in the CRS brings the following benefits:

- Prevent property damage;
- Avoid lost jobs and economic devastation caused by flooding in offices, factories, farms, stores, and other businesses;
- Prevent damage and disruption to roads, schools, public buildings, and other facilities people rely on every day; and
- Possibly reduce casualties if setbacks decrease impact to physical structures.

As long as Westerly maintains compliance with NFIP regulations, Westerly's CRS rating will be recertified on an annual basis. The recertification will occur as long as Westerly continues to implement CRS activities and certify them each May. Verification visits from FEMA take place every five years to ensure the implementation of CRS activities and to adjust any modifications to the program.

The town continues to pursue funding through Federal, state and local opportunities including our capital budget and grant applications for drainage projects, retrofitting and repairing of structures vulnerable to storm damage and the acquisition of land in full, or in part as a means of preserving or expanding open space in floodplains. The town has successfully used Flood Mitigation Assistance grants for home elevation projects. Because Westerly maintains compliance above the minimum floodplain management requirements, property owners are able to purchase insurance through the NFIP with a ten percent discount. There is no requirement that the property be located within an identified SFHA. Instead, any property in the town can be insured through the NFIP as long as Westerly maintains its good participant standing.

In 2013 there was a nationwide project underway to update the FEMA Flood Insurance Rate Maps (FIRMs). As new data became available, many of the old FIRMs were outdated (Rhode Island Emergency Management Agency, 2014). The maps were completed by FEMA contractor, STARR, through extensive modeling using new transects, surveys, and coastal analyses (RIEMA 2014). New FIRMs for Washington County were adopted by the Town of Westerly in 2013. Adopting the FIRMs kept Westerly in good standing with NFIP.

The CRMC plans for and manages the coastal resources of the State. Within the State Coastal Plan, there are numerous policies and programs for the protection of coastal and tidal wetlands. CRMC has statutory authority to restrict the alteration of coastal wetlands in order to preserve them. The preservation of wetlands from development and destruction will provide for the natural and beneficial use of wetlands as related to flood retention and natural buffers from coastal storms.

**Plans and Programs**

CRMC has several ongoing partnerships to reduce risks from coastal hazards and for public education and outreach. Westerly takes advantage of the CRMC plans and program to enhance public knowledge and understanding. Some specific projects include:

- Partnering with URI and RISG to develop a Shoreline Change (Beach) SAMP.

- Partnering with RISG and The Nature Conservancy to examine sea level rise (SLR) impacts to coastal wetlands throughout Rhode Island.
- Working with Federal, state and local agencies for post-Sandy recovery.
- Partnering with statewide and local planners, URI, GIS coordinators, and Sea Grant to develop tools for determining vulnerability to future coastal flooding scenarios.
- Partnering with the RIEMA, the State Building Commission, and Sea Grant to develop regulations for adaptation to SLR for new and substantially improved buildings within the coastal zone.
- Developing regulations for beneficial reuse of dredged sediment for beach and dune restoration.
- Developing "living shoreline" regulations for alternatives to structural shoreline protection.

In addition, CRMC staff give numerous presentations to professional groups and the general public on coastal hazards, climate change and other topics. The CRMC has initiated a new BeachSAMP to assess flood inundation and SLR scenarios and shoreline erosion to better inform planning efforts and decision-making to enhance community resilience. The CRMC and partners received a federal grant to evaluate SLR impacts to coastal wetlands and plan for future preservation.

**Stormwater Management**

The Town of Westerly owns and maintains a stormwater sewer system. Most of the system flows into the river or wetlands rather than the ocean. There are no combined sewer overflow connections between the sanitary sewer and storm sewer systems (Town of Westerly, 2010), which is beneficial to Westerly's surface water quality. The town has an ongoing maintenance program for the storm system that includes cleaning catch basins and pipes and replacing aging pipes and structures. In 2007, the town received approval from Rhode Island's CRMC to install a municipal storm drainage collection and treatment system serving the Misquamicut area to address serious flooding problems during moderate to heavy storms. Phase I is currently operational.

The EPA promulgated the Storm Water Phase II Rule, which targets municipal stormwater systems to comply with the requirements of the Clean Water Act and to protect the nation's streams, rivers, and beaches from polluted stormwater runoff. In Rhode Island the EPA Phase II Rule is administered by the RIDEM. Owners of regulated small municipal separate storm sewer systems (MS4s) authorized to discharge stormwater under the Rhode Island Pollution Discharge Elimination System (RIPDES) Stormwater General Permit for Small MS4s must submit an Annual Report to the RIDEM Office of Water Resources. The report tracks the progress of compliance with requirements of the general permit. The Town of Westerly is a regulated small MS4 (Town of Westerly, Town Ordinances).

**Open Space and Land Conservation**

Preservation efforts in Westerly by public and private entities have protected over seven square miles of conservation land (Westerly Comprehensive Plan, 2010). A large part of Great Swamp in South Kingstown and Westerly is designated as a wildlife reservation (FEMA, 2013b).

#### 4.2.2.1 Emergency Management

The Westerly Emergency Management Agency provides a series of tools and opportunities for citizens to be informed and educated. EMA provides an online training course titled "Westerly Hazard Mitigation Education" which aims to improve the preparedness of course-takers for hurricanes, winter storms, and flooding. The interactive mitigation course tests the course-takers knowledge about risk-reducing strategies for these natural hazards.

The Community Emergency Response Team (CERT) Program is also supported by EMA. The mission of the CERT program is to educate Westerly residents about disaster preparedness for natural hazards and to provide training for basic disaster response skills.

#### 4.2.2.2 Dam Safety

RIDEM has the responsibility to inspect dams and determine their condition (RIDEM, 2016). In accordance with Dam Safety Regulations, visual inspections of high hazard dams are required every two years (RIDEM, 2016). As part of each visual inspection, the condition of the major components of the dam are subjectively rated as good, fair or poor. The major components of a dam are the embankment, the spillway and the low level outlet (RIDEM, 2016). The most recently available Annual Report to the Governor on the Activities of the Dam Safety Program is from 2016, however no dams in Westerly were inspected during this reporting period. In the 2016 report (the most recent reporting year) the Bradford Dam (ID No. 253) which is located in the Pawcatuck River on the boundary of Hopkinton and Westerly was designated as a low hazard dam. The low hazard designation means that if a dam failure occurred there would be no probably loss of human life and economic losses would be low (RIDEM, 2013). Low hazard dams are inspected every five years to determine whether downstream conditions have changed over time in such a way to warrant raising the hazard classification to significant or high. The most recent dam safety inspections for other dams in Westerly are listed in Table 4.3:

**Table 4.3 Westerly Dam Classifications**

| Dam Name | State ID No. | Waterbody | Hazard Level | Inspection Year |
|---|---|---|---|---|
| Bradford | 253 | Pawcatuck River | Low | 2010 |
| Olaf Farm Pond | 493 | Cedar Swamp Brook | Low | 2008 |
| Boiling Spring | 752 | Mastuxet Brook | Low | 2008 |
| Woody Hill Reservoir | 454 | Perry Healy Brook | Low | 2008 |

| | | | | |
|---|---|---|---|---|
| Misquamicut Country Club Pond | 547 | Unnamed | Low | 2008 |
| White Rock | 255 | Pawcatuck River | Low | 2008 |
| Stillmanville | 256 | Pawcatuck River | Low | 2008 |

According to the most recent RIDEM dam inspection report (2016) none of Westerly's dams have been classified as significant or high hazard.

# 5

# Mitigation Plan

## 5.1 Goals and Objectives

The Westerly Hazard Mitigation Plan advocates the concepts of a disaster resilient and sustainable community. Westerly is building a disaster resistant community and achieving sustainable development through the commitment of state and local government and its policymakers to mitigate hazard impacts before disaster strikes and by restricting the infringement on sensitive lands.

As Westerly is striving to be a more resilient community. It is becoming a safer community, through the implementation of mitigation programs and policies. The town implements and institutionalizes hazard mitigation through its human, legal and fiscal resources; the effectiveness of intergovernmental coordination and communication; and the knowledge and tools at hand to analyze and cope with hazard risks and the outcomes of mitigation planning.

The Westerly four phase Mitigation Plan provides a coordinated, consistent set of goals for reducing or minimizing: human and property loss; major economic disruption, and the degradation of ecosystems and environmental critical habitats from natural and technological disasters by integrating policy and action across functional areas and working with the citizenry to maintain the delicate balance with nature.

The four goals of the HMC are:

- **GOAL 1**: Maintain open space in vulnerable areas of Westerly.
- **GOAL 2**: Minimize economic disruption resulting from natural hazards.

- **GOAL 3**: Reduce vulnerability of public and private infrastructure to natural hazards.
- **GOAL 4**: Enhance the capability of the natural environment to protect Westerly from coastal hazards such as storm surge and sea level rise.

Mitigation Actions developed for the 2012 HMP have been continually tracked and assessed. The committee has maintained and updated the Natural Hazard Mitigation Plan Matrix throughout the life of the plan. At the beginning of this update process the matrix was reviewed to determine which actions had been completed, which were in progress, those that should be considered for continued inclusion in the updated plan, and those that should be considered for removal from the update. The committee reviewed completed actions to determine their effectiveness. They also reviewed the actions that were not completed to determine the reasons why and assess the continued viability of those actions.

## 5.2 Existing Mitigation Actions

Westerly has taken a proactive approach to hazard mitigation. Some existing actions have been in place for decades, while others have been implemented as situations change and new vulnerabilities must be addressed.

### 5.2.1 Flood Hazard Overlay Zoning District, Building Codes & Subdivision Design

The Town of Westerly's zoning ordinance contains a "Flood Hazard Overlay District," which corresponds geographically to both A and V flood zones as depicted on FIRM maps. This ordinance states that: "No use shall be approved which would adversely affect the capacity of any drainage facility or system or would involve alteration of sand dunes, barrier beaches, and other natural protective barriers." A Flood Hazard Permit is necessary for most activities located within a flood zone that require a building permit. The purpose of this permit, which is subject to a review by both the Zoning Official and Building Official, is to ensure flood damage potential is minimized through the proper design of sanitary facilities, flood proofing of buildings, and assuring that spaces below a building's established flood elevation are not blocked in order to allow the passage of water and, thus, capable of resisting hydrostatic and hydrodynamic load effects of buoyancy.

Westerly's building codes define how structures are built to enhance their ability to survive nature's wrath. These rules work best with new construction and with existing buildings that undergo extensive remodeling. However, it must be recognized that there are many older buildings in flood prone areas that are clearly in need of retrofit that will not benefit from these regulatory tools since their owners are not proposing any changes or modifications that require local permit approvals.

Since state and federal regulations are periodically updated, a periodic review of Westerly's zoning ordinance, subdivision regulations and building codes should be made to ensure they continue to conform to state and federal requirements. An

excellent publication available in the Westerly Development Services Department is Subdivision Design in Flood Hazard Areas (Planning Advisory Service Report No. 473), produced jointly by FEMA and the American Planning Association. This book discusses site-specific measures to minimize flood damage and preserve natural functions of floodplains, including coastal high hazard areas and low lying areas near rivers.

Following Sandy, the town issued specific guidance for structures considered nonconforming with the requirements of HDR-10 (High Density Residential) or SCG (Shore Commercial General) zoning districts. Legally nonconforming structures were allowed to rebuild to the exact size and height in the same location. Illegal nonconforming structures were not allowed to be rebuilt unless they were brought into conformance.

### 5.2.2 Building Elevation, Relocation & Demolition

Alternatively, consideration may be given to relocating a structure to a safer portion of a property. If there is room on its current parcel, a structure might be a candidate to be relocated within its lot to increase the distance from a known hazard. For example, moving a house that is directly on a beach or atop a foredune to a new location behind the dune will enhance its protection from storm surge and coastal erosion.

In certain circumstances, demolition of a structure may be warranted, particularly when there is a history of repetitive loss insurance claims. The property would then be a candidate for open space designation to prevent future development. However, such actions may constitute a taking of private property, and conversion of a developed lot to open space is expected to occur only at very specific locations, and only when state or federal grant funding has been earmarked for this purpose.

### 5.2.3 Open Space Acquisition

Land conservation efforts of the Watch Hill Conservancy, Westerly Land Trust, and the Weekapaug Foundation for Conservation have often focused on low-lying areas adjoining the ocean, salt ponds and the Pawcatuck River. Recent key acquisitions include four properties along Canal Street that have been acquired by the Town, and nearly 500 acres acquired by Westerly Land Trust from a private mill owner adjoining the Pawcatuck River near Bradford and 306 acres on Chapman Pond and 40 acres on Crandall Swamp Preserve. All of these properties will remain as open space. These efforts should be encouraged in the future, since it reduces the potential for development in flood prone areas subject to the adverse effects of hurricanes, coastal storms and riverine flooding. Sources of open space funding used by Westerly include open space bonds administered by RIDEM and FEMA hazard mitigation grant funds. If property owners convey land to an IRS-registered 501(c)(3) non-profit land trust, it may be possible to obtain a tax deduction for such property.

### 5.2.4 Construction of Flood Control Structures

Manmade structures intentionally constructed to prevent flood damage may consist of floodwalls, dikes, levees, inlet controls, breakwaters or dune replenishment. Most of these structures tend to be large and expensive, requiring federal financing and intervention. Adding to their cost is the need to address ancillary effects on the natural environment and surrounding unprotected properties. For instance, a breakwater built on a beach may affect shoreline sand replenishment, while a levee may simply redirect floodwaters into locations outside the protected area with no prior history of flooding.

In 1994 the USACE studied the feasibility of installing dike-type structures to surround developed portions of Misquamicut Beach. This study was prompted by significant shoreline storm damage from severe winter storms in December 1992 and March 1993. The Army Corps analyzed a number of different types of structural storm damage prevention measures, and concluded that each alternative would be cost prohibitive relative to the benefits to be gained, with estimated project costs from $11 to $28 million (USACE, 1994). Specifically, it was deemed less expensive to replace damaged properties than building a wall to surround them. Fiscal constraints at all levels of government will continue to be an obstacle to construction of large-scale flood control structures in Westerly.

However, not all physical improvements come at a high cost relative to the benefits gained. After Hurricane Bob in 1991 the Misquamicut Fire District secured funds through FEMA to assist in replenishing primary sand dunes near Misquamicut Beach. This project allowed the District to build up the height of several of the dune areas to 11 feet above the mean high water. Also, beach grass was planted on several miles of dune within the District to help stabilize the remaining dunes. A similar dune reconstruction effort was completed in the late 1990's by RIDEM in front of Misquamicut State Beach. In addition, the Town of Westerly created a new dune and planted American Beach grass in the spring of 2007 at one of the two town owned beaches on Atlantic Avenue.

Dune replenishment will continue to be the flood control measure of choice. There may be opportunities in the future for Westerly to take advantage of various state or federally-funded projects, such as the USACE's proposal to dredge shoaled-in portions of Winnapaug and Quonochontaug Ponds. When such plans are presented to the Town for review and comment, Westerly should seek surplus dredged sand for primary dune reconstruction in coastal areas at risk from storm surge.

### 5.2.5 Improved Floodplain Drainage

A well designed and maintained drainage system can more efficiently direct the flow of stormwater to points where the impacts of flooding will be minimized, thus lessening the after- effects of a storm event. The Town of Westerly has an ongoing effort to improve stormwater drainage infrastructure in flood prone areas, driven by the need to comply with the RI Nonpoint Source Pollution Management Plan and the RI Pollutant Discharge Elimination System regulations. Both riverine and coastal

flooding can be relieved through drainage projects implemented to address these regulations, and by adherence to a regular maintenance schedule to ensure that such systems are functioning properly.

In the mid-1990s, the Town initiated discussions with RIDEM to construct a new storm water drainage system in Misquamicut Beach. This project was completed and pumps excess stormwater runoff from the neighboring streets into a discharge point in Winnapaug Pond. This effort has improved the ability of the storm water drainage system to handle heavy rains and flooding in this low-lying area.

To maintain the capacity of natural flood water drainage systems, the town's subdivision, development plan and special use permit review procedures should insure that unnecessary filling and encroachment into wetlands and FEMA designated flood hazard areas does not occur.

### 5.2.6 Debris Management Plan for Bridges & Dams

Westerly's flood Mitigation Plan must anticipate problems associated with debris such as trees and buildings collecting behind bridges and dams located along the Pawcatuck River. From a long-term perspective, the best solution is to reconstruct bridges to conform with RIDOT regulations, which include design standards that accommodate the 100-year flood event. Following these standards, deck spans for new bridges tend to be wider and provide greater clearance beneath them. The recently replaced Potter Hill Road Bridge and Whiterock/Bridge Street Bridge both have wider spans between abutments, allowing for the passage of larger quantities of flood debris.

However, older structures including the West Broad Street Bridge and Boombridge Road Bridge can act as a weir, and collect large amounts of river borne debris. Rising floodwaters behind these structures could jeopardize the foundations of these structures or cause great amounts of upstream flooding. Consequently, Westerly's public works forces and/or equipment should be pre-positioned prior to an anticipated flood event in order to remove flood debris as it is accumulating. As evidence of this, the Boombridge Road Bridge was impassible after the intense rain event on July 1, 2009.

### 5.2.7 Siting of Municipal Facilities & Infrastructure

In 2001, Westerly's Department of Public Works updated its Water Supply Management Plan to focus on emergency management. This Plan describes actions to be taken in the event of an earthquake, flooding or high winds, focusing on the inspection of critical components of the water supply distribution system. Specific responses to problems that may be discovered during this post-disaster inspection are detailed in the Plan.

A vulnerability analysis conducted as part of Westerly's Water Supply Management Plan update indicates that none of the water pumping facilities or reservoir tanks are located in FEMA flood hazard zones. A review of wastewater pumping station

locations suggests that only one – the Old Canal Pump Station – is located within a 1-percent-annual flood, or A-zone, while the balance are in the X zone. This proactive policy of flood zone avoidance should be followed in the future as Westerly expands its water supply distribution and wastewater collection systems.

Consideration should also be given to flood hazard zone avoidance when siting municipal facilities such as a new police department, emergency operations center or public works garage to prevent the isolation of a facility due to flooding, it is recommended that they be sited near designated evacuation routes since these roadways will permit access throughout much of the community without threat of inundation. A review of Westerly's zoning map and zoning ordinance is warranted, such that elderly housing, nursing homes and assisted living facilities should be sited outside of FEMA flood hazard zones.

Since an earthquake could potentially damage or break water mains, Westerly's capital improvement budget process should allocate funds for interconnecting exiting water distribution systems in order to maintain steady water pressure throughout the service delivery area. As new subdivision streets are constructed in portions of Westerly served by public water supply, opportunities for looped and interconnected systems should be explored. Construction of additional water towers disparate locations will also help to maintain water pressure should there be a need to replace water mains damaged due to an earthquake.

### 5.2.8 Drought Management

The Town of Westerly's Department of Public Works has the primary responsibility for managing the town's water supply distribution system, and for ensuring that it can provide sufficient water to meet public health and safety needs of its customers. The Rhode Island Water Resources Board (RIWRB) issues notices regarding drought conditions in the state, and the Drought Management Element of the State Guide Plan controls state policy relative to long-term drought response. The following five phases are used to classify existing drought conditions:

- Normal
- Advisory
- Watch
- Warning
- Emergency

Based upon local water supply conditions, Westerly can initiate its own actions ranging from voluntary water use restrictions to declarations of local water emergencies. Information-sharing between state and local officials is essential in assessing drought situations. The local water entity must provide the specific information about its own circumstances to RIDEM, which is responsible for assessing the broader situation faced by Washington County as a whole. Similarly, state drought levels and information must be provided to water suppliers should prompt action be required of local communities.

The Town has the lead role in preparing for and managing all stages of drought at the community level. Drought preparedness measures are included in Westerly's Water Supply Management Plan, which stress policies that promote water conservation wherever possible, including a provision for local ordinances to ensure that established regulations and procedures can respond to drought conditions. The following water supply alert phases are based upon monitored groundwater levels during periods of drought, focusing on well drawdown levels:

**Table 5.1 Water Supply Alert Phases**

| | |
|---|---|
| Drought Watch / Advisory Phase | 70% normal depth |
| Conservation Phase | 65% normal depth |
| Expanded Restriction Phase | 60% normal depth |
| Emergency Phase | 55% normal depth |

Emergency powers are conferred upon the chief elected municipal official pursuant to Rhode Island General Laws, 30-15-12, which enables Westerly to plan for and declare a drought emergency. Local government's most visible role in Westerly may be educating the public on the drought status and in the development and enforcement of local regulations should the situation worsen.

### 5.2.9 Wildfire Loss Prevention

Urban-wildland interface fires tend to be more damaging than urban structural fires, are often more difficult to control, and behave differently from structural fires. When these fires erupt, people and structures must take priority, often at a devastating expense to natural resources. People who live in heavily forested portions of Westerly have little understanding of wildfire cycles and danger since it occurs so infrequently in Rhode Island. Consequently, homes and other structures are often built and maintained in a manner that leaves them and their occupants vulnerable.

Since Westerly is susceptible to prolonged drought, which increases the risk of wildfire, homeowners can protect themselves via a well-maintained landscape, reduction of woody vegetation and brush around the perimeter of the property, a fire-resistant roof, and a good access driveway with a turnaround area.

The Three R's of Wildfire Loss Prevention

- **Removal**: This technique involves the elimination of entire plants, particularly trees and shrubs, from the site. Examples include removal a dead tree or the cutting out of a flammable shrub.
- **Reduction**: The removal of plant parts, such as branches or leaves, constitutes reduction. Examples include pruning dead wood from a shrub, removing low tree branches, and mowing dead grass.
- **Replacement**: Replacement is the substitution of less flammable plants and vegetation. For example, removal of a dense stand of flammable shrubs and planting an irrigated, well maintained flower bed would be a type of replacement

### 5.2.10 Public/Private Partnerships

The purpose of public-private partnerships is to maintain and quickly restore the community's well-being. The Greater Westerly-Pawcatuck Area Chamber of Commerce, in a cooperative effort with the Westerly Emergency Management Agency, has surveyed its member's who own heavy construction equipment and supplies in an effort to improve the town's emergency response capability. This list should be revisited at least annually both to ensure that it remains up-to-date, and to serve as a reminder to private businesses of their important role in post-disaster clean up. Furthermore, it is imperative that owners of individual businesses assess which natural hazards and risk factors may affect them, and make plans to minimize anticipated impacts.

Increased opportunities for volunteer involvement should be explored. As an example from another Rhode Island community, volunteers were employed to secure bookshelves to walls in local childcare centers as a safety measure. This type of activity will serve to supplement large- scale mitigation measures at a minimal cost.

### 5.2.11 Permits for Building Reconstruction

Section 180 of the RI Coastal Resources Management Program deals with Emergency Assents. CRMC's post hurricane and storm permitting procedures impose a temporary 30-day moratorium on reconstruction after a disaster has been declared in order for municipalities to assess damages, determine changes that may have occurred to the coastline, and identify mitigation opportunities. During this moratorium, CRMC grants priority approval to the reconstruction and/or replacement of public facilities such as bridges, roads and public infrastructure. After the moratorium has passed, CRMC gives highest priority to applications for reconstruction of private dwellings and structures that were physically damaged or destroyed 50 percent or more by storm-induced flooding, wave or wind damage.

The Building Office has the authority to enforce all State Building Code regulations, including §23-27.3-106, and advises property owners of best practices and mitigation measures to help prevent damage.

## 5.3 Update of the Mitigation Plan and Actions

In the process of preparing this update, the town has continued to review past and ongoing actions to determine their relevance in the future. The types of activities that were considered when developing new actions to reduce the community's vulnerability have been divided into the following categories:

- Local Plans and Regulations
- Structure and Infrastructure Projects
- Natural Systems Protection
- Education and Awareness Programs

The Hazard Mitigation Committee conducted several reviews of the 2012 Mitigation Plan Actions. The 2012 actions were assessed for their continued relevance and value to the community in light of changes in the community and events that have occurred since the previous plan was implemented. During this review, several changes were made to the mitigation actions. Actions were again realigned and modified to address current needs and future development trends. The newly formatted actions were presented to the public for comment and input. Based on input from the public and the Hazard Mitigation Committee, the actions listed in the following sections will be implemented.

**Table 5.2 2010 Mitigation Action Status**

| | | | |
|---|---|---|---|
| **1** | Improve water conveyance along Canal Street | ✓ | Completed |
| **2** | Elevate Larry Hirsh Way | ✓ | Completed |
| **3** | Relocate utility | ✓ | National Grid has substantially completed the relocation |
| **4** | Water distribution infrastructure- upgrade water lines | ➔ | Continued in 2017 plan |
| **5** | Drainage improvements, Pierce & Ann Streets | ➔ | Continued in 2017 plan |
| **6** | North End Neighborhood housing in flood zone | ➔ | Continue. Align with USACE flood proofing project. |
| **7** | Critical roads subject to flooding- improve drainage | ➔ | Continue. Phase I of stormwater pump system installed. |
| **8** | Dams and Bridges- repair or remove | ➔ | Continue. White Rock Dam removed. |
| **9** | Downtown Areas subject to Pawcatuck River flooding- mitigation flood damage | ✓ | Funding secured to complete drainage improvements. |
| **10** | Clean and maintain clogged drainage at Wilcox Park. | ✓ | Completed |
| **11** | Textile mills, Dye Plants & Hazardous Materials Handlers- contain contamination during flooding | ➔ | Continue. Brownfields assessment funding secured. |
| **12** | Verizon telephone switching station, Main Street & Noyes Neck- flood protection | ✓ | Completed |
| **13** | Babcock Cove & Mastuxet Brook at Watch Hill Road- improve drainage and wetland capacity | ➔ | Continue. Grant received to study TDML. Expand area. |
| **14** | Breachway Seawalls / Jetty,<br>Cosways in Avondale, River banks on Canal Street | ➔ | Continue |
| **15** | Debris Management | - | Moved to capabilities |
| **16** | Private septic systems (OWTS units) in flood prone areas | ➔ | Continue |
| **17** | Stormwater Retention & Detention Ponds. | ➔ | Continue. Add new areas of Town. |
| **18** | Barrier Beaches, RI State Beach, Town Beaches, Private beaches | ➔ | Continue. Modified to remove capabilities related items |
| **19** | Boom Bridge Road Bridge | ➔ | Continue. Funding for permitting and final design approved by RIDOT and CTDOT. |
| **20** | Sanitary sewer lines/ Pumping Stations/ WWTP | ➔ | Continue. 2 generators have been purchased. |
| **21** | Homes & buildings subject to wildfire | ➔ | Continue |
| **22** | Hazard Mitigation Element to Comprehensive Plan | ✓ | Completed |

## 5.4 Prioritization

Once all the possible actions were on the table, the committee used some basic evaluation criteria can help to decide which actions will work best. Following the period of public input, the HMC assigned priorities to each mitigation action. The most important criterion is whether the proposed action mitigates the particular hazard or potential loss. Each action was also examined for conflict with other community programs or goals, and for how the action will impact the environment, as it is very important to consider whether the proposed action will meet state and local environmental regulations. Other considerations included whether the mitigation action affects historic structures or archeological areas or whether it helps achieve multiple community objectives. Another important issue is timing, and how quickly the action has to take place to be effective, as well as which actions will produce quick results. It is particularly important to consider if funding sources have application time limits, whether it is the beginning of storm season, or if the community is in the post-disaster scenario, where everyone wants to recover at maximum speed.

Each of the considered actions was given a priority score based upon the STAPLEE criterion as described in Section 5.4.1. The scores were then translated into a relative priority ranking. Highest priority was placed on those actions given a ranking of 1. Those actions scoring the same were given equal ranking and may be accomplished simultaneously or at the very least they should be given equal consideration for implementation.

This prioritization exercise helped the Committee evaluate seriously the new hazard mitigation strategies that had been developed throughout the Hazard Mitigation Planning process. While all the actions would help improve the town's resilience, funding availability will be a driving factor in determining what and when new mitigation strategies are implemented. For example, while elevating structures out of the 100-year floodplain will definitely decrease floodplain losses, the cost of this project may require the project be put off until funding is made available. In contrast, the town can distribute preparedness information to the public at a much lesser cost, making this project more reasonable as a short-term goal. This type of cost to benefit analysis was taken into account when prioritizing each action.

Each mitigation action has been given an expected timeframe for implementation. The assigned timelines are based on a combination of factors that includes the relative priority of the action, the availability of resources needed to complete the action, and the status of any requisite projects that may impede the completion of the action. This committee worked to set goals and objectives that are bounded by a time frame following plan adoption, are compatible and consistent with State Hazard Mitigation Goals and availability of funding. The time frames used for these strategies are as follows:

- Near-term = 0 to 6 Months
- Medium-term = 6 to 18 Months
- Long-term = 18 Months to 5 Years

### 5.4.1 STAPLEE

One tool used by the Westerly Hazard Mitigation Committee developed and refined hazard mitigation actions using evaluation criteria based on the concept of STAPLEE. STAPLEE is an acronym for a general set of criterion common to public administration officials and planners. It stands for the Social, Technical, Administrative, Political Legal and Economic/Environmental criterion for making planning decisions. The Hazard Mitigation Committee ranked each of the new or improved mitigation strategies by utilizing the STAPLEE criterion. The Committee asked and then answered questions in order to determine the acceptability of the proposed mitigation action when being viewed in terms of six distinct criteria. See Table 4.6 for further explanation of the STAPLEE criterion.

**Table 5.3 STAPLEE Criteria for Prioritizing Mitigation Actions**

| Criteria | Explanation |
|---|---|
| Social | Is the proposed action socially acceptable to the community? Are there equity issues involved that would mean that one segment of the community is treated unfairly? Will the action cause social disruption? |
| Technical | Will the proposed action work? Will it create more problems than it solves? Does it solve a problem or only a symptom? Is it the most useful action considering the community goals? |
| Administrative | Can the community implement the action? Is there someone to coordinate and lead the effort? Is there sufficient funding, staff, and technical support available? Are there ongoing administrative requirements that need to be met? |
| Political | Is the action politically acceptable? Is there public support both to implement and to maintain the project? Will the Mayor, his Cabinet, County Council and other decision-making political bodies support the mitigation measure? |
| Legal | Is the community authorized to implement the proposed action? Is there a clear legal basis or precedent for this activity? Is enabling legislation necessary? Are there any legal side effects (e.g. could the action be construed as a taking)? Will the community be liable for action or lack of action? Will the activity be challenged? |
| Economic | What are the costs and benefits of this action? Does the cost seem reasonable for the size of the problem and the likely benefits? Are maintenance and administrative costs considered as well as initial costs? How will this action affect the fiscal capability of the community? What burden will this action place on the tax base or the local economy? What are the budget and revenue effects of this action? Does the action contribute to other community goals, such as capital improvements or economic development? What benefits will the action provide? |
| Environmental | Sustainable mitigation actions should not have an adverse effect on the environment, they should comply with federal, state, and local environmental regulations and should be consistent with the community's environmental goals. |

The Committee responded to each of these above listed criteria, with a numeric score of "1" (indicating low impact), a "2" (indicating medium impact), and a "3" (indicating high impact). These numbers were then totaled and developed into an overall priority score.

A total of 17 actions were developed by the Westerly Hazard Mitigation Committee along with input from stakeholders and the general public.

## 5.5 Mitigation Actions

The following actions have been identified for implementation during the five-year span covered by this plan, following plan adoption. The actions will continually be assessed and evaluated for their continued relevance throughout the period.

### 5.5.1 Action #1: Elevate Repetitive Loss Structures (New action)

As grants become available, the Town plans to continue to offer funding obtained through FEMA to assist owners of Repetitive and Severe Repetitive Loss properties, Repetitive Loss Areas, and other properties susceptible to flood inundation in elevating their homes and/or their utilities in order to reduce the vulnerability to flooding and storm surge. The program criteria will be modified as needed throughout the life of this plan.

**Priority**: High
**Pre or Post Disaster**: Pre-disaster
**Type of Activity**: Structure and Infrastructure Projects; Education and Awareness Programs
**Responsible Departments**: Development Services Department
**Funding Resources**: FEMA Grant/Town Operating Budget/Property Owner
**Cost**: $160,000 per home
**Timeframe**: Near-term

### 5.5.2 Action #2: Improve Misquamicut Drainage– Phase II (Continued and expanded action)

The Town completed the Phase I study for the Misquamicut Beach Drainage Project in 2014. Phase II implementation includes the installation of a collection system, using natural resources such as replenished dunes, planted vegetation, and the removal of impervious surfaces such as paved parking lots. The incorporation of an ISDS management policy is also part of the drainage project.

**Priority**: High
**Pre or Post Disaster**: Pre-disaster
**Type of Activity**: Structure and Infrastructure Projects, Natural Systems Protection
**Responsible Departments**: Engineering, DPW
**Funding Resources**: State & federal stormwater and mitigation grants, municipal bonds.
**Cost**: $1,000,000
**Timeframe**: Medium-term

### 5.5.3 Action #3: Improve Main Street Drainage (New action)

Main Street from the Bridge restaurant to Beach Street is particularly susceptible to flooding caused by overflow from the Pawcatuck River. This action considers building a berm along the river with a pump system to pump stormwater over the berm into the river.

**Priority**: High
**Pre or Post Disaster**: Pre-disaster
**Type of Activity**: Structure and Infrastructure Projects
**Responsible Departments**: Engineering, DPW
**Funding Resources**: FEMA Grant/Town Operating Budget
**Cost**: $500,000
**Timeframe**: Medium-term

### 5.5.4 Action #4: Improve Reliability of Water Distribution Infrastructure and Well Fields (Continued action)

The purpose of this action is to upgrade aging waterlines to improve reliability and reduce the likelihood of service disruption or contamination from storm events. The action would also construct a berm to protect well fields White Rock #1 and #2 from flooding.

**Priority**: High
**Pre or Post Disaster**: Pre-disaster
**Type of Activity**: Structure and Infrastructure Projects, Education and Awareness Programs
**Responsible Departments**: Water & Sewer Department
**Funding Resources**: Grants & local capital improvement program, NRCS, ACOE
**Cost**: $1,250,000
**Timeframe**: Medium-term

### 5.5.5 Action #5: Evaluate Drainage Options for Pierce & Ann Streets (Continued action)

The purpose of this action is to conduct an engineering study to map the existing drainage system supporting Pierce and Ann Street. Future actions will be to develop and implement actions to improve drainage infrastructure, inspect, clean, augment, and replace necessary components.

**Priority**: High
**Pre or Post Disaster**: Pre-disaster
**Type of Activity**: Local Plans and Regulations, Structure and Infrastructure Projects, Education and Awareness Programs
**Responsible Departments**: Engineering, DPW
**Funding Resources**: RIDEM grant, Capital budget, CDBG-DR application pending
**Cost**: $50,000
**Timeframe**: Near-term

### 5.5.6 Action #6: Reduce Residential Flooding of North End Neighborhood (Continued and expanded action)

Promote flood resiliency through adaptive strategies by encouraging higher flood protection standards to reduce future losses. Develop and mail an informational

flyer to North End residents. Include flood resistant building design ideas and low impact development suggestions.

**Priority**: High
**Type of Activity**: Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, Education and Awareness Programs
**Responsible Departments**: Development Services Department, and Neighborhood Association, Planning Board
**Funding Resources**: CDBG, RIHMFC
**Cost**: $3,000
**Timeframe**: Near-term

### 5.5.7 Action #7: Improve Drainage on Critical Roads Subject to Flooding (Continued action)

This action will reduce flooding on critical transportation routes through and roadway elevation and improved drainage by enlarging culverts, providing open drainage swales, and increasing underground stormwater pipe storage. Aging waterlines will be replaced (see action #4) while exposed for roadway improvements. Wherever possible and prudent, overhead utility lines will be placed underground. A memorandum of agreement will be established RIDOT to address issues with state owned roads.

**Critical roads subject to flooding**: Atlantic Ave. & adjacent roads*, Bridge Road, Route 91*, Airport Road, Sunset & Wauwinnet Avenues, Watch Hill Road*, Bay Street, Canal Street*, Dunn's Corners, Pound Roads, Perkins Avenue, Langworthy*, Bradford, Bowling Lane, Maplewood*, & Ranger Roads, Weekapaug Road*, Breach Drive, Spruce Street, Narragansett Avenue, Friendship Street, Pierce, Pond, Pleasant Streets, Cottage and Wall streets, Springbrook and White Rock Roads, Main Street at School and Cross Streets

**Priority will be given to roads that are part of the evacuation route.*

**Priority**: High
**Pre or Post Disaster**: Pre-disaster
**Type of Activity**: Local Plans and Regulations, Structure and Infrastructure Projects
**Responsible Departments**: RIDOT, Westerly DPW, FHWA
**Funding** Resources: State & federal grants, municipal bonds.
**Cost**: $10,000,000
**Timeframe**: Near-term

### 5.5.8 Action #8: Dam Management (Continued action)

The purpose of this action is to continue to monitor dams in need of repair, reconstruction or removal. All of the dams in Westerly are classified as a low hazard (Woody Hill Reservoir, Olaf Farm Pond, Misquamicut Country Club Pond, Boiling Springs, and Stillmanville). Clarification of responsible parties is needed where there

are jurisdictional boundaries. If dam conditions change, additional actions may be required.

**Priority**: High
**Pre or Post Disaster**: Pre-disaster
**Type of Activity**: Structure and Infrastructure Projects
**Responsible Departments**: Development Services Department
**Funding Resources**: Site specific
**Cost**: $13,000
**Timeframe**: Near-term

### 5.5.9 Action #9: Improve Downtown Areas Subject to Pawcatuck River Flooding (Continued and expanded action)

The purpose of this action is to reduce vulnerability and improve resiliency by educating business owners about retrofitting buildings to mitigate flood water and debris damage. This action may be supplemented by improvements to the drainage systems in the future.

**Priority**: High
**Pre or Post Disaster**: Pre-disaster
**Type of Activity**: Education and Awareness Programs
**Responsible Departments**: Development Services Department
**Funding Resources**: Property owners
**Cost**: $3,000
**Timeframe**: Near-term

### 5.5.10 Action #10: Reduce Contamination from Textile Mills, Dye Plants, and Hazardous Materials Handlers (Continued action)

The purpose of this action is to reduce the potential for hazardous materials contamination resulting from textile mills, dye plants, and hazardous materials handlers located in flood zones through zoning restrictions, acquisition, relocating businesses, and retrofitting sites.

**Priority**: High
**Pre or Post Disaster**: Pre-disaster
**Type of Activity**: Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, Education and Awareness Programs
**Responsible Departments**: Development Services Department
**Funding Resources**: Property owners, ACOE
**Cost**: $100,000,000
**Timeframe**: Medium-term

### 5.5.11 Action #11: Improve Drainage along Babcock Cove & Mastuxet Brook at Watch Hill Road Continued action)

The purpose of this action is to improve roadway drainage & elevate, cleanup TMDL's in Mastuxet Brook and Airport Road, and maintain wetlands for floodwater storage.

**Priority**: High
**Pre or Post Disaster**: Pre-disaster
**Type of Activity**: Structure and Infrastructure Projects, Natural Systems Protection, Education and Awareness Programs
**Responsible Departments**: Westerly DPW, RIDOT
**Funding Resources**: RIDOT, FHWA
**Cost**: $500,000
**Timeframe**: Near-term

### 5.5.12 Action #12: Construct Breachways/Seawalls/Jetties/Causeways in Avondale, River banks on Canal Street (Continued action)

The purpose of these action is to protect the built environment, retail district, and improve submerged vegetative cover. Actions include: (A) Build seawalls on the Pawcatuck River to protect manufacturing district and low lying residential property. (B) Proposed work along Bay Street includes replacement of curbing, sidewalk, pavement, and lighting. Although the elevation will not drastically change, slight changes will allow stormwater to drain to catch basins. (C) Dredge Weekapaug Breachway to improve pond flushing.

**Priority**: High
**Pre or Post Disaster**: Pre-disaster
**Type of Activity**: Structure and Infrastructure Projects, Natural Systems Protection
**Responsible Departments**: Westerly DPW, Development Services Department
Funding Resources, State & federal grants, town operating budget
**Cost**: $2,000,000
**Timeframe**: Long-term

### 5.5.13 Action #13: Reduce Contaminants from Private Septic Systems (OWTS Units) in Flood Prone Areas (Continued action)

The purpose of this action is to reduce contamination emanating from private septic systems located with flood prone areas by encouraging owners to inspect, repair, pump out, upgrade, or replace systems. Included in a direct mailing would be information on the Community Septic System Loan Program (CSSLP) which provides low interest loans for septic repairs and replacements.

**Priority**: Medium
**Pre or Post Disaster**: Pre-disaster
**Type of Activity**: Local Plans and Regulations, Structure and Infrastructure Projects,

Natural Systems Protection, Education and Awareness Programs
**Responsible Departments**: Westerly Development Services Department, Engineering Department, Homeowners
**Funding Resources**: Westerly Development Services Department, Homeowners
**Cost**: $2,000 staff time
Timeframe: Near-term

### 5.5.14 Action #14: Expand Stormwater Retention & Detention Ponds (Continued action)

The purpose of this action is to improve stormwater retention capacity in developments by incorporating into subdivision design & development plan applications review maintenance schedules during application process, improve design standards for landscaping, and incorporate into zoning & land development regulations. This action also calls for the increasing the detention capacity at Argyle Drive, Westerly Middle School, Springbrook School, Linnate, Davenport, Walton Streets & Yankee Drive Trolley Lane, and Brandywine.

**Priority**: High
**Pre or Post Disaster**: Pre-disaster
**Type of Activity**: Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, Education and Awareness Programs
**Responsible Departments**: Westerly DPW, Building Official
**Funding Resources**: Capital budget, Private-sector developers of subdivisions & commercial projects.
**Cost**: $100,000
**Timeframe**: Medium-term

### 5.5.15 Action #15: Raise Boombridge Road Bridge (Continued action)

Boombridge Road Bridge (Pawcatuck River) has been closed for nearly 10 years due to safety concerns. If the bridge were to be repaired/rebuilt, it should also be elevated. Increasing the clearance beneath bridge will improve flood passage.

**Priority**: High
**Pre or Post Disaster**: Pre-disaster
**Type of Activity**: Structure and Infrastructure Projects
Responsible Departments: Westerly DPW, Building Official
**Funding Resources**: Town of North Stonington, Conn DOT, RIDOT & FHWA
**Cost**: $2,500,000
**Timeframe**: Long-term

### 5.5.16 Action #16: Protect Pumping Stations and WWTF from flooding (Continued and expanded action)

Protect auxiliary power, generators, and other equipment from flooding.

Specific actions as per the RIDEM study on *Implications of Climate Change on Rhode Island Wastewater Treatment Facilities* (2016).

**Action 16a Protect Secondary Clarifiers at WWTF from Flooding**

Protect facility entrances with flood barriers. Replace sludge pumps with submersibles. Store replacement drive components on site. Pumps may be temporarily augmented.

**Action 16b Protect Disinfection Components at WWTF from Flooding**

Elevate or relocate disinfection system components.

**Action 16a Protect New Canal Pump Station from Flooding**

Protect facility entrances with flood barriers and relocate building penetrations for louvers. Elevate back-up generator system.

**Action 16b Protect Old Canal Pump Station from Flooding**

Protect facility entrances with flood barriers. Elevate back-up generator systems.

**Action 16c Protect Old Canal Pump Station from Flooding**

Protect facility entrances with flood barriers.

**Priority**: High
**Pre or Post Disaster**: Pre-disaster
**Type of Activity**: Structure and Infrastructure Projects
**Responsible Departments**: Police, Water and Sewer Department
**Funding Resources**: Grants & local capital improvement program
**Cost**: $500,000
**Timeframe**: Near-term

### 5.5.17 Action #17: Protect Homes and Buildings Subject to Wildfire (Continued action)

The purpose of this action is to reduce the vulnerability of homes and buildings to wildfire by removing damaged trees, clearing underbrush, and conducting controlled burns. The action also calls for a fire safety program to inform homeowners.

**Priority**: Medium
**Pre or Post Disaster**: Pre-disaster
**Type of Activity**: Structure and Infrastructure Projects, Education and Awareness Programs
**Responsible Departments**: Fire Districts, Conservation Commission
**Funding Resources**: Homeowner, Town operating budget
**Cost**: 100,000
**Timeframe**: Near-term

**Table 5.4 Town of Westerly – Natural Hazard Mitigation Plan Matrix**

| | PROJECTS WHAT IS AT RISK | TYPE OF MITIGATION | | | | IMPLEMENTATION | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Local Plans & Regulations | Structure and Infrastructure Projects | Natural Systems Protection | Education and Awareness | Priority | Timeframe | Responsible Person / Agency | Financing Options | Estimated Cost of Mitigation |
| 1 | Repetitive Loss Structures | Continue to enforce building codes for substantial improvement in a flood zone. | Acquisition and Elevation Program. | Purchase property adjacent to the Atlantic Ocean to increase open space, reduce debris and repetitive losses. | Continue to develop public outreach to inform and educate the public about acquisition and elevation. | High | Near-term | Development Services Department | FEMA Grant/Town Operating Budget/Property Owner | Average cost per home elevation: $160,000 |
| 2 | Misquamicut Drainage Project – Phase II | Incorporate ISDS management policy into drainage project. | Mitigate adverse drainage and flooding impacts from roadways in vicinity of Atlantic Avenue. | Replenish dunes, plant vegetation, remove impervious surfaces such as paved parking lots. | | High | Medium-term | Engineering, DPW | State & federal grants, municipal bonds. | $1,000,000 |
| 3 | Main Street Drainage | | Improve drainage on Main Street from the Bridge restaurant to Beach Street. | | | High | Medium-term | Engineering, DPW | FEMA Grant/Town Operating Budget | $500,000 |
| 4 | Water distribution infrastructure & well fields | | Upgrade aging water lines. Construct a berm to protect White Rock #1 and #2 well fields from flooding. | | | High | Medium-term | Water & Sewer Department | Grants & local capital improvement program, , NRCS , ACOE<br>Feasibility study in progress | $1,250,000 within 5-years |
| 5 | Drainage Improvements Pierce & Ann Streets | Conduct engineering study to map the drainage system. | | | | High | Near-term | Engineering, DPW | RIDEM grant, Capital budget, CDBG-DR application pending | $50,000 within 2 years |
| 6 | North End Neighborhood Housing in flood zone | | | | Promote flood resiliency by encouraging higher flood protection standards for residents. | High | Near-term | Local EMA and Neighborhood Association | CDBG, RIHMFC | $3,000 within 2 years |
| 7 | Critical roads subject to flooding | Create a Memorandum of Agreement with the State of Rhode Island to make mitigation improvements on State owned roadways. | Improve roadway drainage & elevate above flood zone where appropriate and cost effective. Replace aging water lines where applicable when trenches are open. Upgrade fire hydrants. Direct overhead utilities underground where possible. Enlarge culverts, provide open drainage swales, and increase underground stormwater pipe storage. | Use Experimental Erosion and sediment control BMP's. | Educate residents of danger of moving water and flooding. | High | Near-term | RIDOT, Westerly DPW | State & federal grants, municipal bonds. | $10,000,000 5+ years |
| 8 | Dam Management | | | Continue to monitor dams in need of repair, reconstruction, or removal. | | High | Near-term | Development Services Department | Site specific | $13,000 within 3 years |
| 9 | Downtown areas subject to Pawcatuck River flooding. | Conduct map study to upgrade culverts & drainage | | | Increase awareness of flood insurance. Provide FEMA retrofitting literature. | High | Near-term | Development Services Department | Property owners, DPW<br>ACOE<br>Feasibility study in progress | $3,000 within 2 years |

| | PROJECTS WHAT IS AT RISK | TYPE OF MITIGATION | | | | IMPLEMENTATION | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Local Plans & Regulations | Structure and Infrastructure Projects | Natural Systems Protection | Education and Awareness | Priority | Timeframe | Responsible Person / Agency | Financing Options | Estimated Cost of Mitigation |
| 10 | Textile mills, Dye Plants & Hazardous Materials Handlers | | Retrofit sites to provide containment during flooding. Relocate business away from watercourses. Land acquisition. | | | High | Medium-term | Development Services Department | Property owners ACOE<br>Feasibility study in progress | $100,000,000 5+ years |
| 11 | Babcock Cove & Mastuxet Brook at Watch Hill Road | . | Improve roadway drainage & elevate if cost effective. Cleanup TMDL's in Mastuxet Brook and in vicinity of Airport Road. | Maintain wetlands for floodwater storage. | Educate residents of danger of moving water. | High | Near-term | RIDOT & DPW (RIDEM & CRMC permit approvals) | RIDOT & FHWA | $500,000 within 3 years |
| 12 | Breachways/Seawalls/Jetties/ Causeways in Avondale, River banks on Canal Street | | Build seawalls on Pawcatuck River to protect manufacturing district and low lying residential property, and Bay Street to protect retail district. | Improve submergent vegetative cover.<br>Dredge Weekapaug Breachway to improve pond flushing. | | High | Long-term | Development Services Department | State & federal grants, town operating budget | $2,000,000 within 5 years |
| 13 | Private septic systems (OWTS units) in flood prone areas | | | | Encourage owners to inspect, repair, pump out, upgrade, or replace systems. | Medium | Near-term | Homeowners and DPW | Homeowner responsibility | $2,000 within 3 years |
| 14 | Stormwater Retention & Detention Ponds. | Incorporate into subdivision design & development plan applications toreview maintenance schedule during application process, improve design standards for landscaping, and incorporate into zoning & subdivision regulations. | Improve detention at Argyle Drive, Westerly Middle School, Springbrook School, Linnate, Davenport, Walton Streets & Yankee Drive Trolley Lane, Brandywine Establish residential ponds. Clean & maintain existing ponds. | Remove exotic invasive plants. Plant native plants. | Educate homeowners to establish residential retention ponds and trench drains in steep driveways to capture runoff. | High | Medium-term | DPW | Capital budget, Private-sector developers of subdivisions & commercial projects. | $100,000 within 5 years |
| 15 | Boom Bridge Road Bridge | | Inspect, repair, reinforce, rebuild.<br>Increase clearance beneath bridge. Improved flood passage. | | | High | Long-term | DPW | Town of North Stonington, Conn DOT, RIDOT & FHWA | $2,500,000 within 4 years |
| 16 | Sanitary sewer lines/ Pumping Stations/ WWTP | | Protect components of WWTF, New Canal Pump Station, and Old Canal Pump Station from flooding. | | Ensure staff awareness of Emergency Operations Plan. | High | Near-term | Police, Water & Sewer Department | Grants & local capital improvement program | $500,000 within 5 years |
| 17 | Homes & buildings subject to wildfire | | Remove damaged trees, clear underbrush & conduct controlled burning. | | Provide fire safety information to property owners. | Medium | Near-term | Fire Districts, Conservation Commission | Homeowner responsibility | $100,000/ event |

# 6

# References

Algier, A.J. January 12, 2015. Small earthquake shakes Connecticut, R.I. border. The Westerly Sun. http://www.thewesterlysun.com/news/latestnews/6656950-129/small-earthquake-shakes-connecticut-ri-border.html

Benson, Judy. April 2, 2010. Aging dams overtopped, but most holding as R.I., Connecticut hasten inspection. The Day. http://www.theday.com/apps/pbcs.dll/article?AID=2010304029906.

Boston.com July 2, 2012. Police: three kids indirectly hit by lightning in RI. http://www.boston.com/yourtown/boston/fenway_kenmore/articles/2012/07/02/police_3_kids_indirectly_hit_by_lightning_in_ri/

Brandt, M., Brown, C., Burkhart, J., Burton, N., Cox-Ganser, J., Damon, S., Falk, H., Fridkin, S., Garbe, P., McGeehin, M., Morgan, J., Page, E., Rao, C., Redd, S., Sinks, T., Trout, D., Wallingford, K., Warnock, K., and Weissman, D. 2006. Mold prevention strategies and possible health effects in the aftermath of hurricanes and major floods. Morbidity and Mortality Weekly Report, Center for Disease Control and Prevention.

Boothroyd, Jon C., August 21, 2008. Testimony of Jon C. Boothroyd, PhD, State Geologist, Rhode Island Geological Survey. Prepared for Briefing on Global Warming Impact on Narragansett Bay. https://www.whitehouse.senate.gov/download/testimony-of-john-boothroyd

Cicilline, David. February 24, 2014. Delegation announces $1 million to reimburse RI for snow removal costs. Press Release from Congressman David Cicilline.

http://cicilline.house.gov/press-release/delegation-announces-1-million-reimburse-ri-snow-removal-costs

Coastal Resources Management Council, March 2015. The Rhode Island Sea Level Affecting Marshes Model (SLAMM) Project: Summary Report.

Craig, Kris. 31 October 2012. Hurricane Sandy devours southern R.I. coastline. The Providence Journal. http://www.providencejournal.com/topics/photos/photo-story/20121031-hurricane-sandy-devours-southern-r.i.-coastline.ece

Del Santo, T.J. A Look Back at the 1986 Cranston/Providence Tornado. May 21, 2014. WPRI Eyewitness News. http://blogs.wpri.com/2013/05/21/a-look-back-at-the-1986-cranstonprovidence-tornado/

Dillingham, Timothy P., Rush Abrams, Alan Desbonnet, and Jeffrey M. Willis. 1993. The Pawcatuck River Estuary and Little Narragansett Bay: An Interstate Management Plan. Rhode Island Coastal Resources Management Council & Connecticut Department of Environmental Protection.

Ernst, Larura M., Laura K. Miguel, Jeff Willis. April 12, 1999. Rhode Island's Salt Pond Region: A Special Area Management Plan (Machaug to Point Judith Ponds). Rhode Island Coastal Resources Management Council.

Faulkner, Dale. P. March 1 2014. Fortifying the beach: Town official pushes bag system to stabilize sand. The Westerly Sun. http://www.thewesterlysun.com/news/westerly/3603172-129/fortifying-the-beach-town-official-pushes-bag-system-to-stabilize.html

Federal Emergency Management Agency. 2012. Fact Sheet: Historic Structures and the Biggert-Waters Flood Insurance Reform Act of 2012.

Federal Emergency Management Agency. 2013a. Hazard Mitigation Assistance program information fact sheet. https://s3-us-gov-west-1.amazonaws.com/dam-production/uploads/20130726-1708-25045-7878/hma_grants_factsheet_4pages_032111.pdf

Federal Emergency Management Agency. 2013b. Flood Insurance Study: Washington County, Rhode Island (All Jurisdictions). Flood Insurance Study Number 44009CV001B. Volumes 1 & 2.

Federal Emergency Management Agency. 2016. Flood zone definitions. http://www.fema.gov/floodplain-management/flood-zones

Federal Emergency Management Agency. 2015. Definitions that have specific meaning to the National Flood Insurance Program. https://www.fema.gov/national-flood-insurance-program/definitions#R

Federal Emergency Management Agency. April 30, 2015. Policy Statistics of Rhode Island as of April 30, 2015. Town of Westerly. http://bsa.nfipstat.fema.gov/reports/1011.htm#RIT

Freedman, Janet. January 13, 2013. Rhode Island Coastal Resources geologist says sea level has risen roughly 10 inches since 1930. Interview with Channel 10 News Conference. http://www.politifact.com/rhode-island/statements/2013/feb/08/janet-freedman/rhode-island-coastal-resources-geologist-says-sea-/

Goonan, Peter. October 30 2012. Hurricane Sandy leaves beaches along Westerly, R.I., shore, including Misquamicut, devastated and nearly unrecognizable. Mass Live. http://www.masslive.com/news/index.ssf/2012/10/hurricane_sandy_leaves_beaches.html

Greene, Lewis R. 1938. The Hurricane Sept. 21, 1938: Westerly Rhode Island and Vicinity~

Hehre, Rachel, John Boothroyd. 2007. Westerly Shoreline Change maps 1939-2004. Coastal Resources Management Council.

Heinz Center for Science, Economics, and the Environment. 2000. The Hidden Costs of Coastal Hazards: Implications for Risk Assessment and Mitigation. Washington, D.C.: Island Press.

Historical and Pictorial. Westerly: The Utter Company, Printers.

Hanrahan, Ryan. 5 November 2012. Misquamicut unrecognizable after Sandy. NBC Connecticut. http://www.nbcconnecticut.com/news/local/Misquamicut-Unrecognizable-After-Sandy-177367451.htm

Hogan, Susan. June 11, 2014. Changes with RIPTA Ride program leaves some stranded. WPRI. http://wpri.com/2014/06/11/changes-with-ripta-ride-program-leaves-some-stranded/

Kafka, Alan L. February 2014. Yes, the Earth Does Quake in New England! Boston College, Department of Earth and Environmental Sciences. https://www2.bc.edu/~kafka/Why_Quakes/why_quakes.html

Lee, Brad and Don Jones. 2005. Septic Systems in Flooded Wet Soil Conditions. Purdue University Extension: Home & Environment series.

National Bridge Inventory Database. 2012. Rhode Island. http://nationalbridges.com/

National Oceanic and Atmospheric Administration. 2010. Thunderstorms, tornadoes, lightning: a preparedness guide. http://www.nws.noaa.gov/om/severeweather/resources/ttl6-10.pdf

National Oceanic and Atmospheric Administration, National Lightning Safety Institute. 2016. Lightning, Fatalities, Injuries, and Damage Reports in the United States. http://www.lightningsafety.com/nlsi_lls/fatalities_us.html

National Oceanic and Atmospheric Administration. May 2013. Hurricane Research Division. Frequently Asked Questions: How many direct hits by hurricanes have affected each state? http://www.aoml.noaa.gov/hrd/tcfaq/E19.html

National Oceanic and Atmospheric Administration. January 2013. NOAA Technical Report NESDIS 142-1: Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Climate of the Northeast U.S

National Oceanic and Atmospheric Administration, National Weather Service. Massachusetts Tornado Outbreak 2011. http://www.erh.noaa.gov/box/sigevents/jun01_2011_summary.php

National Oceanic and Atmospheric Administration, Enhanced F Scale for Tornado Damage. 2007. http://www.spc.noaa.gov/faq/tornado/ef-scale.htm l

National Weather Service. National Oceanic and Atmospheric Administration. Flooding in Rhode Island: The Great Flood of 2010. http://www.floodsafety.noaa.gov/states/ri-flood.shtml

Providence Journal. September 2, 2013. Lightning strikes Tower Hill Fire Station. http://www.providencejournal.com/breaking-news/content/20130903-thunderstorms-in-r.i.-prompt-power-outages-lightning-strike.ece

Rapoza, Kenneth. February 9, 2013. Massachusetts, Rhode Island Grounded from Blizzard 'Nemo'. Forbes News. http://www.forbes.com/sites/kenrapoza/2013/02/09/massachusetts-rhode-island-grounded-from-blizzard-nemo/

Rhode Island Department of Environmental Management a. Climate Change and Rhode Island: Fact Sheet #2. Rhode Island Climate Change Consortium. http://www.dem.ri.gov/climate/pdf/fs2.pdf

Rhode Island Department of Environmental Management b. Wildland Fire Weather Information for Rhode Island. http://www.dem.ri.gov/programs/bnatres/forest/pdf/firewthr.pdf

Rhode Island Department of Environmental Management. 2009. State of Rhode Island: Annual Report to the Governor on the Activities of the Dam Safety Program.

Rhode Island Department of Environmental Management. 2010. State of Rhode Island: Annual Report to the Governor on the Activities of the Dam Safety Program.

Rhode Island Department of Environmental Management. 2012. State of Rhode Island: Annual Report to the Governor on the Activities of the Dam Safety Program.

Rhode Island Department of Environmental Management. 2014. State of Rhode Island: Annual Report to the Governor on the Activities of the Dam Safety Program.

Rhode Island Department of Environmental Management. 2016. State of Rhode Island: Annual Report to the Governor on the Activities of the Dam Safety Program.

Rhode Island Department of Environmental Management. 2013. Rhode Island Department of Environmental Management Emergency Response Plan, Section 6-8 Animal Disaster/Animal Care Plan.

Rhode Island Department of Environmental Management, Office of Water Resources. September 30, 2014. Summary of Rhode Island Municipal Onsite Wastewater Programs.

Rhode Island Emergency Management Agency. 2015. Rhode Island Community Rating System. http://www.riema.ri.gov/resources/citizens/mitigation/insurance.php

Rhode Island Emergency Management Agency. May 22, 2006. Rhode Island National Flood Insurance Program Conference: RIEMA to host NFIP conference with FEMA. http://www.ri.gov/press/view/1990

Rhode Island Emergency Management Agency. 2007. Floodplain management in Rhode Island: a quick guide the National Flood Insurance Program.

Rhode Island Emergency Management Agency a. 2014. Rhode Island Hazard Mitigation Plan 2014 Update. 468 p.

Rhode Island Emergency Management Agency b. 2014. Rhode Island Floodplain Management. http://www.riema.ri.gov/prevention/floods/

Rhode Island Emergency Management Agency 2016. State of Rhode Island Hazard Identification and Risk Assessment. http://www.riema.ri.gov/planning/hazardmitigation/Documents/Final_Draft_Rhode%20Island%20Hazard%20Identification%20and%20Risk%20Assessment_29AUG16.pdf

Rhode Island Department of Health. 2014. Rhode Island Special Needs Emergency Registry. http://www.health.ri.gov/emergency/about/specialneedsregistry/

Rhode Island Department of Labor and Training. 2010. Rhode Island City and Town Resident Population from Census 2010. Census Statistics from U.S. Census Bureau.

http://www.dlt.ri.gov/lmi/census/pop/townpop.htm

Rhode Island Department of Labor and Training, Labor Market Information Unit. January 2014. State of the State: A Statistical Profile of Rhode Island's Cities and Towns.

Rhode Island Health, Office of Drinking Water Quality. 2003. Westerly Water Source Assessment. Prepared by University of Rhode Island Cooperative Extension.

Rhode Island Statewide Planning Program. April 2013. Rhode Island Population Projections 2010-2040, Technical Paper 162.

Save the Bay. March 2010. Dam Safety and Dam Removal in Rhode Island, Analysis and Recommendations.

Save the Bay. May 2013. Coastal Erosion and Adaptation on the Rhode Island Coastline: Summary report.

Schulteis, Ryan. July 29, 2014. NWS: EF2 tornado touched down in Revere. WHDH News. http://www.whdh.com/story/26129324/nws-tornado-touched-down-in-revere

Seaside Topics. 1938. Watch Hill in The Hurricane of September 21st, 1938.

Souza, Michael. August 22, 2014. Town nears Hewitt Dam bid decision. The Westerly Sun. http://www.thewesterlysun.com/news/northstonington/4216928-129/town-nears-hewitt-dam-bid-decision.html

Spotts. Pete. June 2, 2011. Massachusetts tornado: What are deadly tornadoes doing way up in New England? The Christian Science Monitor. http://www.csmonitor.com/USA/2011/0602/Massachusetts-tornado-What-are-deadly-tornadoes-doing-way-up-in-New-England

Strauss, Neal. 2008. The great northeast blizzard of 1978 remembered 30 years later in southern New England. National Oceanic and Atmospheric Administration. http://www.erh.noaa.gov/box/papers/blizzard78/mainblizzardof78.htm

Sullivan, Margo. August 30, 2012. Beware Coastal Erosion: State geologist discusses the danger at URI lecture. Jamestown Press. http://www.jamestownpress.com/news/2012-08-30/News/Beware_coastal_erosion.html

The Day. December 9, 2013. Westerly receives $700,000 in grants to continue its Sandy Storm cleanup. http://www.theday.com/article/20131209/NWS01/312099952/1044

Town of Westerly. 1998. Wastewater Facilities Plan. Submitted by BETA Engineering.

Town of Westerly. 2010. Town of Westerly Comprehensive Plan.

Town of Westerly. 2017. Draft Town of Westerly Comprehensive Plan.

Town of Westerly. 2012. Natural Hazard Risk Assessment & Mitigation Plan.

Town of Westerly. 2014. Fiscal year 2015-2016 Budget for General Fund, Water Fund, Sewer Fund.

Town of Westerly. 2013 b. Water Supply Management Plan: Executive Summary.

Town of Westerly Finance Department. 2013. Town of Westerly Comprehensive Annual Financial Report For the Fiscal Year Ended June 30, 2013.

Turner, Greg. June 11, 2011. Governor Deval Patrick requests federal disaster aid for tornadoes. The Boston Herald. http://bostonherald.com/news_opinion/local_coverage/2011/06/gov_deval_patrick_requests_federal_disaster_aid_tornadoes

United States Army Corps of Engineers. November 11, 2013. 30 Day Public Notice for Misquamicut Beach Erosion Control Project, Westerly Rhode Island. http://www.nae.usace.army.mil/Portals/74/docs/PublicServices/PublicNotice/MisquamicutBeachPN.pdf

United States Army Corps of Engineers. January 1979. Water Resources by the U.S. Army of Corps of Engineers in Rhode Island. Waltham, Massachusetts.

United States Census Bureau. 2010. Westerly town, Washington County, Rhode Island. 2010 Demographic Profile. American Fact Finder. http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF

United States Environmental Protection Agency. February 19, 2013. Newsroom: Westerly, R.I. Wastewater Treatment Plant Recognized for Excellence. http://yosemite.epa.gov/opa/admpress.nsf/6427a6b7538955c585257359003f0230/0745b561d556b15085257b1900569ef1!OpenDocument

United States Geological Survey. 1989. Rhode Island Floods and Droughts. National Water Summary. md.water.usgs.gov/publications/wsp-2375/ri

United States Geological Survey. January 12, 2015. M 3.3 – 0km NE of Wauregan, Connecticut. http://earthquake.usgs.gov/earthquakes/eventpage/usc000tesx#impact_dyfi

Shedlock, Kaye M. and Pakiser, Louis C. 1995. Predicting Earthquakes, excerpt from "Earthquakes". United States Geological Study http://pubs.usgs.gov/gip/earthq1/predict.html

University of Rhode Island Cooperative Extension Office. Learning from the past: Rhode Island Forest History. www.uri.edu/ce/wq/has/PDFs/woodPDF/HISTORY_3F.PDF

Vallee, David R. and Dion, Michael R. 1998. Hurricane Bob from Southern New England Tropical Storms and Hurricanes, A Ninety-Eight Year Summary (1909-1997). National Weather Service, Taunton, MA. http://www.erh.noaa.gov/box/hurricane/hurricaneBob.shtml

Vallee, David R. and DelliCarpini, Joseph. A River and Flash Flood Climatology of southern New England: results from 1994-2000. NOAA/National Weather Service. http://www.erh.noaa.gov/box/flood%20climatology.htm

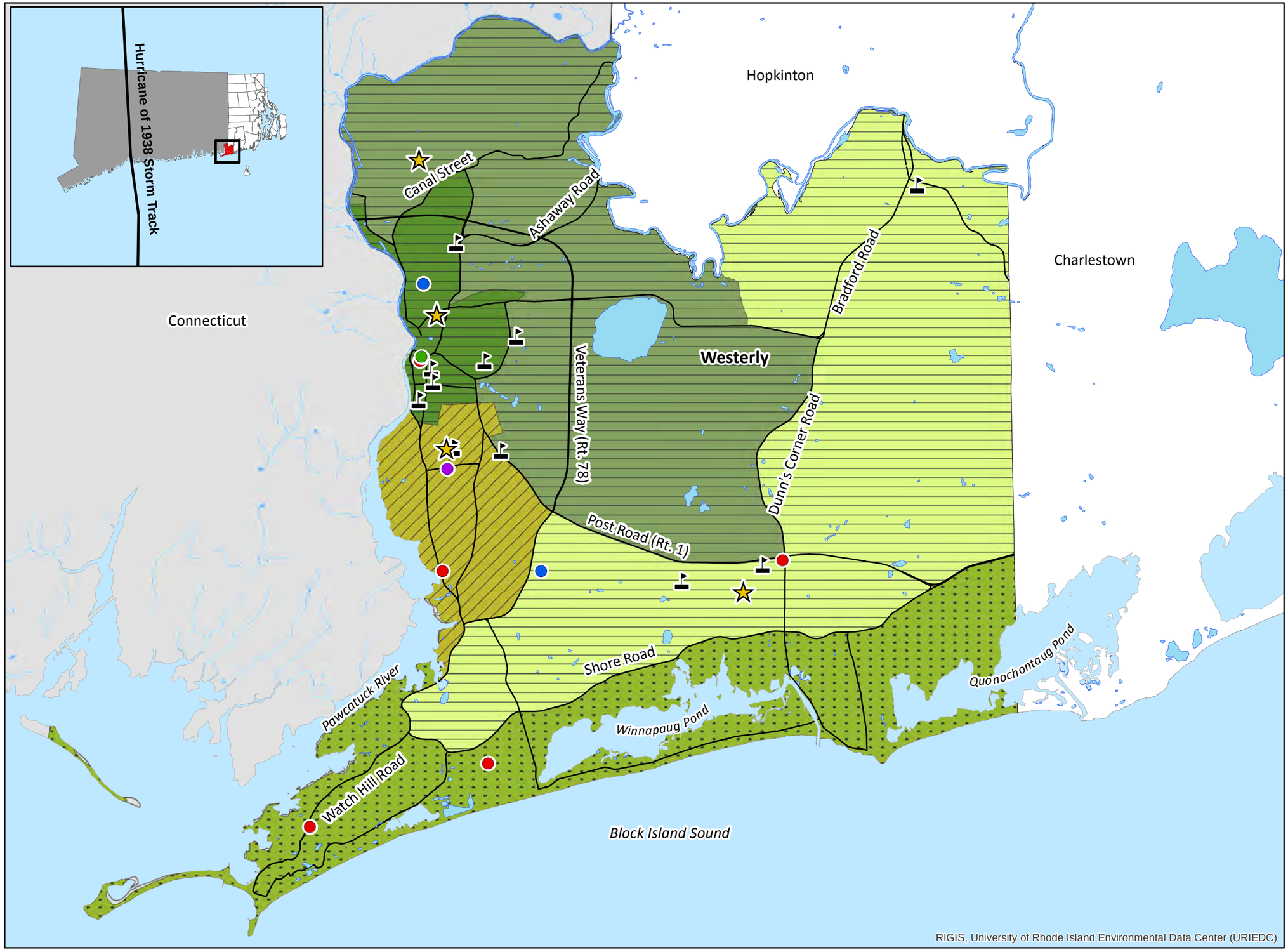
Weisman, Janine. January 25, 2012. The Storm Governor. Newport Daily News. http://www.newportri.com/features/personalities/the-storm-governor/article_86f22e9a-4775-11e1-9f1a-001871e3ce6c.html

Yee, Vivian. June 18, 2011. Insurance claims for tornadoes hit $140 million. Boston.com. http://www.boston.com/news/local/massachusetts/articles/2011/06/18/insurance_claims_for_tornadoes_hit_140m/

# Appendix A:  Assessing Risk – Maps

- Map 1 – Historic Hurricane Scenario (1938 Track)
- Map 2 – Historic Hurricane Scenario (1954 Track)
- Map 3 – FEMA Flood Hazard Designation Areas
- Map 4 – 100 Year Base Flood Elevation with Projected Sea Level Rise
- Map 5 – Hurricane Inundation Zones
- Map 6 – Evacuation Zones

\\vhb\proj\Wat-TS\72617.00\graphics\FIGURES\Westerly_Map_One.mxd




Emergency Shelter
Westerly Hospital
Town Hall
Police Department
Fire Department
School

**Peak wind gust (mph)**

110
111
113

**Number of displaced households**

20
23
43
44
82

0 6,000 12,000 Ft

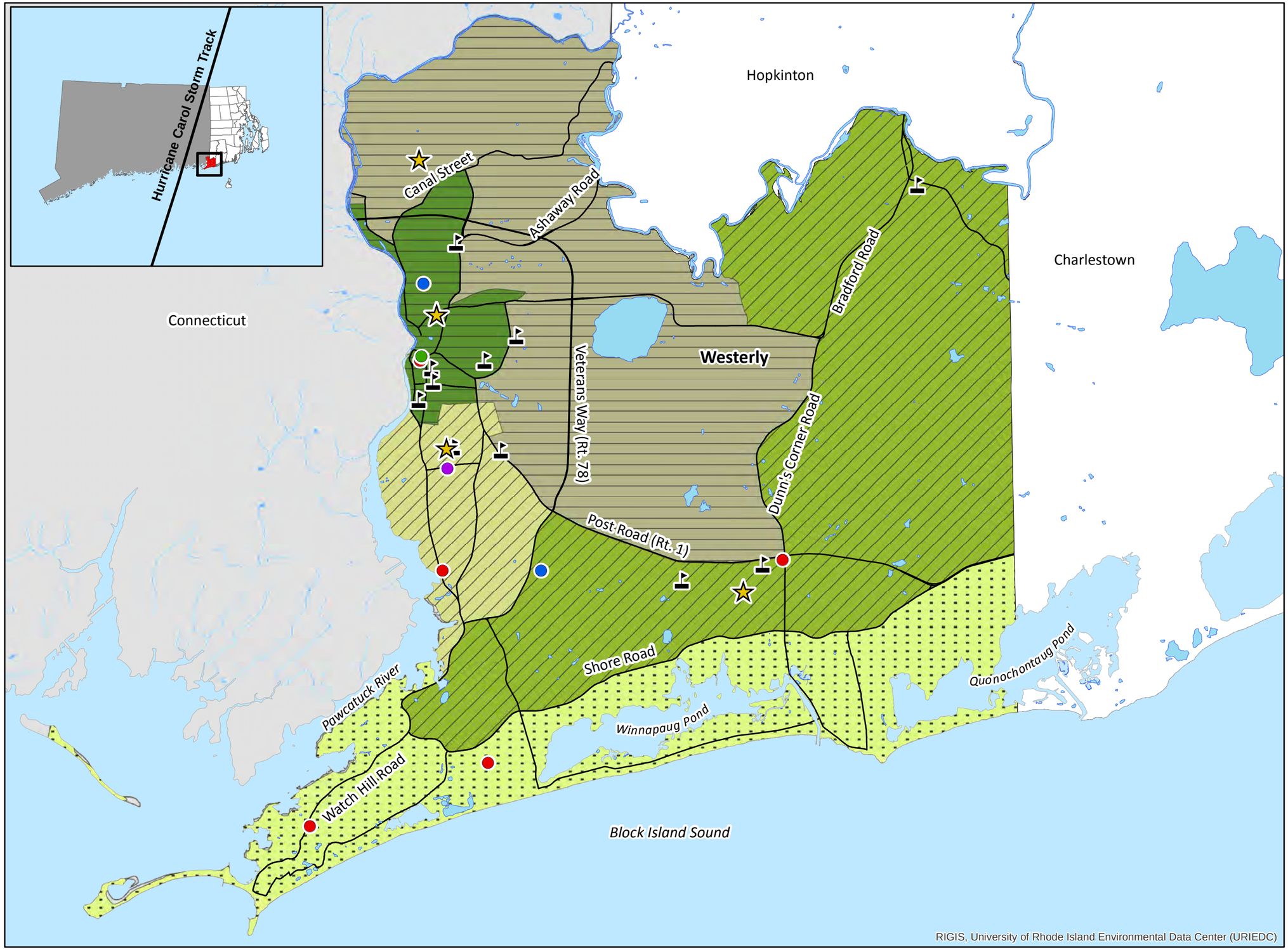
1 inch = 5,913 feet

Map 1

Historic Hurricane Scenario
Based on the Hurricane of 1938 Storm Track
Westerly, Rhode Island
November 2015

Source:FEMA HAZUS-MH v. 2.2
February 2015
Data Based on 2010 U.S. Census

\\vhb\proj\Wat-TS\72617.00\graphics\FIGURES\Westerly_Map_Two.mxd




Emergency Shelter
Westerly Hospital
Town Hall
Police Department
Fire Department
School

**Peak wind gust (mph)**

94
96
98

**Number of displaced households**

2
3
7
8
15

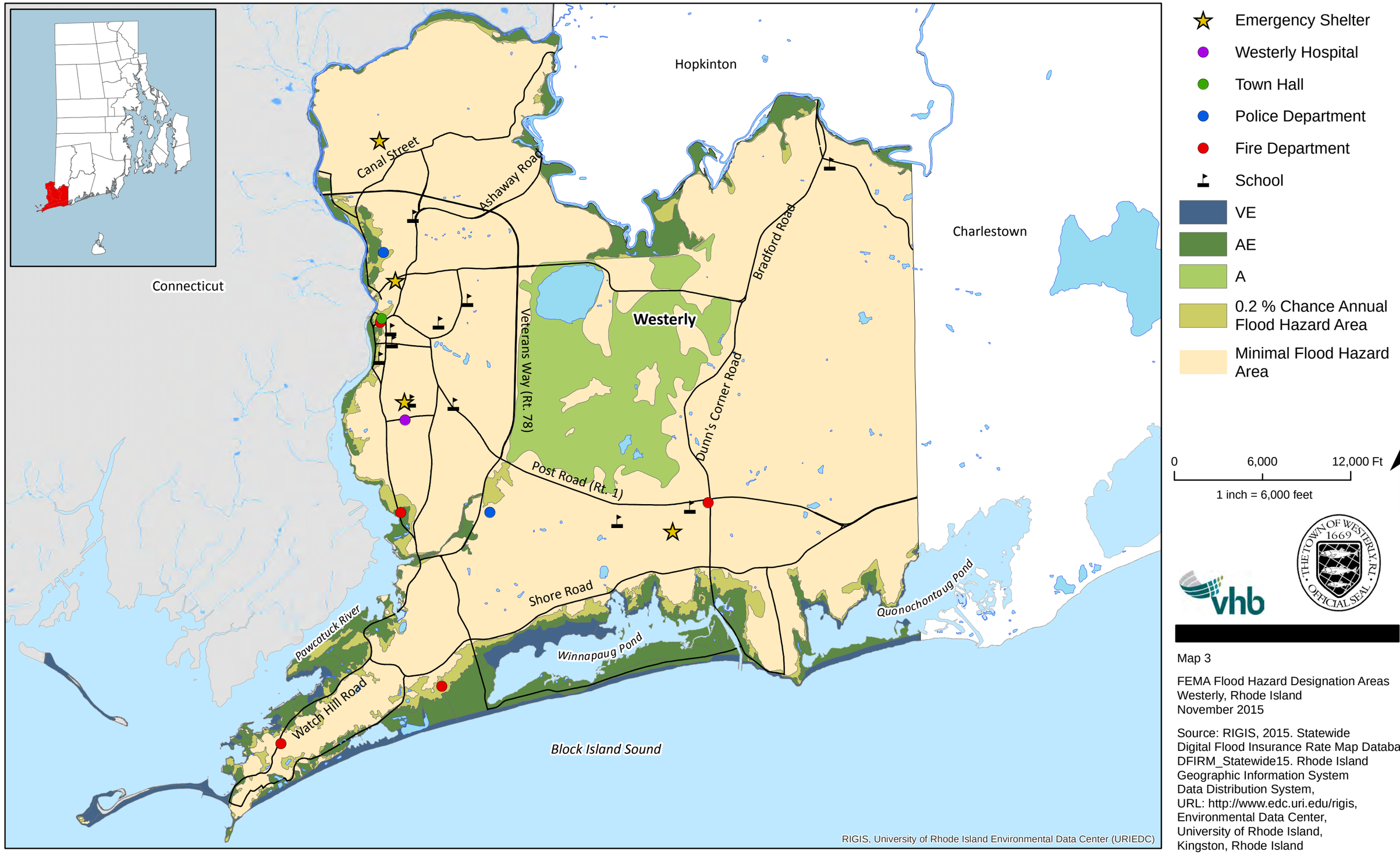
0 6,000 12,000 Ft

1 inch = 5,913 feet

Map 2

Historic Hurricane Scenario
Based on Hurricane Carol's (1954) Storm Track
Westerly, Rhode Island
November 2015

Source:FEMA HAZUS-MH v. 2.2
February 2015
Data Based on 2010 U.S. Census




- Emergency Shelter
- Westerly Hospital
- Town Hall
- Police Department
- Fire Department
- School
- VE
- AE
- A
- 0.2 % Chance Annual Flood Hazard Area
- Minimal Flood Hazard Area

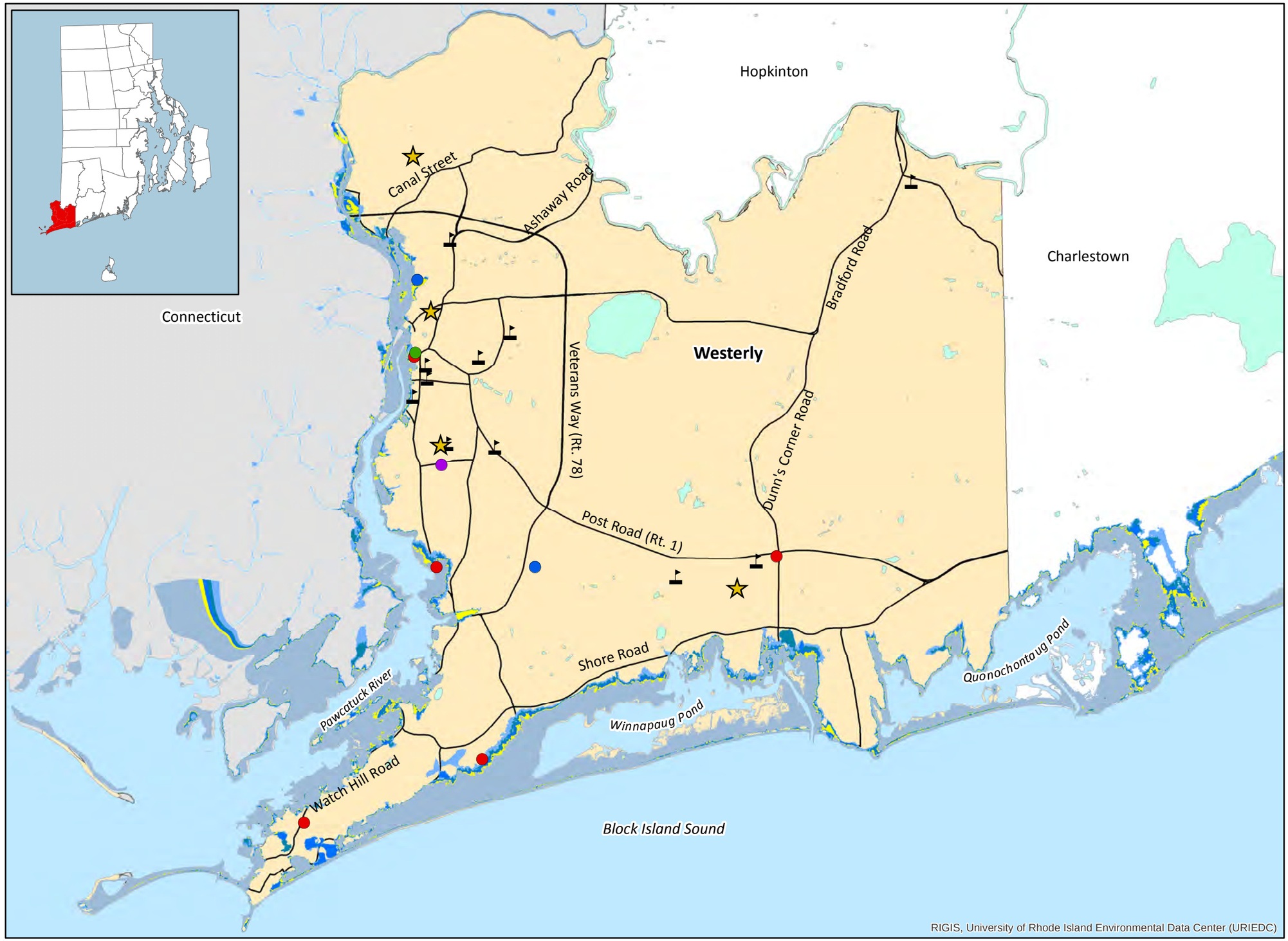
0 6,000 12,000 Ft

1 inch = 6,000 feet

Map 3

FEMA Flood Hazard Designation Areas
Westerly, Rhode Island
November 2015

Source: RIGIS, 2015. Statewide Digital Flood Insurance Rate Map Database; DFIRM_Statewide15. Rhode Island Geographic Information System Data Distribution System, URL: http://www.edc.uri.edu/rigis, Environmental Data Center, University of Rhode Island, Kingston, Rhode Island




- Emergency Shelter
- Westerly Hospital
- Town Hall
- Police Department
- Fire Department
- School
- 100 Year Base Flood Level
- Base Flood Level Plus 1' Sea Level Rise
- Base Flood Level Plus 2' Sea Level Rise
- Base Flood Level Plus 3' Sea Level Rise
- Base Flood Level Plus 5' Sea Level Rise
- Area not affected
- Water Body

0 6,000 12,000 Ft

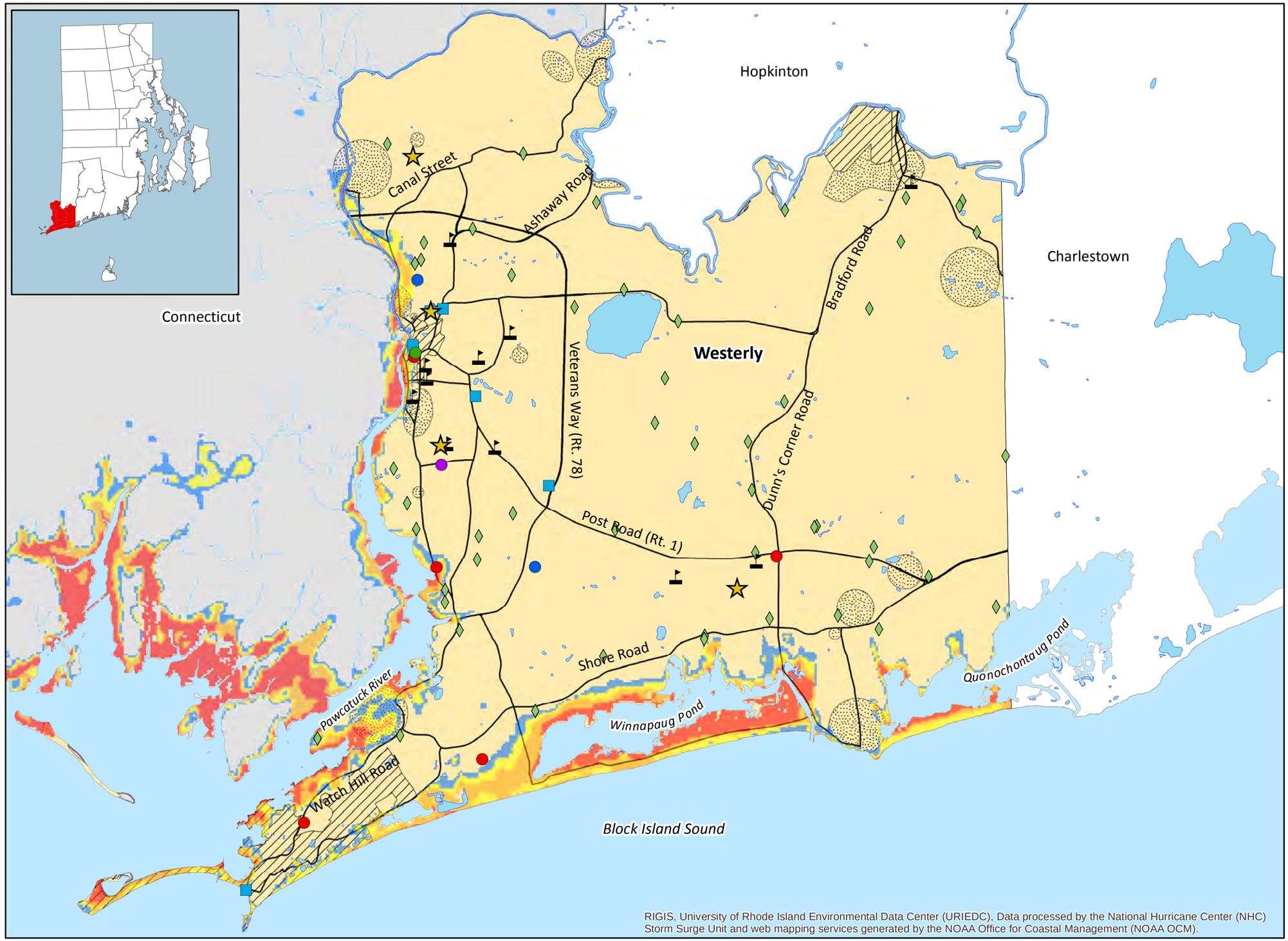
1 inch = 6,000 feet

Map 4

100-Year Base Flood Elevation
with Projected Sea Level Rise
Westerly, Rhode Island
November, 2015

Source: STORMTOOLS. 2015.
Developed by URI Coastal Resources Center
Rhode Island Sea Grant
http://www.beachsamp.org/
resources/stormtools/

\\vhb\proj\Wat-TS\72617.00\graphics\FIGURES\Westerly_Map_Five_Revised_with_Historic.mxd




RIGIS, University of Rhode Island Environmental Data Center (URIEDC), Data processed by the National Hurricane Center (NHC) Storm Surge Unit and web mapping services generated by the NOAA Office for Coastal Management (NOAA OCM).

- Emergency Shelter
- Westerly Hospital
- Town Hall
- Police Department
- Fire Department
- School
- Historic Cemetery
- Historic Site
- Historic District
- Historic Candidate Site
- Up to 3 feet above ground
- Greater than 3 feet above ground
- Greater than 6 feet above ground
- Greater than 9 feet above ground

0 6,000 12,000 Ft

1 inch = 6,000 feet

THE TOWN OF WESTERLY, RI • 1669 • OFFICIAL SEAL

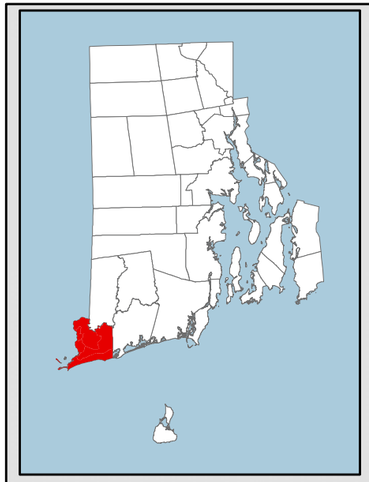
vhb

Map 5

Category 2 Hurricane Storm Surge Inundation
Westerly, Rhode Island
November, 2015

Source: National Hurricane Center (NHC)
NHC_SeamlessSLOSH_Category2
Storm Surge Unit and web mapping services
generated by the NOAA Office
for Coastal Management.
URL: http://tiles.arcgis.com/tiles/
C8EMgrsFcRFL6LrL/arcgis/rest/
services/NHC_SeamlessSLOSH_
Category2/MapServer

\\vhb\proj\Wat-TS\72617.00\graphics\FIGURES\Westerly_Map_Six.mxd



Hopkinton

Charlestown

Connecticut

**Westerly**

Ashaway Road

Veterans Way (Rt. 78)

Bradford Road

Rose Hill Road

Dunn's Corner Road

Post Road (Rt. 1)

Shore Road

Pawcatuck River

Watch Hill Road

Winnapaug Pond

Quonochontaug Pond

Block Island Sound

- Emergency Shelter
- Westerly Hospital
- Town Hall
- Police Department
- Fire Department
- School
- Zone A: Evacuate prior to a category 1 or 2 hurricane
- Zone B: Evacuate prior to a category 3 or 4 hurricane
- Area not affected

0 6,000 12,000 Ft

1 inch = 6,000 feet

Map 6

Westerly Hurricane Evacuation Zones
Westerly, Rhode Island
November, 2015

Source:
RIGIS, 2014. Hurricane Evacuation Areas; evacAreas09.
Rhode Island Geographic Information System Data Distribution System,
URL: http://www.edc.uri.edu/rigis,
Environmental Data Center, University of Rhode Island, Kingston, RI.
Based on data set developed by
US Army Corps of Engineers, 2009.

# Appendix B:  Building Support: Planning Process Additional Documentation

# Invites, Public Meeting Announcements, Web/Ad Postings

**HAZARD MITIGATION PLAN WORKSHOP MEETING**
**THURSDAY, MAY 19, 2016 – 10:00 A.M.**
**WESTERLY POLICE STATION**

*[Minutes for the May 19, 2016 Hazard Mitigation Plan Workshop meeting were recorded using a digital audio recorder. Not all voices could be identified]*

The meeting was brought to order by Peter Cusolito, VHB, at [10:00 a.m.]

**STAFF PRESENT:** Derrik Kennedy, Town Manager
Edward St. Clair, Chief of Police
Amy Grzybowski, Development Services Director
Peter Chiaradio, Highway Division Superintendent
Paul Corina, Utilities Division Superintendent
Marilyn Shellman, Town Planner
Tammy Loughlin, Animal Shelter Manager

**OTHERS PRESENT:** Michael Frink, Chief of the Dunn's Corners Fire Department
Lisa Konicki, Ocean Community Chamber of Commerce Executive Director
Bethany Gencarelli, Chief of the Westerly Ambulance Corps., Inc.

**CONSULTANTS PRESENT:** Peter Cusolito, VHB
David Westcott, Mason & Associates, Inc.

Mr. Cusolito overviewed the goals and actions of the Hazard Mitigation Plan and stated hazards for the community had not changed and the categorization of mitigation measures had changed since the last plan was drafted. Goals remained relatively unchanged from the previous year. He noted the state in its review was interested in seeing items which were completed. Actions were ranked as either completed, continued, modified or added.

Dir. Grzybowski stated anything relating to hazard mitigation the community felt should be included on the matrix or would like to see grant funding for in the future needed to be included.

Mr. Cusolito clarified actions did not need to be listed in order of priority and would be organized as high, medium or low priority.

Dir. Grzybowski stated priority two was completed.

Supt. Corina, regarding priority three, stated the substation had been removed and he was not aware of a new station being planned for construction. He stated for Ms. Shellman monitoring and guard rails for wells had been installed and the berm by the Pawcatuck River relating to water distribution was pending. He stated drainage improvements for Pierce and Ann streets had not been done.

Ms. Shellman stated there were some new structures in the North End built to meet new flood standards and noted it was an older neighborhood.

Mr. Cusolito questioned if the item should be removed from the plan as a date to begin implementation within the plan's five-year timeframe was required to be included.

Dir. Grzybowski recommended the item be maintained in the plan as the Army Corps. of Engineers was continuing work on the Pawcatuck River Flood Study with the Town and would be speaking with business owners.

Mr. Westcott stated that, if discussing pursuing grant funding for property owners or the Town establishing a funding program to assist property owners with residential structure flood-proofing, a program could be instituted

Mr. Cusolito questioned what work had been done regarding critical roads' flooding issues.

Supt. Corina stated the first phase of a stormwater pump system was installed to serve the developed area around Benson Avenue, Montauk Avenue, First Street and Second Street.

Ms. Shellman stated drainage upgrades for Bay Street were ongoing and Canal Street and White Rock Road recently received stormwater infrastructure upgrades through increasing pipe capacity.

Mr. Cusolito noted stormwater improvements were somewhat continuous actions.

Ms. Shellman stated the Town was seeking funding for a comprehensive drainage study of the Pierce Street area due to buried streams beginning to resurface.

Supt. Chiaradio recommended listing Pierce Street from Pleasant Street to Pond Street and Brookside Drive.

Attendants noted Beach Street was incorrectly labeled Breach Street.

Dir. Grzybowski confirmed state roads could be included on the list.

[Unidentifed 1] recommended listing Main Street, School Street and Cross Street.

Supt. Chiaradio noted Route 1A floods nearby the Westerly Fire Department's Station 2 and the Westerly Yacht Club.

Mr. Cusolito noted the list was within the existing plan and would be modified to update categories. He stated the table was meant to represent the plan narrative.

[Unidentified 2] recommended listing Hiscox Road.

Ms. Shellman noted the White Rock dam was removed. She stated the Wood-Pawcatuck Flood Resiliency study included all bridges, culverts and dams and was available in draft form. She noted the study would be presented to the town councils of municipalities within the watershed in June 2016 or after and expected to be completed in October 2016.

Mr. Cusolito questioned what actions the Town would take to address issues found in the study.

Ms. Shellman noted the Town was cautioned to identify what is local and what belongs to the state. She noted Bradford dam would be redesigned in the near future to allow kayak and fish passage.

Dir. Grzybowski noted that, regarding priority nine, $1.5 million in funding had been secured to update the culvert. She confirmed the Town had secured $200,000 in brownfields assessment funding.

Ms. Shellman stated the Town recently secured a grant with VHB to study the TMDL issue regarding Babcock Cove and develop an IP plan.

Supt. Chiaradio noted Mastuxet Brook was an issue regarding Airport Road.

Dir. Grzybowski stated for Mr. Cusolito the Town had not currently done any dredging of the Weekapaug Breachway and was seeking National Resources Conservation Service (NCRS) funding to do so.

Mr. Cusolito noted, regarding priority fifteen, a plan was currently in process and would be transferred from mitigation actions to capabilities.

Ms. Shellman stated a program for funding private septic systems was brought before the Town Council two years ago and was tabled. She noted it impacted the ability of the Town to apply for funding from the state regarding the cesspool phase-out. She clarified there were separate programs for the sewer plant and private septic systems.

Mr. Westcott noted properties in the state could not be sold if a cesspool was present and stated denitrification systems were an issue as they were buoyant.

Ms. Shellman noted the issue was brought up after seeking an updated reference for the Comprehensive Plan update and learning an update for the on-site plan had not been done.

Dir. Grzybowski confirmed installation of denitrification systems was required by the Rhode Island Department of Environmental Management (RIDEM).

Mr. Westcott confirmed for Mr. Cusolito there was no code requiring how the systems were to be installed.

Mr. Cusolito noted additional discussion would be needed.

Ms. Shellman stated Argyle Drive, in regard to the situation of stormwater retention ponds, should remain on the list as the pond was under capacity and required a worker to monitor the pump in stormwater events. Funding from the Federal Emergency Management Agency (FEMA) had been sought. She stated Westerly Middle School and Springbrook Elementary School were additional sites experiencing issues.

Supt. Chiaradio recommended Dunn's Corners Elementary School be added.

Ms. Shellman recommended retention ponds be redesigned for greater capacity.

Mr. Cusolito confirmed calculations could be done to determine how much additional capacity should be planned for.

Ms. Shellman stated the Springbrook Elementary School site was a notable total maximum daily load (TMDL) area due to bacteria being present behind the school. She clarified the source of the bacteria had not yet been determined.

Mr. Cusolito confirmed a portion of priority eighteen would be transferred to the capabilities section and stated priority eighteen would be focused on individual sewage disposal system (ISDS) management limiting development and similar items.

Supt. Chiaradio stated the State of Connecticut would be conducting work on the Boombridge Bridge and both Connecticut and Rhode Island were expected to repair the bridge. He noted the bridge had been closed for nine years.

Mgr. Kennedy noted Supt. Chiaradio received confirmation from the Town of North Stonington one week earlier the project would be moving forward.

Supt. Chiaradio stated two generators were put in in the town and one was raised in a flood zone on Canal Street.

Dir. Grzybowski stated Fisherman's Avenue would be flood-retrofitted.

Supt. Chiaradio stated the two generators were sited on Apache Drive and at Cimalore Field. He clarified retrofitting for Fisherman's Avenue did not involve sewer.

Mr. Cusolito stated that the result of an analysis indicated wildfire was not a threat to invest resources towards addressing.

Chief Frink stated for Ms. Shellman the Dunn's Corners Fire Department had not conducted controlled burns recently.

Mr. Westcott noted the community's fire suppression program was effective against wildfire threats.

Mr. Cusolito recommended priority twenty-one be kept for educational and outreach purposes.

Ms. Shellman questioned if weather events such as drought and extreme cold should be included.

Mr. Cusolito clarified recommending cooling and heating stations for such conditions would be components of a response plan and the hazard mitigation plan should be focused on preventing drought and extreme conditions. He stated hazard mitigation would be addressed in several areas of the

Comprehensive Plan update and priority twenty-two would be included in capabilities.

Dir. Grzybowski confirmed shelter facilities could be removed from completed projects.

Supt. Corina confirmed the first phase of the Misquamicut drainage process was completed.

Mr. Cusolito confirmed beginning the second phase, collection system, would be included under actions. He stated the base radio system upgrade would be transferred from completed project to capabilities.

Mr. Westcott noted the Comprehensive Plan would include a section on communications.

Mr. Cusolito stated the Police Department harbor patrol boat would be transferred from completed project to capabilities.

Chief St. Clair confirmed the Police Department had two boats.

Ms. Shellman confirmed, regarding stormwater drainage and retention, the Town had acquired a new jet vac truck.

Attendants confirmed priorities eighteen, one and ten were completed.

Mr. Cusolito clarified any priority mentioning maintenance would be listed as a capability and any mentioning of sustaining could be a mitigation action.

Dir. Grzybowski recommended the plan address acquisition and elevation of flood-prone structures. She stated funding was available to do fifteen elevations and five were complete.

Mgr. Kennedy stated drainage on Main Street was an unlisted issue.

Mr. Cusolito confirmed for Mgr. Kennedy Westerly's location at the mouth of the Pawcatuck River provided greater justification for dam removal. He also confirmed intentional flood zones existed in designated areas.

Ms. Shellman noted the Pawcatuck River study report recommended leaving debris in remote areas untouched to spread out the river flow.

Mr. Cusolito confirmed information from the report would be incorporated into the Hazard Mitigation Plan.

Dir. Grzybowski recommended citing the Potter Hill mill as an issue and Ms. Shellman stated her agreement.

Supt. Chiaradio questioned if road conditions caused by snow, such as frost heaves, were included. Upon confirmation from Mr. Cusolito, Supt. Chiaradio recommended Tom Harvey Road be added to the list of roads.

Mr. Cusolito stated the next steps would be updating the plan and creating a new format. He suggested the Town Council be given an opportunity to review the plan after updating. He stated for Ms. Shellman there was no objection to posting the draft plan on the Town's website and confirmed the plan would be provided to neighboring communities.

Ms. Shellman stated invitations to attend the meeting were sent to all neighboring communities.

The meeting adjourned at [11:03 a.m.]

# Input needed on Westerly plan

View Article

*Westerly Sun, The (RI) - May 28, 2015*
***Author/Byline:*** *DALE P. FAULKNER*
***Section:*** *A: Main*
***Page:*** *A03*

Public session set for Friday on town goals and rules.

Sun Staff Writer

WESTERLY - The Comprehensive Plan Citizens Advisory Committee is encouraging residents, property owners, and business owners to attend and participate in a public input session and workshop scheduled for Friday from 8:30 a.m. to 3 p.m. at Westerly Public Library. The meeting is part of the committee's work on a five-year update of the plan, which sets out the town's conservation and development goals and priorities.

The committee, which has been meeting since it was appointed by the Town Council in February, must submit its final proposed update of the plan to the state Division of Planning by Oct. 1. The update will help steer the town's course for the next 20 years.

The session on Friday will focus on economic development, services and facilities; natural resources and housing; and zoning, energy, and hazard mitigation.

Each topic will be presented briefly by a member of the committee. Representatives of Mason & Associates, a consultant hired to assist with the plan update, will participate in some of the presentations. Each presentation will be followed by public response, discussion, and question and answer sessions.

Two 30-minute long breakout sessions, one in the morning and one in the afternoon, will be devoted to informal discussions in a drop-by round-table format. Members of the public may attend the entire meeting or attend only those topics which are of specific interest. Lunch will be provided from noon to 1 p.m.

The meeting agenda, including the time of each session, is posted online on The Sun's website and on the Secretary of State's website under Westerly Comprehensive Plan Citizens Advisory Committee at http://sos.ri.gov/ openmeetings/?page=meeting& id=180149.

Town Planner Marilyn Shellman, who is overseeing the committee's work, said public participation is critical.

"We welcome input from everyone. It's the taxpayers' project, they should be at the table," Shellman said.

Two other public input workshop sessions will be conducted in the future. One of the sessions will have a neighborhood focus looking at specific sections of the town including the North End, Misquamicut, Watch Hill, and Bradford. A focus topic for the second additional meeting has not yet been selected. Both of the additional meetings will be conducted in the evening.

The updated plan will include new sections on hazard mitigation and alternative energy. The committee's work is also likely to result in recommendations for changes to some of the town's zoning regulations, according to Shellman.

Zoning changes to beef up protections of the town's public drinking water supply are likely, as are regulations to address the many inactive and active quarry sites in the town, Shellman said.

The update will also include a report on progress made toward completing the 52 action items that were set in the current edition of the plan, which was adopted in 2010. State law requires all municipalities to have a comprehensive plan to guide decision-making by setting development and preservation priorities. Full-scale updates of the plans are required every 10 years.

The law also requires an informational report on the status of the Comprehensive Plan not more than five years from the date of municipal approval of a plan. It is this report the new committee is working on.

dfaulkner@thewesterlysun. com

- ***Record:*** *052815A03art2.xml*
- 

TOWN OF WESTERLY

**COMPREHENSIVE PLAN CITIZENS' ADVISORY COMMITTEE**

Hazard Mitigation Meeting – June 18, 2015 – 6:00 p.m.

Squad Room – Westerly Police Station

**Members Present:** Barbara Cardiff

**Members Absent:** Faith Besette-Zito, Stuart Blackburn, Julie Cardinal, James J. Federico III, Gina Fuller, Joe MacAndrew, Gail Mallard, Nancy Richmond, and Zallee T. Rosso

**Staff Present:** Marilyn Shellman, Project Manager and Town Planner; Michael Castagna, Public Works Department; Paul Corina, Utilities Superintendent; Paul Duffy, Recreation Director; Cindy Kirchhoff, Finance Department; Paul LeBlanc, Town Engineer; Tammy Loughlin, Animal Shelter Manager; David Murphy, Building Official; Michael Serra, Minimum Housing Director; Edward St. Clair, Chief of Police; Larry Steadman, Harbor Master; and David Thompson, Assessor

**Liaisons Present:** Catherine DeNoia, Planning Board

**Consultants Present:** Nancy Letendre and David Westcott, Mason & Associates; and Peter Cusolito, VHB

**A. CALL TO ORDER AND INTRODUCTIONS**

The meeting was brought to order by Peter Cusolito, VHB, at 5:58 p.m.

Mr. Cusolito stated that the process of drafting a Hazard Mitigation plan requires characterizing the community and identifying, prioritizing, and reviewing the effects of potential hazards. Goals, objective, and actions will be included to reduce vulnerabilities, consistent with the concurrent Comprehensive Plan update that it will be encompassed into.

**B. PRESENTATION**

Mr. Cusolito explained the process of the plan's adoption, including FEMA approval. Hazards identified include:

- Climate change
- Coastal erosion
- Coastal flooding
- Dam breaches
- Drought
- Earthquakes
- Extreme cold
- Extreme heat
- Flash flooding
- High winds
- Hurricanes
- Ice
- Riverine flooding
- Seal level rise
- Storm surge
- Snow
- Tornadoes
- Urban flooding
- Wildfires

Susan Hurst, resident, questioned the potential impact of tremors. Mr. Cusolito stated that future earthquakes in the long-term could be worse than those on the west coast due to differences in the tectonic plates and that the only mitigation practices that can be done are through building

structures.

Barbara Cardiff, Committee member, questioned the potential impact of subsidence. Mr. Cusolito stated that the area was not at great enough risk.

Mr. Cusolito stated that mitigation is developing solutions to problems in a long timeframe and that intermediate steps can be taken. The solutions include lasting infrastructure, planning and management, regulatory change, and education and training, and are achieved through goals, objectives, and actions.

Mr. Cusolito noted that the Town has maintained its current mitigation actions and that businesses often help communities recover more quickly.

The goals presented include:

1.) Maintaining open space in vulnerable areas of the Town.

2.) Minimize economic disruption resulting from natural hazards

3.) Reduce the vulnerability of public and private infrastructure to natural hazards

4.) Enhance the capability of the natural environment to protect the Town from coastal hazards

Mr. Cusolito noted that all goals have one objective and several actions.

**1. Goal 1**

The objective of the first goal is to 'minimize the exposure of people, property, and infrastructure to the effects of natural hazards.' The actions include: (1.1) enforcing current laws, (1.2) enacting new zoning codes, (1.3) beach protection through building and zoning codes, and (1.4) acquiring property for open space conversion. Mr. Cusolito noted the sensitivity of government's acquiring land.

David Westcott, Mason & Associates, stated that natural hazards may be a subject for finding in issuing variances and zoning changes.

Paul Duffy, Recreation Director, questioned if the support for Misquamicut as an economic engine was in conflict with natural hazards. Mr. Cusolito stated that the effects of natural hazards can be reduced through identifying vulnerabilities and mitigation practices, such as building structures properly and protecting utilities.

Larry Cioppa, resident, questioned if an Environmental Impact Statement (EIS) should be required for any change. Mr. Cusolito stated that EISs are not always worth their cost

Nancy Letendre, Mason & Associates, questioned if certain building codes can be used to deter beach area construction. Mr. Cusolito confirmed that this could be done and reiterated the importance of building correctly.

Mr. Westcott noted the issue of identifying hurricane damage as the result of wind or rain, including after Hurricane Sandy (2012). Mr. Cusolito cited examples of actions taken by insurance companies following the landfall of Hurricane Katrina (2005).

Mr. Murphy, addressing action 1.4, questioned if jurisdiction was primarily at the Federal or State level. Mr. Cusolito stated that it is the Municipal level.

**2. Goal 2**

The objective of the second goal is to 'support the establishment of a sustainable local economy.' The actions include: (2.1) building seawalls on the Pawcatuck River and Bay Street to protect residential and retail property, (2.2) retrofit buildings to mitigate flood damage, and (2.3) create structural barriers.

Mr. Cusolito stated that water should be provided a route to travel and that mitigation practices should not protect from one hazard while becoming more exposed to another.

Ms. Shellman stated that action 2.1 is now off the table as the river is entering the process of being designated wild and scenic.

Mr. Murphy stated that the Building Department requires structural elevation to be done on property damaged by floods and allows elevations to be above the minimum requirement.

Larry Steadman, Harbor Master, questioned if a maintenance plan existed for the seawall running along High, Main, and West Beach streets. Ms. Shellman stated her belief that the structure will be evaluated. David Prescott, Save the Bay, recommended that 'maintain' be replaced with 'assess,' as Mr. Cusolito noted FEMA's avoidance of 'maintain.' Mr. Cusolito also cited that a significant portion of flooding during the 2010 Flood resulted from culverts being blocked by downed trees.

Mr. Cioppa recommended that the plan should address beaver dams. Mr. Cusolito stated that beavers construct dams where they hear running water and so have to have their hearing deceived. Mr. Cusolito also stated for Ms. Letendre that he did not know of other wildlife effecting hazard mitigation and will look into aquatic life.

Mr. Prescott stated that the Bay Street seawall, mentioned in action 2.1, should still be addressed and noted the importance of the dune system. An elevated seawall would not prevent flooding if the nearby dune was washed away as it was during Hurricane Sandy.

Ms. Letendre questioned if droughts were identified as a hazard. Mr. Cusolito stated that it is not a hazard the region normally applies resources to.

**3. Goal 3**

The objective of the third goal is to 'enhance resiliency of Town infrastructure by developing programs and projects that improve maintenance, protection, and redundancy.' Mr. Cusolito noted that maintenance programs for culvert systems and trees should exist.

Ms. Shellman noted a previous discussion on inventorying right-of-ways and removing hazardous trees. It was pointed out that a majority of the costs for tree maintenance is carried by National Grid.

Mr. Cusolito stated that water and other utility services should be able to be routed.

The actions include: (3.1) inventorying the existing storm water drainage system and prioritize undersized pipes and culverts and aging infrastructure, (3.2) increasing the use of roadside swales for storm water, (3.3) size new infrastructure for 100-year storm events, (3.4) incrementally relocate utility buildings out of the flood zone, (3.5) repair existing bridges, and (3.6) create a permanent secondary access connection on Route 78.

Mr. Cusolito stated that greater reliance on roadside swales is a cheaper alternative to transporting storm water and noted that evacuation routes are planned with the expectation that evacuating is done before a storm. Ms. Shellman confirmed that under-utilized buildings exist to

relocate utilities to and that action 3.6 can be deleted because the Town Council recently approved funding for the construction of a secondary access.

Ms. Cardiff noted the level of detail for evacuation plans in southern California and Mr. Cusolito stated that the Occupational Safety and Health Administration (OSHA) requires plans for facilities nationwide.

**4. Goal 4**

The objective of the fourth goal is to 'repair and maintain the natural environment assets that protect the coast.' The actions include: (4.1) removing exotic and invasive plants and planting native species, (4.2) maintaining wetlands, (4.3) replenishing dunes and removing impervious surfaces, (4.4) providing a resilient, temporary barricade to block over-wash at public access points, and (4.5) adopting an ISDS management plan to reduce post-hurricane pollution.

Mr. Prescott recommended that removing impervious surfaces should be a separate action item. Mr. Westcott additionally recommended that parking requirements could be reduced and Ms. Letendre recommended allowing more pervious surfaces.

Mr. Prescott noted his concerns about action 4.4, as barriers change the flow of water and temporary infrastructure often becomes permanent.

Mr. Steadman stated that the temporary barrier was envisioned to act as a portable gate that would be installed only during times of a hazard such as a hurricane. Mr. Cusolito stated that action 4.4 will be clarified.

Ms. Shellman stated that the Rhode Island Coastal Resources Management Council (CRMC) recently approved South Kingstown and Westerly as a separate section in a plan, which Mr. Westcott added that it allows the two communities to experiment with alternative practices to limit erosion.

Ms. Letendre recommended that removing impervious surfaces should be relocated to goal three.

Catherin DeNoia, Planning Board, noted that the Misquamicut State Beach was a major portion of the post-Hurricane Sandy cleanup. Mr. Cusolito stated that FEMA would likely disapprove the piling of debris that occurred at the State Beach and that the Rhode Island Department of Environmental Management (DEM) and Department of Transportation (DOT) be part of future solutions.

Ms. Cardiff questioned where the Resilient Rhode Island Act of 2014 would fit into the Plan. Mr. Cusolito stated that all actions will be included in table and paragraph form and that specific regulations will be referenced as required.

Mr. Westcott stated that many elevated homes were unaffected by Hurricane Sandy except for damage to their septic systems. Mr. Prescott stated that the Rhode Island House of Representatives had just earlier passed an act to phase out all cesspools statewide. Ms. Shellman recommended the possibility of hiring someone to monitor residential septic systems.

**5. Mitigation Action Table and Questions**

Ms. Hurst questioned what the next step of the process would be. Mr. Cusolito stated that comments and recommendations from the meeting will be gone over by the Hazard Mitigation Committee and that a draft Plan will be posted online and in hard copy at the Westerly Public Library for additional feedback.

Mr. Steadman questioned if FEMA or another federal agency could withhold funding for a project not specifically identified in the Plan. Mr. Cusolito stated that the chance of funding is greater when something is identified.

Ms. Letendre noted the potential impact of ice damage to personal property.

Mr. Westcott stated that power failures could have a serious impact, especially on communities with aging populations. Mr. Cusolito responded that a resilient power system is preferable to identifying individual parts of the infrastructure.

Ms. Shellman noted the high cost of ice and snow damage from the previous winter. Mr. Cusolito clarified for Ms. Cardiff that snow melt is considered water in the Plan.

Mr. Steadman noted the issue of capsizing in the Harbor Management Plan. Mr. Westcott recommended that capsized boats be considered as debris management for inclusion in the Plan.

Mr. Prescott noted moveable structures, such as Sam's Snack Bar, as examples that fit well into the objective of the first goal. Ms. Letendre added that such structures are also good economically.

Paul Corina, Utilities Superintendent, questioned the plan for maintaining open space. Mr. Cusolito stated that the Town is engaged in expanding open space and has enacted an ordinance to maintain open spaces already. Ms. Shellman cited that about 29-percent of the Town's land area is open space.

Mr. Prescott noted that Simultaneous Localization and Mapping (SLAM) models are being used to identify the migration of salt marshes.

Tammy Loughlin, Animal Shelter Manager, questioned if the Plan would include a process for marsh cleanup. Ms. Shellman stated that the project for the Chapman Pond area has been designated a high priority for 2016.

Ms. DeNoia recommended the possibility of creating new wetlands.

Mr. Prescott stated that Save the Bay and the State are collaborating on the buildup of marsh elevation around Ninigret Pond.

Mr. Westcott recommended the possibility of dredging the Pawcatuck River to enhance its capacity.

Mr. Cusolito stated that the next meeting for the Hazard Mitigation Plan will take place about a month after the draft Plan has been made available.

**C. ADJOURNMENT**

The meeting adjourned at 7:57 p.m.

Minutes for the June 18, 2015 unnamed meeting submitted by:

Benjamin Delaney

# Appendix C: Technical and Financial Assistance for Mitigation

## State Resources

Narragansett Bay
National Estuarine Research Reserve
55 South Reserve Drive
Prudence Island, RI 02872
401-683-6780
http://nbnerr.org

Rhode Island Coastal Resource Management Council
4808 Tower Hill Road
Wakefield, RI 02879
(401) 783-3370
www.crmc.ri.gov

Rhode Island Emergency Management Agency
645 New London Ave.
Cranston, RI 02920
(401) 946-9996
www.riema.ri.gov

Rhode Island Department of Environmental Management
235 Promenade Street
Providence, RI 02908
(401) 222-2776
www.dem.ri.gov

University of Rhode Island Coastal Resources Center
2200 South Ferry Road
Narragansett, RI 02882
(401) 874-6224
www.crc.ri.edu

## Federal Resources

Federal Emergency Management Agency
Region I Office
99 High Street, 6th Floor
Boston, MA 02109
(617) 956-7506
www.fema.gov

U.S. Department of the Interior
National Park Service
U.S. Custom House
200 Chestnut Street, 5th Floor
Philadelphia, PA 19106
(215) 597-7013
www.nps.gov

U.S. Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742-2751
(978) 318-2751
www.nae.usace.army.mil

U.S. Fish and Wildlife Service
New England Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-4986
(603) 223-2541
www.fws.gov

U.S. Department of Agriculture
Natural Resources Conservation Service
(formerly Soil Conservation Service)
451 West Street
Amherst, MA 01002
(413) 253-4362
www.soils.usda.gov

U.S. Department of Housing and Urban Development
Region 1 Providence Field Office
121 South Main Street
Providence, RI 02903
(401) 277-8300
www.hud.gov

U.S. Department of Commerce
National Weather Service
Forecast Office
445 Myles Standish Boulevard
Taunton, MA 02780
(508) 823-2262
www.nws.noaa.gov

United States Small Business Administration
Region 1
10 Causeway Street, Suite 265A
Boston, MA 02222

(617) 565-8416
www.sba.gov

Economic Development Administration
Philadelphia Regional Office
The Curtis Center
601 Walnut Street, Suite 140 South
Philadelphia, PA 19106-3323
(215) 597-8822
www.eda.gov

U.S. Environmental Protection Agency
Region I – New England Headquarters
5 Post Office Square, Suite 100
Boston, MA 02109-3912
1-888-372-7341
www.epa.gov

# National/Regional Resources

## The Association of State Floodplain Managers (ASFPM)

http://www.floods.org

A professional association with a membership of almost 1,000 state employees that, assists communities with the NFIP. 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.

## The Rhode Island Flood Mitigation Association (RIFMA):

http://www.riflood.org

The goal of the organization is to form a network of associates who could bring their ideas and experiences to a forum for people to share and learn from. The result of the Association is a network of floodplain managers who can improve the effectiveness and efficiency of all aspects of floodplain management in the State of Rhode Island. RIFMA regularly provides training opportunities and an annual floodplain conference.

## Natural Hazards Center at the University of Colorado, Boulder

Tel: (303) 494-6818

http://www.colorado.edu/hazards

The Natural Hazards Center is an international/national information center that provides information on natural hazards and human adjustments to hazards and disasters, by providing information dissemination, free library and referral services, research, and an annual workshop.

## 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, or by one or more churches. No government disaster declaration is needed. Local officials should recommend that the finds be held until an applicant exhaust all sources of public disaster assistance. Doing so allows the funds to be used for mitigation and other projects that cannot be funded elsewhere.

## Volunteer Organizations

Organizations, such as the American Red Cross, the Salvation Army, Habitat for Humanity, Interfaith, and the Mennonite Disaster Service, are often available to help after disasters. Service organizations, such as the Lions, Elks, and VFW are also available. These organizations have helped others with food shelter, clothing,

money, etc. Habitat for Humanity and the Mennonite Disaster Service provide skilled labor to help rebuild damaged buildings incorporating mitigation or flood proofing concepts. The offices of individual organizations can be contacted directly, or the FEMA Regional Office may be able to assist.

## New England States Emergency Consortium (NESEC)

Lakeside Office Park

http://www.serve.com/NESEC

NESEC conducts public awareness and education programs on natural disaster and emergency management activities throughout New England. Brochures and videotapes are available on such topics as earthquake preparedness, mitigation, and hurricane safety tips.

## Institute for Business and Home Safety (IBHS)

http://www.ibhs.org

An insurance industry-sponsored, nonprofit organization dedicated to reducing losses-deaths, injuries, and property damage-resulting from natural hazards. IBHS efforts are directed at five specific hazards: floods, windstorms, hail, earthquakes, and wildfires. Through its public education efforts and information center, IBHS communicates the results of its research and statistical gathering, as well as mitigation information, to a broad audience.

# Appendix D: Final Local Mitigation Plan Review Tool

# LOCAL MITIGATION PLAN REVIEW TOOL

## Town of Westerly, Rhode Island

The *Local Mitigation Plan Review Tool* demonstrates how the Local Mitigation Plan meets the regulation in 44 CFR §201.6 and offers States and FEMA Mitigation Planners an opportunity to provide feedback to the community.

- The Regulation Checklist provides a summary of FEMA's evaluation of whether the Plan has addressed all requirements.
- The Plan Assessment identifies the plan's strengths as well as documents areas for future improvement.
- The Multi-jurisdiction Summary Sheet is an optional worksheet that can be used to document how each jurisdiction met the requirements of the each Element of the Plan (Planning Process; Hazard Identification and Risk Assessment; Mitigation Strategy; Plan Review, Evaluation, and Implementation; and Plan Adoption).

The FEMA Mitigation Planner must reference this *Local Mitigation Plan Review Guide* when completing the *Local Mitigation Plan Review Tool*.

| **Jurisdiction:** Town of Westerly, Rhode Island | **Title of Plan:** Local Hazard Mitigation Plan Update | **Date of Plan:** November, 2017 |
|---|---|---|
| **Single or Multi-jurisdiction plan? SINGLE** | **New Plan or Plan Update? UPDATE** | |
| **Local Point of Contact:**<br>Jason Parker<br>Town Planner/Development Services<br>45 Broad Street<br>Westerly, RI 02891<br>401-348-2604<br>jparker@westerlyri.gov | **Local CEO:**<br>Derrik Kennedy<br>Town Manager<br>45 Broad Street<br>Westerly, RI 02891<br>401-348-2530<br>dkennedy@westerly.org | |

| **State Reviewer:** | **Title:** | **Date:** |
|---|---|---|
| | | |

| **FEMA Reviewer:** | **Title:** | **Date:** |
|---|---|---|
| | | |
| **Date Received in FEMA Region I** | | |
| **Plan Not Approved** | | |
| **Plan Approvable Pending Adoption** | | |
| **Plan Approved** | | |

## SECTION 1:
## REGULATION CHECKLIST

**INSTRUCTIONS:** The Regulation Checklist must be completed by FEMA. The purpose of the Checklist is to identify the location of relevant or applicable content in the Plan by Element/sub-element and to determine if each requirement has been 'Met' or 'Not Met.' The 'Required Revisions' summary at the bottom of each Element must be completed by FEMA to provide a clear explanation of the revisions that are required for plan approval. Required revisions must be explained for each plan sub-element that is 'Not Met.' Sub-elements should be referenced in each summary by using the appropriate numbers (A1, B3, etc.), where applicable. Requirements for each Element and sub-element are described in detail in this *Plan Review Guide* in Section 4, Regulation Checklist.

| **1. REGULATION CHECKLIST**<br>**Regulation** (44 CFR 201.6 Local Mitigation Plans) | **Location in Plan (section and/or page number)** | **Met** | **Not Met** |
|---|---|---|---|
| **ELEMENT A. PLANNING PROCESS** | | | |
| A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1)) | Section 2.0, Throughout the plan; Appendix B | X | |
| A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2)) | Section 2.2, Appendix B | X | |
| A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1)) | Section 2.2.2, Appendix B | X | |
| A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3)) | Section 2.4, Section 4.0 | X | |
| A5. Is there discussion of how the community will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii)) | Section 2.5.1 | X | |
| A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i)) | Section 2.4, Section 2.5 | X | |
| **ELEMENT A: REQUIRED REVISIONS** | | | |
| **ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT** | | | |

| 1. REGULATION CHECKLIST<br>**Regulation** (44 CFR 201.6 Local Mitigation Plans) | Location in Plan (section and/or page number) | Met | Not Met |
|---|---|---|---|
| B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i)) | Section 3.0, pp.; Appendix A | X | |
| B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i)) | Section 3.2, Appendix A | X | |
| B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii)) | Section 3.2, Section 3.3, Appendix A | X | |
| B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii)) | Section 4.2.2 | X | |
| **ELEMENT B: REQUIRED REVISIONS** | | | |
| **ELEMENT C. MITIGATION STRATEGY** | | | |
| C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement §201.6(c)(3)) | Section 4.0, Appendix C | X | |
| C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii)) | Section 4.2.1.4 Section 4.2.2 | X | |
| C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i)) | Executive Summary, Section 2.4.1, Section 5.1 | X | |
| C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement §201.6(c)(3)(ii)) | Section 5.2 Section 5.5 | X | |
| C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii)) | Section 5.4 | X | |
| C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement §201.6(c)(4)(ii)) | Section 2.5, Section 4.2, Section 5.3, | X | |
| **ELEMENT C: REQUIRED REVISIONS** | | | |
| **ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION** (applicable to plan updates only) | | | |
| D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3)) | Section 1.2 | X | |

| 1. REGULATION CHECKLIST<br>**Regulation** (44 CFR 201.6 Local Mitigation Plans) | Location in Plan (section and/or page number) | Met | Not Met |
|---|---|---|---|
| D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3)) | Section 2.4, Section 5.3 | X | |
| D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3)) | Section 5.4 | X | |
| **ELEMENT D: REQUIRED REVISIONS** | | | |
| **ELEMENT E. PLAN ADOPTION** | | | |
| E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5)) | n/a | | |
| E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5)) | This is a single jurisdiction plan. | n/a | |
| **ELEMENT E: REQUIRED REVISIONS** | | | |
| **ELEMENT F. ADDITIONAL STATE REQUIREMENTS (OPTIONAL FOR STATE REVIEWERS ONLY; NOT TO BE COMPLETED BY FEMA)** | | | |
| F1. | | | |
| F2. | | | |
| **ELEMENT F: REQUIRED REVISIONS** | | | |

## SECTION 2:
## PLAN ASSESSMENT

### A. Plan Strengths and Opportunities for Improvement

This section provides a discussion of the strengths of the plan document and identifies areas where these could be improved beyond minimum requirements.

#### Element A: Planning Process

| |
|---|
| |

#### Element B: Hazard Identification and Risk Assessment

| |
|---|
| |

#### Element C: Mitigation Strategy

| |
|---|
| |

#### Element D: Plan Update, Evaluation, and Implementation (*Plan Updates Only*)

| |
|---|
| |

### B. Resources for Implementing Your Approved Plan

| |
|---|
| |

# Appendix E: Glossary

| | |
|---|---|
| Accretion | The deposition of sediment, sometimes indicated by the seaward advance of a shoreline indicator such as the water line, the berm crest, or the vegetation line. |
| Active Beach | The portion of the littoral system that is frequently (daily or at least seasonally) subject to transport by wind, waves, and currents. |
| Algal Bloom | A sudden increase in the amount of marine algae (seaweed) often caused by high levels of phosphates, nitrates, and other nutrients in the near shore area. |
| Armoring | The placement of fixed engineering structures, typically rock or concrete, on or along the shoreline to reduce coastal erosion. Armoring structures include seawalls, revetments, bulkheads, and rip rap (loose boulders). |
| Backshore | The generally dry portion of the beach between the berm crest and the vegetation line that is submerged only during very high sea levels and eroded only during moderate to strong wave events. |
| Beach | An accumulation of loose sediment (usually sand or gravel) along the coast. |
| Beach Loss | A volumetric loss of sand from the active beach. |
| Beach Management District | A special designation for a group of neighboring coastal properties that is established to facilitate cost sharing and streamline the permitting requirements for beach restoration projects. |
| Beach Narrowing | A decrease in the useable beach width caused by erosion. |
| Beach Nourishment | The technique of placing sand fill along the shoreline to widen the beach. |
| Beach Profile | A cross-sectional plot of a shore-normal topographic and geomorphic beach survey, usually in comparison to other survey dates to illustrate seasonal and longer-term changes in beach volume. |
| Berm | A geomorphologic feature usually located at mid-beach and characterized by a sharp break in slope, separating the flatter backshore from the seaward-sloping foreshore. |
| Building Setback | The country-required seaward limit of major construction for a coastal property. Building setbacks on Maui vary from 25 feet to 150 feet landward of the certified shoreline. |
| Coastal Dunes | Dunes within the coastal upland, immediately landward of the active beach. |
| Coastal Erosion | The wearing away of coastal lands, usually by wave attack, tidal or littoral currents, or wind. Coastal erosion is synonymous with shoreline (vegetation line) retreat. |
| Coastal Plain | The low-lying, gently-sloping area landward of the beach often containing fossil sands deposited during previously higher sea levels. |
| Coastal Upland | The low-lying area landward of the beach often containing unconsolidated sediments. The coastal upland is bounded by the hinterland (the higher-elevation areas dominated by bedrock and steeper slopes). |
| Day-use Mooring | A buoy or other device to which boats can be secured without anchoring. |
| Deflation | A lowering of the beach profile. |
| Downdrift | In the direction of net longshore sediment transport. |

| | |
|---|---|
| Dune | A landform characterized by an accumulation of wind-blown sand, often vegetated. |
| Dune Restoration | The technique of rebuilding an eroded or degraded dune through one or more various methods (sand fill, drift fencing, re-vegetation, etc.). |
| Dune Walkover | Light construction that provides pedestrian access without trampling dune vegetation. |
| Dynamic Equilibrium | A system in flux, but with influxes equal to outfluxes. |
| Erosion | The loss of sediment, sometimes indicated by the landward retreat of a shoreline indicator such as the waterline, the berm crest, or the vegetation line. |
| Erosion Hotspots | Areas where coastal erosion has threatened shoreline development or infrastructure. Typically, the shoreline has been armored and the beach has narrowed considerably or been lost. |
| Erosion Watchspots | Areas where the coastal environment will soon be threatened if shoreline erosion trends continue. |
| Foreshore | The seaward sloping portion of the beach within the normal range of tides. |
| Hardening | See Armoring. |
| Inundation | The horizontal distance traveled inland by a tsunami. |
| Improvement Districts | A component of a beach management district established to help facilitate neighborhood-scale improvement projects (e.g., beach nourishment). |
| Land banking | The purchase of shoreline properties by a government, presumably to reduce development pressure or to preserve the parcel as a park or as open space. |
| Littoral budget | The sediment budget of the beach consisting of sources and sinks. |
| Littoral System | The geographical system subject to frequent or infrequent beach processes. The littoral system is the area from the landward edge of the coastal upland to the seaward edge of the near-shore zone. |
| Longshore Transport | sediment transport down the beach (parallel to the shoreline) caused by longshore currents and/or waves approaching obliquely to the shoreline. |
| Lost Beaches | A subset of erosion hotspots. Lost beaches lack a recreational beach, and lateral shoreline access is very difficult if not impossible. |
| Monitoring | Pperiodic collection of data to study changes in an environment over time. |
| Nutrient Loading | The input of fertilizing chemicals to the nearshore marine environment, usually via non-point source runoff and sewage effluent. Nutrient loading often leads to algal blooms. |
| Offshore | The portion of the littoral system that is always submerged. |
| Overwash | Transport of sediment landward of the active beach by coastal flooding during a tsunami, hurricane, or other event with extreme waves. |
| Revetment | A sloping type of shoreline armoring often constructed from large, interlocking boulders. Revetments tend to have a rougher (less reflective) surface than seawalls. |
| Risk | Refers to the predicted impact that a hazard would have on people, services, specific facilities and structures in the community. |

| | |
|---|---|
| Risk Management | The process by which the results of an assessment are integrated with political, economic, and engineering information to establish programs, projects and policies for reducing future losses and dealing with the damage after it occurs. |
| Scarp | A steep slope usually along the foreshore and/or at the vegetation line, formed by wave attack. |
| Scarping | The erosion of a dune or berm by wave-attack during a storm or a large swell. |
| Sea bags | Large sand-filled geotextile tubes used in coastal protection projects. |
| Seawall | A vertical or near-vertical type of shoreline armoring characterized by a smooth surface. |
| Shoreline Setback | See Building setback. |
| Siltation | The input of non-calcareous fine-grained sediments to the nearshore marine environment, or the settling out of fine-grained sediments on the seafloor. |
| Storm Surge | A temporary rise in sea level associated with a storm's low barometric pressure and onshore winds. |
| Urban Runoff | The input of hydrocarbons, heavy metals, pesticides and other chemical to the near shore marine environment from densely populated areas. |
| Vulnerability | The characteristics of the society or environment affected by the event that resulted in the costs from damages. |
| Vulnerability Assessment | The qualitative or quantitative examination of the exposure of some component of society, economy or the environment to natural hazards. |