RHODE ISLAND STATE HAZARD MITIGATION PLAN

Prepared by:
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May 1, 2005

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State Hazard Mitigation Plan Adoption

The Rhode Island Multi-Hazard Mitigation Plan has been developed in accordance with the Federal Disaster Mitigation Act of 2000, (DMA 2000) P.L. 106-390. This Plan has also been developed in accordance with the 1998 Rhode Island Executive Order No. 98-13. This plan implements hazard mitigation measures intended to eliminate or reduce the effects of future disasters throughout the State, and was developed in a joint and cooperative venture by the Rhode Island Emergency Management Agency, Mitigation Division, the Rhode Island National Flood Insurance Program, members of the State Hazard Mitigation Committee, local hazard mitigation committee council members, and stakeholders from various state, local and private agencies within Rhode Island.

Once the state plan is completed and receives final approval by the Federal Emergency Management Agency, the State Hazard Mitigation Committee will continue to function in an advisory capacity on hazard mitigation efforts, including evaluation and revision of the state Plan. Participation by state agencies was critical in its development. State agencies identified potentially vulnerable state owned and/or operated facilities and will continue to identify agency-specific actions to address these vulnerabilities through hazard mitigation actions and initiatives.

Accordingly, pursuant to this Plan, responsibilities for natural hazard mitigation activities are assigned to appropriate state agencies. I hereby direct these agencies to become familiar with this Plan and prepare to discharge their responsibilities under the coordination of the Rhode Island Emergency Management Agency, Mitigation Division and the Rhode Island National Flood Insurance Program.

Finally, by my signature, I adopt the State of Rhode Island Multi- Hazard Mitigation Plan.

This Plan is hereby approved for distribution and implementation.

Reginald Centracchio
Director
Rhode Island Emergency Management Agency

April 8, 2005

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Federal Assurances

Below are the assurances that the State of Rhode Island will comply with all applicable Federal assurances.

As a condition of approval of the Rhode Island Multi-Hazard Mitigation Plan by the FEMA I Regional Director, 44 CFR Part 201.4(c)(7) requires that the plan contain certain assurances. The State must assure that it will comply with Federal statutes and regulations that pertain to grant funding, and will amend the plan to reflect changes in pertinent State or Federal laws.

The State of Rhode Island will:

1. Comply with all applicable Federal statutes and regulations in effect with respect to the periods for which it receives grant funding, in compliance with 44 CFR 13.11(c); and

2. Amend this plan whenever necessary to reflect changes in State or Federal laws and statutes as required in 44 CFR 13.11(d).

Reginald Centracchio
Director
Rhode Island Emergency Management Agency

April 8, 2005

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Key Terms & Acronyms

All-hazards approach integrated hazard mitigation strategy that incorporates planning for and consideration of all potential natural and man made hazard threats.

Base Flood the flood having a one percent chance of being equaled or exceeded in magnitude in any given year. (Also known as the 100-year flood). This is the flooding event that is used to calculate flood risk for the National Flood Insurance Program (NFIP) and the Federal Emergency Management Agency (FEMA).

Base Flood Elevation the height (above sea-level) that flood waters will reach at a given location in the event of the Base (100-year) flooding event.

BOCA Building Official & Code Administration

CAPSSE Community Assistance Program Support Services Element

CBRA Coastal Barrier Resource Act

CFR Code of Federal Regulations

Contour a line of equal ground elevation on a topographic map

Critical Facility facilities that are critical to the health and welfare of the population and that are especially important following disasters. Critical facilities include, but are not limited to, shelters, police and fire and hospitals.

CRMC Rhode Island Coastal Resources Management Council

CRS Community Rating System a National Flood Insurance Program that provides incentives for NFIP communities to complete activities that reduce flood hazard risk. When the community completes specified activities, the insurance premiums of NFIP policyholders in these communities are reduced.

CSC Coastal Services Center, part of NOAA located in Charlestown, South Carolina

CZM Coastal Zone Management

DBR Department of Business Regulation

DEM Department of Environmental Management

DMA 2000 Disaster Mitigation Act of 2000

DOA Department of Administration

DOT Department of Transportation

Earthquake a sudden motion or trembling that is caused by a release of strain accumulated within or along the edge of the earth's tectonic plates

EDC University of Rhode Island Environmental Data Center

EMA Emergency Management Agency

EOP Emergency Operations Center

EPA Environmental Protection Agency

FEMA Federal Emergency Management Agency

FIRM Flood Insurance Rate Map

Flood means a general and temporary condition of partial or complete inundation of normally dry land areas from: (1) the overflow of inland or tidal waters; (2) the unusual and rapid accumulation of runoff of surface water from any source.

Flood Boundary and Floodway Map a floodplain management map issued by FEMA that shows, based on detailed and approximate analyses, the boundaries of the 100-year and 500-year floodplains and the 100-year floodway.

Flood Depth height of the floodwater surface above the ground surface

Flood Elevation elevation of the water surface above an established datum, e.g. National Geodetic Vertical Datum of 1929, North American Vertical Datum of 1988, or Mean Sea Level

Flood Fringe that portion of the 100-year floodplain outside the floodway in which total encroachment is permissible.

Flood Hazard Boundary Map (FHBM) the initial insurance map issued by FEMA that identifies approximate areas of 100-year flood hazard in a community.

Flood Insurance Rate Map (FIRM) the insurance and floodplain management map issued by FEMA that identifies areas of 100-year flood hazard in a community. In some areas, the map also shows base flood elevations and 500-year floodplain boundaries and occasionally, regulatory floodway boundaries.

Flood Insurance Study (FIS) engineering study performed by FEMA to identify flood hazard areas, flood insurance risk zones, and other flood data in a community.

Floodplain any land area susceptible to inundation by floodwaters from any source.

Floodproofing any combination of structural and non-structural additions, changes or adjustments to structures which reduce or eliminate flood damage to real estate or improved real property, water and sanitary facilities, structures and their contents.

Floodway the channel of a river or watercourse and the adjacent land areas that must be reserved in order to discharge the 100-year flood without cumulatively increasing the water surface elevation more than one foot.

FMAP Flood Mitigation Assistance Program

FMO Fire Marshall's Office

Fujita Scale of Tornado Intensity rates tornadoes with numeric values from F0 to F5 based on tornado wind speed and damage sustained. An F0 rating indicates light damage such as broken tree limbs or signs, while an F5 rating indicates incredible damage was sustained.

Geographic Information System (GIS) a computer software application that relates physical features on the earth to a database to be used for mapping and analysis

Hazard a source of potential danger or adverse conditions. Hazards included in this plan are natural in origin and include: floods, droughts, high winds, winter storms; hurricanes; tornadoes; dam failures and coastal erosion. These events are hazards when they have the potential to harm people or property.

Hazard Identification the process of identifying hazards that threaten an area.

Hazard Mitigation sustained actions taken to reduce or eliminate long-term risk from hazards and their effects.

Hazard Profile A description of the physical characteristics of hazards and a determination of various descriptors including magnitude, duration, frequency, probability, and extent.

Hazards U.S. (HAZUS) a GIS-based software program that is a nationally standardized earthquake loss estimation tool developed by FEMA.

HMGP Hazard Mitigation Grant Program

Hurricane an intense tropical cyclone, formed in the atmosphere over warm ocean areas, in which wind speeds reach 74 miles-per-hour or more and blow in a large spiral around a relatively calm center or "eye." Hurricanes develop over the North Atlantic Ocean, northeast Pacific Ocean, or the South Pacific Ocean east of 160 degrees longitude. Hurricane circulation is counter-clockwise in the northern hemisphere and clockwise in the southern hemisphere.

Hydrology the science of dealing with the waters of the earth. A flood discharge is developed by a hydrologic study.

IA Individual Assistance

IBC International Building Code

IHP Individual and Households Program

Intensity a measure of the effects of a hazard event at a particular place.

Liquefaction the phenomenon that occurs when ground shaking causes loose soils (such as till and outwash) to lose strength and act like a viscous fluid. Liquefaction causes two types of ground failure: lateral spread and loss of bearing strength.

Lowest Floor under the NFIP, the lowest floor of the lowest enclosed area (including basement) of a structure

Magnitude a measure of the strength of a hazard event. The magnitude (also referred to as severity) of a given hazard is usually determined using technical measures specific to a hazard

Mitigation the process of reducing the severity of the impact of natural hazards through planning. Each hazard requires a specific type of mitigation. In some cases, we can use engineering solutions (such as an earthquake -resistant building) to at least temporarily reduce the impact of a natural hazard. In other cases, the only form of mitigation that is guaranteed to be successful is to limit or not allow human activities where the hazard occurs (such as in floodplains).

Mitigation Plan a systematic evaluation of the nature and extent of vulnerability to the effects of natural hazards typically present in the state and includes a description of actions to minimize future vulnerability to natural hazards.

Natural Disaster a natural hazard event, such as a flood or tornado, which results in widespread destruction of property or caused injury and/or death.

Natural Hazard an unexpected or uncontrollable natural event of unusual magnitude that threatens the activities of people or people themselves.

NESEC New England States Emergency Consortium

NFIP National Flood Insurance Program

NOAA National Oceanic and Atmospheric Administration

Nor'easter an extra-tropical cyclone producing gale-force winds and precipitation in the form of heavy snow.

NRCS Natural Resource Conservation Service

100-Year Flood (also called the Base Flood) the flood having a one percent chance of being equaled or exceeded in magnitude in any given year. Contrary to popular belief, it is not a flood occurring once every 100 years

PA Public Assistance

Pre -Disaster Mitigation Program PDM authorized by 203 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act), 42 USC, as amended by 102 of the Disaster Mitigation Act Mitigation Fund to assist States and local governments (to include Indian Tribal governments) in implementing cost-effective hazard mitigation activities that complement a comprehensive mitigation program.

PDM/C Pre -Disaster Mitigation Program Competitive Grants (national competitive program)

PUC Public Utilities Commission

Repetitive Loss Property A property that is currently insured for which two or more National Flood Insurance Program losses (occurring more than ten days apart) of at least $1,000.00 each have been paid within any 10-year period of time since 1978.

RIBC Rhode Island Building Commission

RIEMA Rhode Island Emergency Management Agency

Risk the estimated impact that a hazard would have on people, services, facilities, and structures in a community; the likelihood of a hazard event resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as high, moderate, or low likelihood of sustaining damage above a particular threshold due to a specific type of hazard event. It can also be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Riverine of or produced by a river

SBA Small Business Administration

Scour removal of soil or fill material by the flow of floodwaters. The term is frequently used to describe storm-induced, localized conical erosion around pilings and other foundation supports where the obstruction of flow increases turbulence.

Special Flood Hazard Area (SFHA) the darkly shaded area on the Flood Hazard Boundary Map (FHBM) or Flood Insurance Rate Map (FIRM) which identifies an area that has a one percent chance of being flooded in any given year (100-year floodplain). The FIRM identifies these shaded areas as FIRM Zones A, AO, AH, A1-A30, AE, A99, V, V1-30, and VE

Stafford Act the Robert T. Stafford Disaster Relief and Emergency Act, P.L. 100-107 was signed into law November 23, 1988 and amended the Disaster Relief Act of 1974, P.L. 23-288. The Stafford Act is the statutory authority for most Federal disaster response activities, especially as they pertain to FEMA and its programs.

State Hazard Mitigation Officer (SHMO) the representative of state government who is the primary point of contact with FEMA, other State and Federal agencies, and local units of government in the planning and implementation of pre- and post-disaster mitigation activities.

Storm Surge rise in the water surface above normal water level on the open coast due to the action of wind stress and atmospheric pressure on the water surface

Substantial Damage damage of any origin sustained by an obstruction whereby the cost of restoring the obstruction to its before-damage condition would equal or exceed 50 percent of the market value of the obstruction before the damage occurred.

Substantial Improvement any reconstruction, rehabilitation, addition, or other improvement of an obstruction, the cost of which equal or exceed 50 percent of the market value of the obstruction before "start of construction" of the improvement. This includes obstructions which have incurred "substantial damage," regardless of the actual repair work performed. The term does not, however, include either (1) any project for improvement of a structure or other obstruction to correct existing violations of state or local health, sanitary, or safety code specifications which have been identified by the local code enforcement official and which are the minimum necessary to assure safe living conditions, or (2) any alteration of a "historic structure," provided that the alteration will not preclude the structure's continued designation as a "historic structure."

Technological Disaster a disaster that results from a technological or man-made hazard event

Technological Hazard a hazard that originates in accidental or intentional human activity (oil spill, chemical spill, building fires, terrorism, etc.)

Topographic Map shows natural features and indicates the physical shape of the land using contour lines. These maps may also include manmade features.

Tornado a violently rotating column of air extending ground-ward

Tropical Cyclone a generic term for a cyclonic, low pressure system over tropical or subtropical waters

Tropical Storm a tropical cyclone with maximum sustained winds greater than 39 miles per hour and less than 74 miles per hour.

USDA United States Department of Agriculture

USGS United States Geological Service

Vulnerability describes how exposed or susceptible to damage an asset is. Vulnerability depends upon an asset's construction, contents, and the economic value of its functions. Like indirect damages, the vulnerability of one element of the community is often related to the vulnerability of another.

Wildfire an uncontrollable fire spreading through vegetative fuels, exposing and possibly consuming structures.

ZONE A (UNNUMBERED) Special Flood Hazard Areas subject to inundation from the 100-year flood. Because detailed hydraulic analyses have not been performed, no base flood elevations or depths are shown. Mandatory flood insurance purchase requirements apply.

ZONE AE and A1-30 Special Flood Hazard Areas subject to inundation by the 100-Year flood determined in a Flood Insurance Study by detailed methods. Base flood elevations are shown within these zones. Mandatory flood insurance purchase requirements apply. *(Zone AE is used on new and revised maps in place of Zones A1-30.)*

ZONE AH Special Flood Hazard Areas subject to inundation by 100-year shallow flooding *(usually areas of ponding)* where average depths are between one and three feet. Base flood elevations derived from detailed hydraulic analyses are shown in this zone. Mandatory flood insurance purchase requirements apply.

ZONE AO Special Flood Hazard Areas subject to inundation by 100-year shallow flooding *(usually sheet flow on sloping terrain)* where average depths are between one and three feet. Average flood depths derived from detailed hydraulic analyses are shown within this zone. Mandatory flood insurance purchase requirements apply.

ZONE B, C, and X areas that have been identified in the community flood insurance study as areas of moderate or minimal flooding from a principal source in the area. However, buildings in these zones could be flooded by severe, concentrated rainfall coupled with inadequate local drainage systems. Flood insurance is available in participating communities but is not required by regulation in these zones. *(Zone X is used on new and revised maps in place of Zones B and C.)*

ZONE D unstudied areas where flood hazards are undetermined but flooding is possible. No mandatory flood insurance purchase requirements apply, but coverage is available in participating communities.

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1. Foreword

For decades, most Americans assumed that they were immune to, or could control, the forces and unrelenting fury of natural hazards. As headlines and non-stop CNN coverage continue to document each new hurricane, flood, blizzard, wildfire or earthquake, we can no longer feel as though we can hold the reigns on Mother Nature. In the last 10 years, the United States has experienced numerous major natural disasters, among them Hurricanes Andrew, Marilyn, Opal and Georges; the Midwest Flood of 1993 and the Northridge Earthquake; and countless wildfires in California and the southwest. Lest we also not forget the three major hurricanes that recently hit the Florida coast within 8 weeks this past season (2004). This period has been the most costly in U.S. history.

As challenging, since 9-11, 2002 the national emphasis has shifted from mitigating natural hazards to living in a state of fear, color codes and terrorism. From national government down to state and local governments, the amount of resources assigned to "combat terrorism" has been dramatically increasing, while the amount of funding for mitigation programs has been significantly reduced. Unfortunately, the mindset of much of the populace and current administration appears to be that natural hazards no longer pose as great a potential impact on our lives, homes and communities. Have they forgotten that natural disasters generate exorbitant human, economic, and environmental costs? One only needs to recall the horrific event that occurred on December 26, 2004 to over 250,000 innocent lives in the Asian Pacific, one of the most devastating tsunamis ever recorded in human history that forever changed the lives of millions of people. With each new natural hazard event, it becomes apparent that a concerted, unified approach is needed.

Hazard Event vs. Disaster

It is people that turn a natural hazard event into a disaster. Compare the direct and indirect costs of a coastal storm of significant magnitude (e.g. Hurricane of 1938) hitting an undeveloped, abandoned barrier beach vs. the present day densely developed Rhode Island South County shoreline. The obvious advantage that we are fortunate to have today is the remarkable advancements made in forecasting severe weather and broadcasting oncoming storms to the populace in potential danger. Today, people have ample warning to evacuate. However, how would the increased coastal development and public infrastructure in these special flood hazard high velocity zones fare? Can property owners afford to rebuild? Can communities afford to replace age old public infrastructure such as roads, bridges, sewer and water lines and wastewater treatment facilities? Consider the potential financial impact to the private sector water-dependent and water enhanced industries such as marinas, hotels, boatbuilding yards and fish processing plants. Can the state afford to lose precious environmental resources such as the pristine coastal lagoons and estuaries, rivers and valuable beachfront all serving a lucrative and seasonal attraction for millions of tourists each season?

With regard to economic costs of disasters in Rhode Island, it is important to recognize that small to medium sized businesses, which provide nearly 80% of the j6bs statewide, are at high risk for failure after a disaster. As cited in many studies and publications, businesses that experience heavy damage from a disaster, particularly power failure and loss of their suppliers, must be "on-line" and operable within 48 hours or close to 72% of them fail. Business recovery is a critical component to community recovery. If a business is able to quickly recover from the inevitable disaster (whether natural or "man-made"), then the impact of that disaster on the community will be significantly reduced. The people within a community depend upon the goods and services provided by their local businesses (e.g. food, building supplies, cash and other banking services, etc). Even more important, those suppliers to the local businesses must also be prepared as they are depended upon to continue to supply needed goods for the local businesses in order to keep financially solvent.

Mitigation Benefits

As the direct and indirect costs of disasters continue to rise, it becomes particularly critical to prepare for the potential damages from hazardous events in order to reduce the amount of both direct and indirect impacts of damage and destruction. The strategy that is advocated throughout this Plan to address the harmful potential impacts of natural disasters is *mitigation.* The purpose of mitigation, or multi-hazard mitigation (addressing more than one hazard through similar means), is twofold: 1) to protect people and structures from harm and destruction; and 2) to minimize the costs of disaster response and recovery. Hazard mitigation planning is the process that analyzes a community's risk from natural hazards, coordinates available resources, and implements actions to reduce risks.

Mitigation actions help safeguard personal and public safety. Mitigation planning embraces the two-pronged approach of incorporating mitigation activities into day-to-day community operations, as well as focusing on what the local government can do to plan for a post-disaster recovery and reconstruction. The implementation of mitigation planning and cost-effective mitigation projects will lead toward the national goal of safer and more livable communities.

Focusing resources (financial, planning, staffing, training, projects, public education and outreach, etc.) on preventative measures can significantly reduce the impact of disasters in the future, including the cost of post-disaster cleanup. Retrofitting bridges can keep them from being washed out, which means they will be available to emergency services in the event of a disaster. Installing hurricane clips can reduce personal and real property losses caused by hurricanes, coastal erosion, Nor'easters and storm surge. Increased setbacks and building a structure at the time of new construction one to two feet above base flood not only reduces the risk to property losses from coastal erosion and flooding, but also significantly reduces annual flood insurance premiums.

A Sustainable Community

The World Commission on Environment and Development (the Brutland Commission) in 1987 defined sustainability as the melding of economic, environmental, and societal values to ensure that the needs of the present are met without compromising the needs of future generations. When an association is made with this terminology and the responsibilities emergency managers face related to disaster operations and recovery activities, one should highlight the critical need to build and rebuild smarter, reducing the potential for future disaster impacts and the associated economic and societal effects of such losses.

It is through the Rhode Island Multi-Hazard Mitigation Plan that hazard mitigation has, and will continue to be, incorporated into everyday planning to reduce the need and dependency on federal public assistance and post-disaster recovery issues. Incorporating hazard mitigation concepts into both the daily decision-making of local government planning and private sector entities reinforces community sustainability and strengthens community planning programs. This ensures that the community survives natural disasters so that it can grow and develop as it was envisioned.

For example, sustainable communities make more efficient use of their land by emphasizing open space planning to prevent development from encroaching upon floodplains, eroding coastlines, and areas susceptible to high storm surge. Sustainable communities also take advantage of underutilized urban areas and encourage infill and "brownfield" development. Energy and resource conservation are also high priorities.

Rhode Island has been a national leader in hazard mitigation planning. The first series of local hazard mitigation plans were completed, adopted and implemented over 10 years ago, well before the established planning criteria of the Federal 2000 Disaster Mitigation Act was passed and mandated. Rhode Island also received recognition for its hazard mitigation efforts with the private sector from the Institute of Business and Home Safety (a national leader in insurance) and was distinguished as the first in the country "Showcase State." In 2000, the Federal Emergency Management Agency awarded Rhode Island as "The Most Outstanding State" for its accomplishments in the *Project Impact* program.

While Rhode Island was off to a great start, there is still much to be done. The current efforts to update the State Hazard Mitigation Plan in addition to participation in the FEMA Flood Insurance Rate Mapping & Modernization Program, has resulted in the completion of a statewide risk and vulnerability assessment of natural hazards and geographic information systems (GIS) statewide and local maps depicting those areas and hazards that Rhode Island communities are most susceptible to. Throughout this process valuable data has been gathered, local hazard mitigation committees created, new awareness of how natural hazards affect each community and how mitigation serves a critical role, and public and private stakeholder groups established to work together toward a community and statewide goal of the institutionalization of mitigation. It is hoped that the new found partnerships and collaborative initiatives, both private sector and government agencies will continue their efforts toward a more concerted, unified approach to creating sustainable communities in Rhode Island. Sustainable communities work together with on-going and future State initiatives to practice, and ultimately achieve, the long term goal of making land use decisions based upon achieving "disaster resilience." Disaster resilient communities may bend before the impact of natural disaster events, but they do not break.

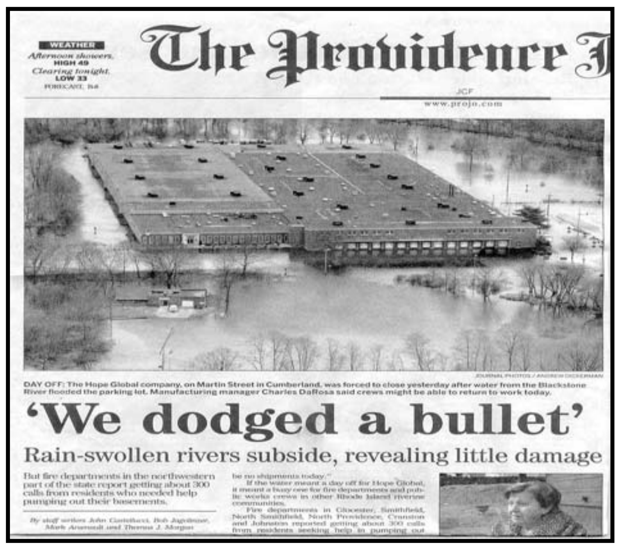
Pam Pogue
Rhode Island National Flood Insurance Program Manager

2. Executive Summary

2.1 Plan Purpose

The purpose of the Rhode Island State Multi-Hazard Mitigation Plan (hereinafter referred to as "Plan") is to provide comprehensive guidance for hazard mitigation in the State of Rhode Island. This Plan has been developed to help serve the people of Rhode Island by providing the impetus for making our homes, businesses, and communities as safe as possible against the impacts of hurricanes, floods, tornadoes, earthquakes, winter storms, wildfires and other natural hazards. It contains a wealth of geographic and demographic information, along with a thorough assessment of the natural hazards faced throughout the state. It also addresses the overall capability of State and local governments to reduce or eliminate the vulnerability of our communities to these natural hazards. Agency annexes to the plan provide strategies for participating state agencies that will improve their resistance to a natural hazard-caused disaster. Agency annexes are not included as part of this document, but are available separately.

This Plan identifies hazard mitigation goals, objectives and recommended actions and initiatives for state government that will reduce injury and damage from natural hazards. Most importantly, the Plan outlines a coordinated "Mitigation Strategy" adopted by the Rhode Island Emergency Management Agency, which includes long-term goals, short-term objectives and the assignment of specific, measurable tasks or actions. Therefore, this Plan is designed to be (1) informative, (2) strategic and (3) functional in nature. Through routine monitoring and updating, this Plan will remain the guide for the Agency's Hazard Mitigation Division to follow in accomplishing its vision of a safe and sustainable future for Rhode Island.


The Providence J

WEATHER
Afternoon showers. HIGH 49
Clearing tonight. LOW 33

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DAY OFF: The Hope Global company, on Martin Street in Cumberland, was forced to close yesterday after water from the Blackstone River flooded the parking lot. Manufacturing manager Charles DaRosa said crews might be able to return to work today.

'We dodged a bullet'

Rain-swollen rivers subside, revealing little damage

But fire departments in the northwestern part of the state report getting about 300 calls from residents who needed help pumping out their basements.

2.2 Benefits of the State Multi-Hazard 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 reduce the need for public assistance in the event of a hurricane. Increasing coastal setbacks reduce the risk of deaths and property losses from tsunamis and storm surge. Increased setbacks also reduce the risk of property losses from coastal erosion.

Another 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 emergency response and post-disaster cleanup.

Community Rating System

Formal adoption and implementation of this strategy will help Rhode Island's cities and towns gain credit points under the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program (NFIP) Community Rating System (CRS). CRS provides discounts on flood insurance premiums for property owners in communities that participate in this voluntary program. For example, points are given to municipalities that form a Local Hazard Mitigation Committee (LHMC). Communities also receive points if they involve the public in the planning process, coordinate with other agencies, assess the hazard and their vulnerability, set goals, draft an action plan (local hazard mitigation strategy), and adopt, implement and revise the plan.

There are many categories to gain credit for public education and awareness activities regarding floodplain management and mitigation. Pre0serving and/or the acquisition 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 and beneficial functions that floodplains serve and helps prevent flood damage.

2.3 Scope of the Plan

The Rhode Island Natural Multi-Hazards Mitigation Plan addresses all natural hazards which pose significant risks to Rhode Island. Each hazard has been assessed using the same methodology, and information on the historical background, vulnerability, exposure and potential losses is provided, as available, for all hazards identified in the Plan.

In addressing Rhode Island's capability to mitigate the effects of these hazards, this Plan analyzes all the relevant Federal, State and Local government agencies and their applicable programs and/or relevant policies. The Plan also addresses certain non-profit organizations and provides a discussion on the private sector.

The mitigation strategy adopted within this Plan establishes the long-term goals and objectives and lists specific strategies and actions to achieve them. This strategy was developed with input from the State Hazard Mitigation Committee members and their State Agency staffs, and will continue to be monitored and updated on a regular basis. The mitigation actions adopted within this Plan address long-term, permanent solutions to problems caused by natural hazards throughout the State of Rhode Island. While these priorities may shift following a particular disaster event, they are designed to provide long-term, pre-disaster mitigation objectives.

The implementation of this Plan is intended to help break the continuing cycle of disaster, damage, and reconstruction that our citizens have been suffering by focusing sharply on the mitigation element of the comprehensive emergency management system. This mitigation element includes policy, planning and project activities that will reduce the vulnerability of Rhode Island communities to all identified hazards. The mitigation element also includes a strong mitigation outreach strategy that will be implemented throughout all phases of emergency management. Disaster response and recovery operations are not discussed within this Plan but are covered in State and Local Emergency Operations Plans (EOPs).

2.4 State Authority

In February 2002, the Federal Emergency Management Agency (FEMA) published Interim Final Rule 44 CFR Part 201, which requires all states and communities to develop natural hazard mitigation plans by November 2004 in order to be eligible for certain hazard mitigation grant programs, and in the case of the states, to be eligible for certain categories of disaster assistance. These planning and hazard mitigation requirements for states and communities will be accomplished in-part through the Pre-Disaster Mitigation Program (PDM). Rhode Island has a solid foundation in natural hazard mitigation, including the state's land use plan, local community comprehensive community plans, building code regulations, coastal resource management regulations, emergency preparedness planning, hazards assessment, and other policies and programs. Despite the growing recognition of the need for long-term planning strategies to reduce risk from natural disasters, many communities continue to experience difficulty developing and implementing natural hazard risk reduction activities. Communities regularly suffer from a lack of technical and funding assistance, as well as insufficient coordination among public, private, and nonprofit sectors at the local, regional, and statewide levels.

2.5 Disaster Mitigation Act of 2000 and Implementing Regulations

The Federal legislation mandating the development and implementation of these plans is: Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act or the Act), 42 V.S.C. 5165, enacted under § 104, the Disaster Mitigation Act of 2000, (DMA 2000) P.L. 106-390. DMA 2000 is intended to facilitate cooperation between state and local authorities, prompting them to work together. It encourages and rewards local and state pre-disaster planning and promotes sustainability as a strategy for disaster resistance. This enhanced planning network is intended to better enable local and state governments to articulate accurate needs for mitigation, resulting in faster allocation of funding and more effective risk reduction projects.

To implement the new DMA 2000 requirements, FEMA prepared an Interim Final Rule, published in the Federal Register on February 26, 2002, at 44 CFR Parts 201 and 206, which establishes planning and funding criteria for states. 44 CFR § 201.1, *et seq.* was promulgated by the Federal Emergency Management Agency (FEMA) on February 26, 2002, in order to implement DMA 2000 (FEMA, Feb. 26, 2002). The rule addresses State mitigation planning, and specifically, in 44 CFR § 201.3(c) identifies the states' mitigation planning responsibilities, which include the responsibilities to:

1. Prepare and submit to FEMA a Standard State Mitigation Plan following the criteria established in 44 CFR § 201.4 as a condition of receiving Stafford Act assistance (except emergency assistance).

2. In order to be considered for 20 percent HMGP funding, prepare and submit an Enhanced State Mitigation Plan in accordance with 44 CFR § 201.5, which must be reviewed and updated, if necessary, every three years from the date of the approval of the previous plan.

3. Review and, if necessary, update the Standard State Mitigation Plan by November 1, 2004 and every three years from the date of the approval of the previous plan in order to continue program eligibility.

4. Make available the use of up to 7 percent of HMGP funding for planning in accordance with 44 CFR § 206.434.

44 CFR § 201.4, "Standard State Mitigation Plans," lists the required components of state hazard mitigation plans. Under 44 CFR § 20 1.4(a), by November 1, 2004, states must have an approved Standard State Mitigation Plan meeting the requirements of 44 CFR § 201.4 in order to receive assistance under the Stafford Act. Under 44 CFR § 201.4(b), the planning process must include coordination with other State agencies, appropriate Federal agencies, and interested groups.

44 CFR § 201.4(c), "Plan content," identifies the following elements that must be included in a State Hazard Mitigation Plan:

1. A description of the planning process used to develop the plan;

2. Risk assessments that provide the factual basis for activities proposed in the strategy portion of the mitigation plan;

3. A Mitigation Strategy that provides the State's blueprint for reducing the losses identified in the risk assessment;

4. A section on the Coordination of Local Mitigation Planning;

5. A Plan Maintenance Process, including a method and schedule for monitoring, evaluating, and updating the plan, a system for monitoring implementation of

mitigation measures and project closeouts, and a system for reviewing progress on achieving goals as well as activities and projects identified in the Mitigation Strategy;

6. A Plan Adoption Process for formal adoption by the State prior to submittal to FEMA for final review and approval; and

7. Assurances that the State will comply with all applicable Federal statutes and regulations in effect with respect to the periods for which it receives grant funding, in compliance with 44 CFR13 11( ) The State must amend its plan whenever necessary to reflect changes in State or Federal laws and statutes as required in 44 CFR 13.11 (d).

On February 26, 2002, FEMA also made changes to 44 CFR Part 206 in order to implement DMA 2000 *(See* 67 Fed. Reg. 8844 (Feb. 26, 2002). Changes to 44 CFR Part 206 authorize Hazard Mitigation Grant Program (HMGP) funds for planning activities, and increase the amount of HMGP funds available to States that develop a comprehensive, enhanced mitigation plan.

In addition, under 44 CFR § 206.400, in order to receive any disaster assistance funding under the Stafford Act, states must conduct repairs or construction funded by a disaster loan or grant in accordance with applicable standards such as the minimum requirements of the National Flood Insurance Program (NFIP) and standards substantially equal to the recommended provisions of the National Earthquake Hazards Reduction Program (NEHRP).

2.6 Overview of Plan Contents

Plan Organization

The plan consists of seven parts and appendices:

Key Terms and Acronyms
Part 1: Foreword
Part 2: Executive Summary
Part 3: Planning Process
Part 4: State Risk Assessment
Part 5: State Hazard Mitigation Strategy
Part 6: State and Local Planning Coordination
Part 7: Plan Maintenance Process
Endnotes
Appendices

Part 1: Foreword describes the history, context and importance of multi-hazard mitigation planning in Rhode Island.

Part 2: Executive Summary of the plan provides a synopsis of the objectives of the Rhode Island Multi-Hazard Mitigation Plan and includes an overview of the plan organization and contents.

Part 3: Planning Process provides an overview of the mitigation planning process, how it was prepared, who was involved in the process, and how coordination with other state and local agencies and integration with other state and local planning efforts, initiatives and programs occurred. This section also includes a description of the State process used to support, through funding and technical assistance, the development of local mitigation plans.

Part 4: State Risk Assessment describes the types of natural hazards that have occurred and that continue to threaten the state. The Risk Assessment includes profiles of all natural hazards that have significantly impacted the state, a relative risk ranking, vulnerability assessment, and loss estimates. The loss estimation and vulnerability assessment is an overview and analysis of the State's vulnerability to natural hazards based statewide hazard risk and vulnerability assessment that was completed in 2002. Natural hazard vulnerabilities will be described in terms of jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events. Additionally, there is an overview and analysis of the State's vulnerability with regard to State owned/operated facilities and critical facilities that are located in the identified hazard areas. Based on the best available data, also included will be the potential dollar losses of State-owned or operated buildings, infrastructure, and critical facilities located in hazard areas.

Part 5: State Hazard Mitigation Strategy includes a description of the State's goals and objectives to guide the selection of mitigation activities, programs and projects to mitigate and reduce potential losses. The State capability assessment describes the existing and emerging state policies relating to hazard mitigation. In assessing state capacity, State laws, regulations, policies, programs, obstacles, opportunities and resource shortfalls related to hazard mitigation, as well as development in hazard-prone areas will be evaluated. In order to implement the State Mitigation Plan, an inventory, evaluation and prioritization of cost-effective, environmentally sound, and technically feasible mitigation actions will be listed. Also included in this section is an identification of current and potential sources of Federal, State, local and private funding to implement mitigation activities. Finally, the potential for new initiatives and partnerships will be discussed.

Part 6: State & Local Planning Coordination recounts the State's efforts to facilitate the development of local mitigation plans in Rhode Island. This section offers a status report for the jurisdictional plans, describes how the State will integrate the local plans into this document, and lays the foundation for how Rhode Island will prioritize and monitor jurisdictional mitigation project grants. Where appropriate, specific reference to local mitigation initiatives and the process for linking to the State Hazard Mitigation Plan will be made.

Part 7: Plan Maintenance Process includes some detail on the State's established method and schedule for monitoring, evaluating and updating the plan. Also included is the description of a system for monitoring the implementation of mitigation measures and project closeouts, in addition to a system for reviewing progress on achieving goals, as well as activities and projects in the Mitigation Strategy.

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3. The Planning Process

Hazard mitigation is action taken to permanently reduce or eliminate long-term risk to people and their property from the effects of natural hazards.

As the direct and indirect costs of disasters continue to rise, it becomes particularly critical that preparing for the onslaught of damage from natural disaster events must be done in order to reduce the amount of damage and destruction. This strategy is commonly known as mitigation. The purpose of multi-hazard mitigation is twofold: 1) to protect people and structures from harm and destruction; and 2) to minimize the costs of disaster response and recovery. Hazard mitigation planning is the process that analyzes a community's risk from natural hazards, coordinates available resources, and implements actions to reduce risks. (Tennessee Emergency Management Agency).

3.1 A Profile of Rhode Island

Geographic Characteristics of Rhode Island

Rhode Island, only 1,214 square miles in area (including the waters of upper Narragansett Bay), is the smallest state in the Union. Located within geographic coordinates of 7105' and 710 50' west longitude and 4.1015' and 4200' north latitude, the state occupies a niche of approximately 37 by 48 miles on the Atlantic seaboard between Connecticut and Massachusetts. Rhode Island adjoins Massachusetts on its northern and eastern borders, Connecticut and Long Island Sound on the west, and the Atlantic Ocean to the south.

The state has a gross land area of 684,089 acres or 1,068.9 square miles (2,768.5 sq. km.) and a net land area, excluding inland waters, of 658,201 acres or 1,028.4 square miles (2,663.6 sq. km). All land in Rhode Island is contained in 39 incorporated municipalities: eight cities and thirty-one towns. The state is also subdivided into five counties which serve as judicial districts but have no inherent governmental powers. An essential feature of Rhode Island is Narragansett Bay, an estuary which extends inland more than 28 miles, from open ocean to the capitol city of Providence. Rhode Island has a total of approximately 420 miles of salt water coastline along its southern shore, Narragansett Bay, and framing the islands in the bay.

In addition to 420 miles of coastline, giving Rhode Island its motto "the Ocean State", the state contains 357 freshwater lakes and ponds, 26 inland salt ponds, and 330 miles of major rivers and tributary streams. The four major river drainage basins in the state are those of the Blackstone, Pawtuxet and Pawcatuck Rivers and Narragansett Bay. Some 565 dam sites dot Rhode Island Rivers, of which 120 are completely or partially breached. Of the remaining existing dams, 78 meet criteria for intermediate hydropower practicability. As of May 1985, nine dams in the state were in operation as hydropower facilities

Population and Growth

Rhode Island had an estimated population of 961,881 in 2002. More than two-thirds of this population lives in the state's 21 coastal communities. The metropolitan nature of the state is indicated in the fact that 33 of the state's 39 municipalities are included within four Metropolitan Statistical Areas (MSA's) identified by the U.S. Bureau of the Census (population and growth data is contained in Table 3-1 “Population, Housing Units, Land Water Area and Density 2000”). Rhode Island is the second most densely populated state in the country. The State has experienced most of its population growth during recent decades in coastal areas. From 1990 through 2000 the permanent population in South County has had the greatest increases. On average, the population increase during that time frame had been 12.3%. However, some communities have experienced more dramatic growth rates. For example in Richmond the increase was 34.97%; Charlestown’s population increase was 21.32% followed by South Kingstown with 13.36%.

Urban areas in the vicinity of the City of Providence experienced a growth of more than 8.02%, Johnston had a 6.23% increase during the 1990s. The highest population increases in Kent County were East Greenwich at 9.13% and Coventry at 8.32%. Jamestown had a 12.46% increase and out in the East Bay, Tiverton‘s population growth rate was 6.63% for the past 10 years.

Population changes due to influxes of seasonal residents to summer homes and beach front cottages vary widely by location. In coastal areas west of Point Judith, Narragansett, seasonal changes in population range as high as

28 percent of the permanent population. In other coastal areas, excluding the urban areas of Providence and vicinity, seasonal changes in population are on average approximately 5 percent of the permanent population. The State's famous Cliff Walk and historic mansions are located in the City of Newport, on Aquidneck Island. Although the Newport region attracts and accommodates many short term tourists, the number of long term seasonal residents is minimal because access to most shore property is owned by large estates and year round residential homes. In the State's most urban areas, Providence, Warwick, Pawtucket, Cranston, and East Providence, there is less than one percent increase in population during the summer time due to seasonal residents

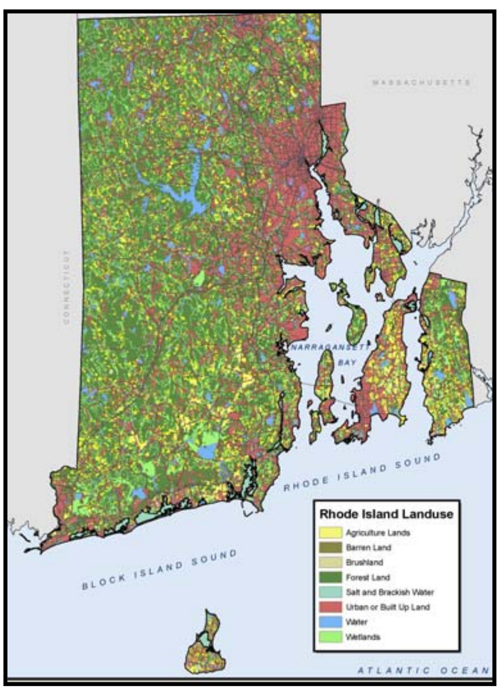
Population, Housing Units, Land & Water Area and Density 2000
TABLE 3-1

Geographic area	Population	Housing units	Area in square miles			Density per square mile of land area	
			Total area	Water area	Land area	Population	Housing units
Bristol County	50,648	19,881	44.71	20.03	24.68	2,051.8	805.4
Kent County	167,090	70,365	188.10	17.92	170.17	981.9	413.5
Newport County	85,433	39,561	313.64	209.59	104.05	821.1	380.2
Providence County	621,602	253,214	435.82	22.56	413.27	1,504.1	612.7
Washington County	123,546	56,816	562.77	230.02	332.75	371.3	170.7
Rhode Island	**1,048,319**	**439,837**	**1,545.05**	**500.12**	**1,044.93**	**1,003.2**	**420.9**

Source: U.S. Census Bureau, Census 2000 Summary File 1

Topography and Landforms

Rhode Island's coast comprises an estimated 190 miles along Block Island Sound,

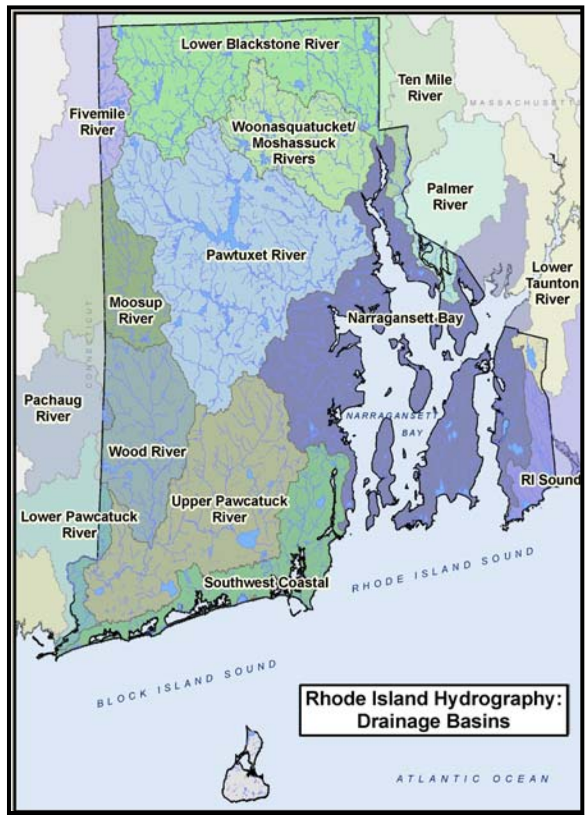


including Block Island, and an estimated 150 miles of shore along Narragansett Bay for a total coastline length (excluding shoreline around the islands in Narragansett Bay) extending approximately 340 miles. The shore is generally characterized as irregular and marked by many headlands, sandy beaches, inlets, and rocky shores. The southwestern coast is exposed directly to the Atlantic Ocean along Block Island Sound and is primarily made up of long barrier beaches fronting a series of salt ponds. The low dunes in the backshore offer some protection from mild storm surges. Shore areas of lower Narragansett Bay on the east and west shores are geologically similar in that they have many small pockets of sandy to rocky beaches located between massive ledge outcrops. The highly urbanized northern parts of Narragansett Bay are for the most part protected by a series of manmade and natural structures.

The state of Rhode Island has a total area of 1,104.5 square miles (the smallest state in the Nation), divided into two distinct of the New England province: the northwestern third of the state consists of hilly upland, and the remainder is in the seaboard lowland section which includes much of the eastern part of the state and a low-lying strip bordering the west shore of Narragansett Bay.

Rhode Island Rivers and Watersheds

Rhode Island's rivers and their associated watersheds, including those of lakes, ponds, reservoirs, wetlands, aquifers, and estuaries are vital resources. They supply the drinking water on which the population depends. They provide critical habitat to support biological diversity. Along with adjacent land, they are greenways of open space and support diverse recreational opportunities. The quality of life in Rhode Island is dependent on its river and estuary systems.



From a global perspective, Rhode Island is a small metropolis, an urban place of approximately a million people. Although much open space exists, all land has been fragmented, developed, or impacted by human activity; there is no wilderness. Agricultural and industrial uses of rivers have declined and the principal contemporary uses of rivers are now water supply, habitat, open space, and recreation. Rhode Island's rivers no longer support a commercial fishery.

To understand Rhode Island's rivers, lakes, ponds, and estuaries, it is helpful not to look at them individually, but to consider how the overall system of rivers and watersheds functions. Rhode Island's rivers and estuaries, and their watersheds, meet different, and in some respects competing needs. What must be improved, preserved, and better managed is the overall system.

The Pawtuxet River watershed contains the state's primary source of drinking water, the Scituate Reservoir. Through the Providence Water Supply system, it serves 60 percent of the state's population. The Big River offers a potential and important groundwater supply reserve. The Wood Pawcatuck watershed, with more than fifty miles of canoeable waterways, is a major recreational resource. It is also a sole source aquifer; the groundwater from municipal and private wells provides drinking water to much of southern Rhode Island. The Blackstone River Valley is the birthplace of the industrial revolution in the United States. Lakes and ponds, which were created to maintain water flow for industrial power in the western portion of the watershed, have become places of recreation. In the eastern portion they are drinking water supplies for the textile mill cities of Woonsocket, Pawtucket, and Central Falls.

The streams in the rocky uplands of western Rhode Island that drain into the Quinebaug River in Connecticut have once again become pristine because of reforestation. The rivers in the East Bay area and the streams and ponds on the state's larger islands are important sources of water supply although limited in quantity and vulnerable for their quality.

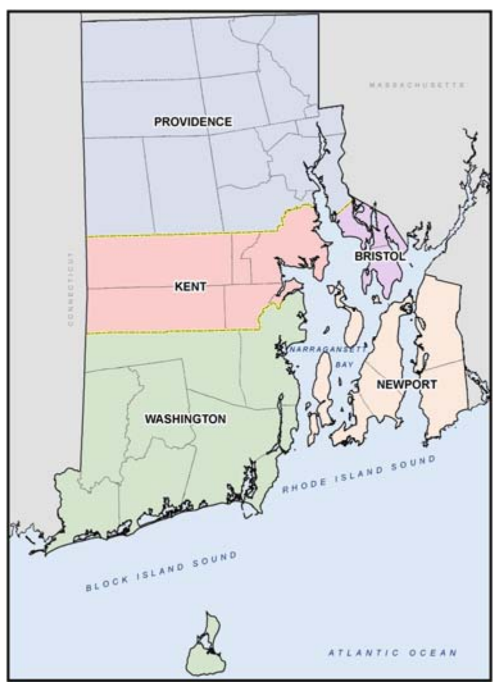
In urban areas, rivers play an increasingly important role as corridors of open space and recreation. The recreation potential and open space value of the Pawtuxet, the Woonasquatucket, the Blackstone, the Runnins, the Ten Mile, and the Saugatucket Rivers, and their estuaries are being explored and developed in a manner that will improve the health and amenity to the communities through which they pass.

Climate

The climate of Rhode Island varies considerably and has a significantly wide range of temperatures due to the diversity in elevation and inland distances from the ocean. Average temperatures may vary by as much as 20 degrees from the coast to the inland areas. The state experiences an average rainfall amount of 45 inches. Snow accumulation averages 37 inches annually, but may vary considerable from year to year.

Government Structure in Rhode Island

In Rhode Island the executive branch consists of five constitutional officers elected for fours years: Governor; Lieutenant Governor; Secretary of State, Attorney General, and General Treasurer. The State Legislature consists of 35 Senate members and 75 House members elected every two years.



There is no form of county government in Rhode Island. There are a total of 39 cities and towns, each with their own governing body. Rhode Island municipalities are governed by elected Mayors, appointed Town Administrators/Managers, and in smaller communities the Town Council. A current listing of state and municipal government agencies and contacts may be found at the State of Rhode Island web site www.ri.gov.

Rhode Island is characterized by very strong local "home rule." All local land use decisions are made by volunteer boards and commissions. The members of these boards and commissions are appointed by the CEO of each municipality. Prior experience and/or knowledge relative to the particular board or commission are not a requirement for appointment. Regarding land use decisions, all proposals for development would appear in an application before the following local boards and commissions, at a minimum, prior to approval:

- Planning Board
- Conservation Commission
- Zoning Board
- Harbor Management Commission (* Only if application is for a water-dependent use such as municipal docks/moorings, or expansion of a marina facility, and all applications that may impact coastal wetlands/and or habitats)
- Building Board of Appeals (if a variance from the State building code or NFIP is being sought)
- Town Council (*in the cases of substantial variances, approval of a proposed subdivision)

Review of applications for development also appears before various State Agencies prior to approval:

- Coastal Resources Management Council (applications within the coastal zone)
- Department of Environmental Management (all applications that may impact freshwater water wetlands, environmental habitats, applications requiring/modifying septic systems)
- Rhode Island Building Commission (in instances when a variance to the State Building Code is being sought)

3.2 Statewide Hazard Mitigation Planning Process

1994 – 2004 Hazard Mitigation Planning in Rhode Island

The Rhode Island Multi-Hazard Mitigation Plan is the culmination of a four year long process that involved state and federal agencies, local government, private sector and various public interest groups. To meet the objective of completing the Plan, over the past three years statewide and local workshops were held discussing the issues that affect Rhode Island and each community. In addition to the workshops, tabletop exercises were held, training sessions, Community Assistance Visits (CAVS) and Community Assistance Contacts (CACs), one-on-one interviews with state agency staff and local personnel. In all of these activities information was collected related to the identification of hazards, location of areas of vulnerabilities and how potential mitigation measures could be implemented within a community to lessen the negative impact of natural hazards.

Since 1994, Statewide Hazard Mitigation workshops have been held involving a diversity of participants including state agencies, cities and towns, and federal agencies. The focus of these meetings varied since the implementation of the 1996 FEMA National Mitigation Strategy. The primary focus has been identifying state and local hazards' issues, vulnerability and the lack of available funding for implementing mitigation projects and programs in Rhode Island. Nonetheless, statewide workshops, sponsored and facilitated by RIEMA have been held each year since 1994.

In 1998, a CEO Business Breakfast and Workshop was held in which the top 85 businesses in Rhode Island attended to discuss the issue of business continuity planning in the event of a natural disaster. This workshop was heavily attended and jointly hosted by the Governor and Lieutenant Governor, and sponsored by RIEMA and Allendale insurance. As a result of this successful CEO breakfast and the well attended forum that followed, Executive Order 98-13 was developed by a working group of private sector and state representatives. This Executive Order, also known as the Showcase State Initiative, was the first of its kind in the country, and was successfully adopted in December 1998.

In 1999, RIEMA hosted a statewide workshop solely addressing the topic of how to write and implement a local multi-hazard mitigation plan. At that time, RIEMA asked interested cities and towns to sign a letter of intent to develop a local hazard mitigation plan. Although no funding was available, RIEMA staff (two people) provided guidance and technical assistance to all thirty-nine communities. In order for each community to receive technical assistance from RIEMA they were required to establish a local hazard mitigation planning committee that would oversee the development and implementation of the hazard mitigation plan.

Since that time, all 39 communities have established local hazard mitigation committees, and all are developing their plans. During the initial meeting and subsequent meetings, local input has been gathered regarding local areas of interest and the potential implications of the state for the hazard mitigation strategy. In addition to forming the Committees and drafting the plan, they are also developing with the assistance of RIEMA and the University of Rhode Island Environmental Data Center (EDC) risk and vulnerability maps using geographical information software. In most cases, this is the first time these communities have seen the overlays of how various hazards will affect their communities and the locations of the areas of greatest vulnerabilities.

In 2000, a statewide risk assessment culminated funded by the National Oceanic Atmospheric Administration, Coastal Services Center (CSC). The Community Vulnerability Assessment Tool (CVAT) was developed by CSC and Rhode Island was the state to test it on a statewide basis. The NFIP Program Manager worked closely with David Odeh, of Odeh Engineers, to define the scope of the project, devise a methodology, identify the hazards to be measured and complete the assessment. In addition to developing a methodology to accurately assess the potential risk posed by each natural hazard to the State of Rhode Island, GIS mapping was used to portray all of the results. Census tract data from 2000 was used in order to have the ability to aggregate the data statewide in addition to breaking the information down for each of Rhode Island's 39 cities and towns for use in their local hazard mitigation plans.

In 2001, a concerted effort began to work with the 39 cities in towns of Rhode Island to assist them in developing their local hazard mitigation plans as mandated by the DMA 2000. The State Hazard Mitigation Officer (SHMO) met with each community's Local Hazard Mitigation Committee and provided the federal guidance. Drafts of the local plan were sent to the SHMO and then simply forwarded on to FEMA Region I for their review and comment.

From 2000 to 2004 annual statewide workshops were held addressing the components of the DMA planning requirements in order to provide ongoing oversight and technical assistance to the communities.

3.3 Coordination with State and Federal Agencies & Partnering with the Private Sector

Listed in the Table 3-2 is the descriptions of how all State and Federal agencies participated throughout the process of developing the Rhode Island State Hazard Mitigation Plan.

State Agency Involvement in the Development of the Multi-Hazard Mitigation Plan
TABLE 3-2

AGENCY	HOW AGENCY PARTICIPATED
RIEMA	Lead, write plan and facilitated all meetings
CRMC	Developed goals, provided data and guidance on all coastal issues
DBR	Provided input for private sector, developed goals and objectives
DEM	Provided data for dams, developed goals & projects; Parks & Recreation - provided acreages and all data on parks including potential purchase sites for open space
DOA	Provided inventory of state properties; RI GIS provided mapping, analyses of data derived from mapping efforts
DOT	Provided detailed risk assessments for bridges & roads; GIS of all evacuation routes & signs
PUC	Identified mitigation projects and polices relating to public utilities
RIBC	Developed goals and objectives; provided mitigation projects, policies relating to RI Building Code

Involvement by Other Interested Groups and Stakeholders

Stakeholders identified in Table 3-3 participated in a series of meetings held throughout the State of Rhode Island. Generally, these meetings served as a forum to develop ideas, approaches and consensus for the preparation of both local and a statewide hazard mitigation plan. These meetings allowed participants that had never met, to work together across state agency and public and private sectors to identify and achieve common goals. Private interests worked with local and state agencies to develop goals that would serve both public and private interests.

Throughout this process, keen education awareness commenced advocating the necessity for public and private partnerships in order to reduce the damages caused by natural disasters. Community leaders began to understand and believe in the importance of protecting both public and private infrastructure in order to minimize the financial and social impacts created by the after affects of storm damage. Many subcommittees and work groups comprised of both private and public interests were formed over the course of stakeholder building and their involvement is described in Table 3-3 below.

Identified Stakeholders to the Rhode Island
Multi-Hazards Mitigation Plan
TABLE 3-3

Stakeholder Type	Agency/Organization	Department (if applicable)	Participation
Academia	Brown University	GIS	Urban flood risk
Academia	University of Rhode Island	Environmental Data Center, College of Business Administration	Risk & assessment maps, critical Facilities inventories
Academia	Rhode Island Sea Grant	Coastal Resources Center	Public outreach
Corporate	Amica Mutual Insurance Company		Host CEO breakfast, meetings with business partners
Corporate	AT&T Wireless Services		Business Continuity Planning
Corporate	Beacon Mutual Insurance Company		Business Continuity Planning
Corporate	Blue Cross/Blue Shield	Business Resumption Planning	Business Continuity Planning
Corporate	The C.J. Fox Company		Business Continuity Planning
Corporate	Eastern Utilities		Business Continuity Planning
Corporate	FM Global	Engineering	Business Continuity Planning
Corporate	Institute for Business & Home Safety	Engineering Services, Showcase Programs, Outreach	Developed Showcase State Initiative
Corporate	Meredith & Clarke Inc.	Architects	Disaster recovery committee
Corporate	Metlife Auto & Home	Legislative & Regulatory Affairs	Showcase State partners, hosted many meetings with businesses
Corporate	Narragansett Electric	Business Services	Business Continuity Planning
Corporate	Odeh Engineers		State risk & vulnerability
Corporate	Pineapple Studios		All video footage and photography
Corporate	R.I. Joint Reinsurance Association	Underwriting Services	Showcase State Committee

Federal	National Oceanic And Atmospheric Administration	Coastal Services Center	Funded CVAT tool and all RVA work
Federal	Natural Resource Conservation Service		Pocassett Watershed study and H&H
Federal	National Weather Service	Taunton Office	Public education and outreach
Federal	Offices of U.S. Senator Jack Reed		Full support of Showcase State Initiative
Federal	Offices of U.S. Senator Lincoln Chafee		Full support of Showcase State Initiative
Federal	U.S. Army Corps of Engineers	New England District	Ongoing RI projects in habitat restoration
Federal	U.S. Coast Guard		Marine and port issues
Federal	U.S. Geological Survey		
Nonprofit	Rhode Island Red Cross	Disaster Services	Shelter issues
State	Building Commission	State Building Code Commissioner	Building code recommendations
State	Coastal Resources Management Council	Policy Staff	Coastal setback issues and coastal erosion
State	Department of Administration	Statewide Planning, Community Planning & Development, GIS	Mapping, Growth Mgt, Comp Plans
State	Department of Business Regulation		Open For Business/CEO breakfast
State	Department of Elementary & Secondary Education		School curriculum development
State	Department of Environmental Management	Dams Division, Division of Forestry, Wetlands, Parks and Recreation	Inventory of dams, forests, wetlands and open space. Recommendations given for all issue areas.
State	Department of Transportation	Division of Highways & Bridges	Extensive data given on bridges & infrastructure
State	E-911		Geo-referenced point data collected for 911 shared with GIS efforts for mapping
State	Economic Development Corporation	Tourism & Port of Providence	Data collected re tourism revenues and port issues
State	Fire Marshall's Office		SHMC member; plan oversight
State	Historical Preservation & Heritage Commission		MOA devised regarding recovery process; inventory of historic structures provided
State	Insurance Commissioners Office		SHMC member; plan oversight
State	Office of the Governor		Implementation of 98-13 EO
State	Office of the Lieutenant Governor		Plan oversight
State	Public Utilities Commission		SHMC member; plan oversight; recommendations for mitigation projects
State	R.I. Airport Corporation		SHMC member; plan oversight; recommendations for mitigation projects
State	Water Resources Board		Collaboration and integration of state drought plan
State Associations	League of Cities and Towns		Comments solicited, workshops attended
State Associations	American Planning Association		Comments solicited, workshops attended

State Associations	Building Officials	Comments received via trainings, CAVs and workshops
Stewardship	Rhode Island Rivers Council	Incorporation of RI Rivers and Watersheds Plan
Stewardship	Save the Bay	Comments solicited, workshops attended
Stewardship	Smart Growth	Comments solicited, workshops attended

3.4 Planning Process for the State Mitigation Plan

State Hazard Mitigation Committee

The Rhode Island Multi-Hazard Mitigation Plan was prepared by the State NFIP Program Manager. Described below are the various groups and individuals that she worked with over the years to develop a State Multi-Hazard Mitigation Plan meeting the federal criteria as set out in the DMA 2000 mandate. The primary group responsible for oversight of the plan is the State Hazard Mitigation Committee. The Rhode Island State Hazard Mitigation Committee was established to identify current hazard mitigation needs, to review project applications and set priorities, and to update previous recommendations. The committee consists of representatives of various state agencies and meets on a quarterly basis to evaluate applications which require their particular expertise and to aid in the follow-up efforts when those applications become projects. The Committee prioritizes the project applications and makes their recommendations to the Governor's authorized representative.

The State Hazard Mitigation Committee (SHMC) provided guidance and assisted with development of the State Hazard Mitigation Plan, including review of previous hazard mitigation planning initiatives and development of the Mitigation Strategy and Action Plan. The members of the Committee provided the center point of state agency coordination. The advantage of this group is that it provides a cross-disciplinary forum in which to discuss the myriad of statewide hazard mitigation issues. This Committee also provides expertise and perspective to the planning process, including state and local emergency management initiatives throughout Rhode Island, natural hazards, land-use planning, building codes, transportation, state owned/operated facilities, critical facilities, state agency capability assessment analyses and public infrastructure.

From 2002 to 2004, during the Committee’s quarterly meetings, each state agency was asked to provide a presentation and submit a report on how hazard mitigation related to the roles and responsibilities of their agency and how hazard mitigation polices, programs and projects could be integrated within their agency. These presentations were extremely informative, and the information is integrated throughout the Plan as appropriate.

The State Hazard Mitigation Committee is comprised of representatives from the following state agencies:

1. Department of Transportation
2. State Building Commissioner
3. National Flood Insurance Program Coordinator
4. Earthquake State Coordinator
5. Hurricane State Coordinator
6. Department of Environmental Management (Dam Safety & Parks and Recreation)
7. Division of Public Utilities & Carriers
8. State Fire Marshal's Office
9. Coastal Resources Management Council
10. Department of Business Regulations
11. Insurance Commissioner's Office
12. Private Building & Construction Industry
13. Water Resources Board
14. Department of Administration
    - Statewide Planning
    - Risk Manager

4. State Risk Assessment

Natural hazards become disasters once they have resulted in the loss of lives and injuries, caused damage to property and interrupted the normal operations of government, community and businesses within those communities.

Heinz Center, The Hidden Cost of Coastal Hazards

In this section natural hazards will be ranked in order of priority based on the frequency of occurrence and area of impact affected. The purpose of this section is to provide a statewide overview of how various natural hazards impact the State of Rhode Island.

4.1 Ranking Natural Hazards

Between 1985 and 2004, the U.S. endured 54 weather-related disasters in which overall damages and costs reached or exceeded $1 billion per event. Of these disasters from natural hazards, 45 occurred during the 1988-2004 period with total damage and related costs of nearly $200 billion for that period.

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.
In order to fulfill the planning guidelines outlined in the Disaster Mitigation Act of 2000, this State Multi-Hazard Mitigation Plan focuses on the risk assessment, analysis and recommendations for natural hazards mitigation only and not the man-made hazards (i.e. structural fires, hazardous materials or terrorism). Sections of this plan, such as critical infrastructure maps, may be utilized to develop other long-term mitigation strategies for man-made hazards.

Rhode Island has experienced its share of natural disasters in the past 70 years. Hurricanes and related coastal flooding, winter storms and riverine flooding affect Rhode Island on a recurring basis. Rhode Island's vulnerability to hurricanes is rated high. Many communities in the state have exposed coastal areas that are very vulnerable to a hurricane storm surge, particularly the associated wave actions and wind hazards. Much of the coastline on the Atlantic Ocean consists of barrier beaches that are open to the full force of destructive hurricane waves. Other damages associated with hurricanes include inland flooding, coastal erosion and tornadoes. The most serious inland flood threats occur when the eye of the hurricane passes just to the west of Rhode Island at a time of high tide. This type of flooding poses an additional health risk as it involves the overflow of storm-sewer systems and is usually caused by inadequate drainage following heavy rain, rapid snow melt or an extreme storm surge up Narragansett Bay.

Identifying the risk and vulnerability for a community is the primary factor in determining how to allocate finite resources to address what mitigation actions to take. The hazard analysis involves identifying all of the hazards that potentially threaten Rhode Island and then analyze 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.

For multi-hazard identification, all hazards that may potentially impact the state should be identified including both natural hazards and cascading emergencies - situations when one hazard triggers others sequentially. For example, severe flooding that damaged buildings storing hazardous water-reactive chemicals could result in critical contamination problems that would dramatically escalate the type and magnitude of events. Dam failures may occur as a result of an earthquake creating a dangerous flash flooding scenario for communities located in dam inundation areas.

Prioritization of Natural Hazards in Rhode Island

In order to fulfill the planning guidelines outlined in the Disaster Mitigation Act of 2000, this State Multi-Hazard Mitigation Plan focuses on natural hazards only and not man-made hazards (i.e. structural fires, hazardous materials, chemical spills, weapons of mass destruction).

For the purposes of the Rhode Island Multi-Hazards Mitigation Plan's risk assessment, 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:

1. **Flood-related hazards**
2. **Wind-related hazards**
3. **Winter-related hazards**
4. **Drought**
5. **Geologic-related hazards**

Other Potential Hazards

The following hazards will not be addressed in the State Hazard Mitigation Plan:

1. Volcanoes (not applicable because there are no volcanoes in RI)
2. Tsunamis
3. Landslides
4. Flash floods
5. Land Subsidence
6. Avalanche (not applicable because there are no mountains in RI)
7. Expansive soils
8. Extreme heat
9. Hail
10. Wildfire

These hazards were discussed by the State Hazard Mitigation Committee and it was decided that due to the lack of frequency in which they occur and/or the minimal probability of their occurrence, in addition to the lack of resources to devote any amount of time to further research the likelihood or potential occurrence or impact, these natural hazards were dropped off the priority list for now. Until such time that adequate resources and expertise is available to study these hazards, or unless they begin to impact the state and/or region these hazards will be put aside for now.

4.2 Profiling Hazards: Location, History and Probability of Future Occurrence

In this section information will describe (as available) how and where natural hazards impact the State of Rhode Island. As information was available, GIS maps depict the locations where natural hazards impact the state. Also included in this section is a brief history of the most recent and significant natural hazard events that have occurred in Rhode Island over the last couple of decades. Finally, based on the availability of relevant data, estimates are given as to the probability of each hazard to recur.

Assessing Risk and Vulnerability by Jurisdiction

The only risk and vulnerability assessment in this Plan is the statewide risk and vulnerability assessment. This is due to the fact that no local hazard mitigation plans were completed or approved by FEMA by the time of the deadline for inclusion into the State Plan (June 2004). However, information from the local hazard mitigation plans will be incorporated during the first update of the Plan as RIEMA receives FEMA approved local plans. This is addressed in Mitigation Action Item 2.1.1.

4.2.1 Flood-Related Hazards

Flooding is a localized hazard that is generally the result of excessive precipitation. Flooding is the most common natural hazard, due to the widespread geographical distribution of river valleys and coastal areas, and the attraction of human settlements to these areas. Floods are among the most frequent and costly natural disasters in terms of human hardship and economic loss. Seventy-five percent of federal disaster declarations are related to flooding. Property damage from flooding totals over $5 billion in the United States each year. The number of people vulnerable to floods is expected to double to 2 billion worldwide by 2050 due to global warming, deforestation, rising sea levels, and population growth in flood-prone areas. One billion people, roughly a sixth of the world's population, now live in the potential path of a worst-case flood, and most of these are among the planet's poorest (United Nations). Floods already kill as many as 25,000 people each year and cost the world economy up to $60 billion per year, much of it in developing nations ill-equipped to cope with such huge costs. (Reuters, United Nations report 6/15/2004). The following section includes brief descriptions of the various types of flood-related hazards most likely to affect Rhode Island.

What is a Floodplain?

A flood, which can be slow or fast rising but generally develops over a period of days, is defined by the National Flood Insurance Program 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 of 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 subject to geo-morphic (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 then natural benefits are either lost, altered, or significantly reduced. http://www.friendsoftheriver.org/Publications/BeyondFlood Control/no5.html.

Types of Flooding in Rhode Island

Flooding in Rhode Island is often the direct result of other frequent weather events such as spring snow melt combined with heavy rains, coastal storms, also known as "nor'easters," heavy rainstorms, tropical storms and hurricanes, and the very dangerous potential of dam breeches. For discussion purposes, these flood events have been separated into four categories: riverine, coastal, urban storm water and dam breeches.

Riverine Flooding

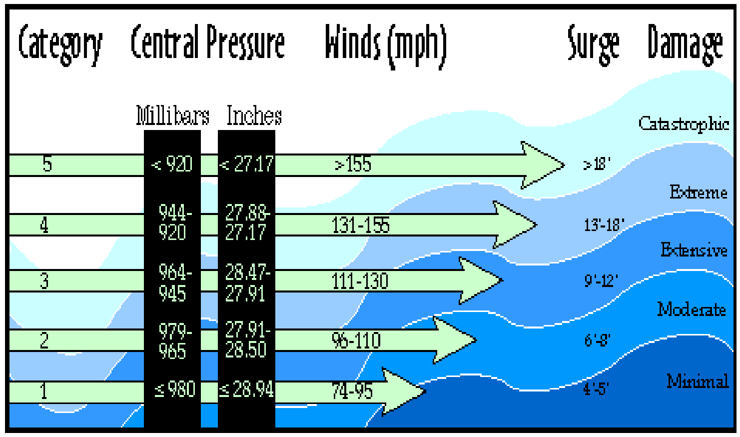
Riverine flooding, a function of precipitation levels (both rain and snow) and water runoff volumes within the stream or river, is defined as the periodic occurrence of over bank flows of rivers or streams resulting in partial or complete inundation of the adjacent floodplain. The recurrence interval of a flood is defined as the average time interval, in years, expected to take place between the occurrence 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.

Coastal Flooding

Coastal flooding is typically a result of storm surge, nor'easters, wind-driven waves, and coastal erosion (natural barrier of the coastline is eroded away and water floods the area.) These conditions are produced by hurricanes during the summer and fall, and nor'easters and other large coastal storms during the 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.

Storm Surge
Another type of coastal flooding that impacts the state of Rhode Island is storm surge. Storm surge is the abnormal rise in water level caused by the wind and pressure forces of a hurricane or nor'easter (typically a winter coastal event). Nationally, storm surge flooding has caused billions of dollars in damage and hundreds of deaths (e.g. storm surge from Hurricane Camille in 1969 accounted for 100 deaths alone and, in 1900, more than 6,000 people drowned in the storm surge from a hurricane that struck Galveston, Texas). Given today's ever increasing population densities in coastal communities, the need for information about the potential for flooding from storm surge has become even more important.

Factors Influencing Storm Surge
There are a number of factors which contribute to the generation of storm surge but the fundamental forcing mechanism is wind and the resultant frictional stress it imposes on the water surface. Winds blowing over a water surface generate horizontal surface currents flowing in the general direction of the wind. These surface currents in turn create subsurface currents which, depending on the intensity and forward speed of the hurricane, may extend from one to several hundred feet below the surface. If these currents are in the onshore direction, water begins to pile up as it is impeded by the shoaling continental shelf causing the water surface to rise. This “dome of water” will increase shoreward until it reaches a maximum height at the shoreline or at some distance inland. The most conducive bathymetry for the formation of large storm surges is a wide gently sloping continental shelf.



The magnitude of storm surge within a coastal basin is governed by both the meteorological parameters of the hurricane and the physical characteristics of the basin. The meteorological aspects include the hurricane's size, measured by the radius of maximum winds; its intensity, measured by sea level pressure and maximum surface wind speeds at the storm center; its path, or forward track of the storm; and the storm's forward speed. The radius of maximum winds is 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 4 miles to as much as 50 miles.

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. This phenomenon has been observed in regions where the shoreline is typical 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 large 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.

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/the approximate rate of 13.2 inches per inch of mercury drop. This can account for a rise of one to two 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.

<u>Nor'easters</u>
A northeast coastal storm, known as a nor'easter, is typically a large counter-clockwise wind circulation around a low pressure center. The storm radius is often as large as 1000 miles, and the horizontal storm speed is about 25 miles per hour, traveling up the eastern United States coast. Sustained wind speeds of 10-40 mph are common during a northeaster with short term wind speeds gusting up to 70 mph. Nor'easters typically occur in the winter months and unlike hurricanes and tropical storms, nor'easters can sit off shore reeking 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 natural resources, such as beaches, dunes and coastal bluffs. The erosion of coastal features commonly results in greater potential for damage to shoreline development from future storms.

This type of storm is a primary concern for Rhode Island residents not only because of the damage potential in any given storm, but because there is a frequent rate of recurrence. Nor'easters have an average frequency of 1 or 2 per year with a storm surge equal to or greater than 2.0 feet. The comparison of hurricanes to northeasters reveals that the duration of high surge and winds in a hurricane is 6 to 12 hours while a noreaster's duration can be from 12 hours to 3 days.

The amount of damage resulting from a strong hurricane is often more severe than a nor'easter but historically, Rhode Island has suffered more damage from nor'easters because of the greater frequency in which they occur. Additionally, nor'easters most frequently cause the greatest amount of coastal erosion in which the damages resulting from that are much more costly than localized areas of flooding. In additiol to the financial impacts from coastal erosion being much higher than localized flooding, often when coastal erosion occurs FEMA does not consider the resulting damages to be eligible for public or individual federal financial assistance.

Urban Flooding/Stormwater Runoff

Urban flooding occurs where there has been development within stream floodplains. This is partly 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 the ensuing 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 areas flooding is due to poor or insufficient storm water 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 archaic sewer systems (or combined sewer overflows – CSOs) are overrun and this results in raw sewage flowing into Narragansett Bay, often creating Bay closures to shellfishing and swimming.

Coastal Erosion

"Today's coastline is of economical, social, cultural, and environmental value to communities and to nations. However, shorelines are dynamic and ephemeral places where erosion trends tend to dominate. Development along the shore places the desires of man (to have a safe and stable home) in direct opposition to the natural trends of nature (to erode, transport, and deposit coastal lands)."

Joan Pope, U.S. Army Corps of Engineers

Coastal zones are dynamic areas that are constantly undergoing change in response to a multitude of factors including sea level rise, 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 sea level rise, all 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.

Erosion has been wearing away beaches and bluffs 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 may become severely damaged beyond use, uninhabitable, or surrender to the powers of the sea. 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 also subject to the highest risk of flooding. Some additional damage will also occur along eroding coastal bluffs.

The beaches 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 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 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.

How and Why Coastal Erosion Affects Rhode Island's Shoreline

Beaches change their shape, depth, and slope in response to wind, wave, and current forces, and the availability of sand. The sources and sinks of sand within a particular beach system and the mechanisms by which they affect the beach morphology are often cumulatively referred to as the sediment budget of the beach. Seaward sources of sand to the sediment budget of a beach include longshore currents moving sand along the coast and cross shore currents moving sand onshore. Landward sources of beach sand include dunes, ancient shorelines, and other onshore sand deposits that release sand to the beach by the forces of the wind and waves. High waves will cause a beach to change its shape, or profile by redistributing sand across the shoreline.

Rhode Island's beaches 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 smaller 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.

Coastal Erosion vs. Beach Loss

It is important to understand the difference between coastal erosion and beach loss. Coastal lands may experience long-term erosion under some conditions. For instance, if the sea level is rising, the beach must eventually migrate landward or drown. This causes coastal land behind the beach to erode. The beach then, remains wide and healthy as it moves with the eroding coastline. If sand is not available to a beach on a chronically eroding shoreline, then beach erosion will ensue, leading to narrowing and eventual beach loss. Beach narrowing and loss occurs where sand supplies are diminished or discontinued (sand supply is usually blocked by manmade structures such as groins, jetties and armoring). Beaches on eroding coasts still undergo seasonal profile adjustments, but they slowly shift their position landward as the land continues to erode without a sand supply.

Chronic Erosion

Chronic erosion may also be caused by repeated episodes of high surf constantly drawing sand stores from the upland area of the beach to feed the beach profile. Along most New England shorelines, sands stored in dunes and fossil shorelines are moved onto the beach by this process. Beaches benefit from this source of sand, in order to remain wide and healthy, even as the land behind them may erode. Chronic erosion, then, causes land loss, not beach loss. Armoring, or hardening of the shoreline with seawalls and revetments to stop chronic coastal land loss, often refocuses wave forces onto the beach in front of the seawall. Beach erosion ensues, leading to a volumetric loss of sand that result in beach narrowing and eventually beach loss.

Episodic Erosion

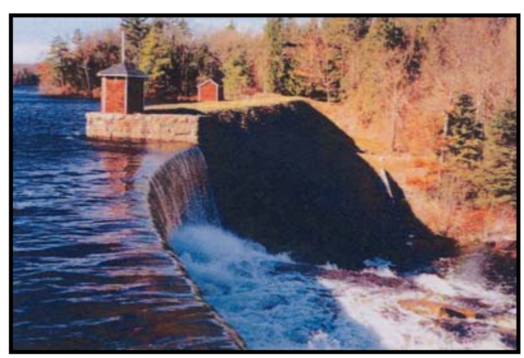
Episodic erosion is also a concern for many of Rhode Island's beaches, especially those lacking a fringing reef and exposed to seasonally high waves. On these beaches a single unusually large wave event or high wave season can cause severe coastal erosion. The vegetation line may retreat as much as 60 feet or more, but if the erosive event is followed by a long period of normal wave conditions, the shoreline can recover, often accreting back to its pre-event location. Beaches subject to rapid erosion and accretion cycles are referred to as dynamic and include barrier islands, headlands and inlets. There may be little or no long-term trend of shoreline erosion, but the risk of episodic erosion remains.

Highly variable local patterns of wind and wave dynamics can be important keys to dispelling misunderstandings of beach processes. Waves are the key factor in the process of coastal retreat because they are able to reach high onto the beach and into the dunes during certain seasons of the year when they are at their maximum height. This reach allows sand to be transported back to the beach face to "make deposits into the beach sand budget. Natural features such as reefs, offshore channels, and offshore depth variability, as well as the orientation of the coast relative to the prevailing winds and approach of distant waves, drive waves in different ways. Man made structures such as jetties, groins, seawalls and armoring blocks the waves from carrying sand back onto the beach, often resulting in scoured and eroded areas.

Dam Breeches

Rhode Island Dam Safety Program

The Rhode Island dam inspection and inventory program had its inception in 1883, and was under the authority and responsibility of the Commissioner of Dams and Reservoirs. As set forth in Rhode Island General Laws, Chapters 46-18 and 46-19, a dam owner has the responsibility for the safe operation of their dam, and is liable for the consequences of accidents or failures of the dam. In general, a dam owner is required to use *"reasonable care"* in the operation and maintenance of a dam and/or reservoir.



This responsibility includes the proper operation, maintenance, repair and rehabilitation of a dam, which are the essential elements in preventing a dam failure.

The regulations governing the administration and enforcement of Rhode Island's Dam Safety Program is contained in the General Laws of Rhode Island, Chapter 46-19. The Department of Environmental Management (DEM or Department) has the responsibility to inspect dams to determine their condition, to review and approve plans for construction or substantial alteration of a dam or reservoir and to order the owner to make repairs or to take other necessary action to make the dam or reservoir safe.

<u>Dam Classification Program</u>
Today there are 565 registered dams in the State. All of the 565 registered dams have been classified by size. This classification provides a relative description of Small, Medium or Large, based on the storage capacity and height of the impounded water. Of Rhode Island's registered dams 195 meet or exceed the minimum criteria for a Small dam, and have been classified as Small, Medium or Large. The remaining 370 dams are below the minimum criteria used to define a Small dam; however, for program identification reasons they have been classified as small dams.

The 195 dams have also been classified to identify the potential hazard to human life and property in the event of a dam failure. These classifications are as follows:

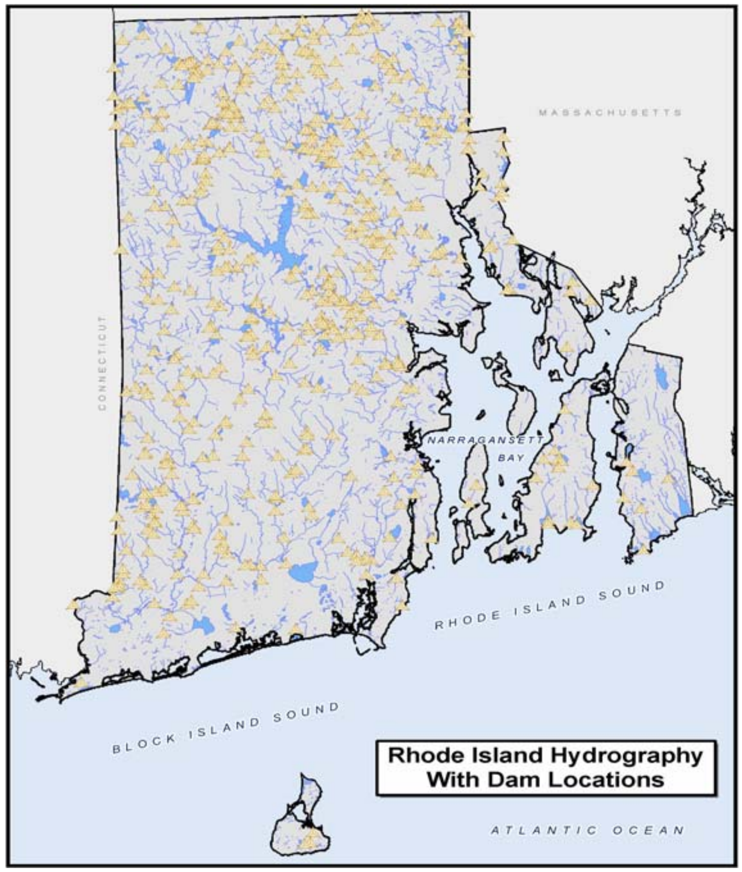
> **High Hazard –** Failure of the dam would most probably result in the loss of more than a few lives and extensive property damage.
>
> **Significant Hazard –** Failure of the dam could possibly result in the loss of life and appreciable property damage.
>
> **Low Hazard –** Failure of the dam would result in no apparent loss of life and only minimal or no property damage.

As is indicated above, these classifications relate to the potential for harm if the dam fails; it does not relate to the current condition of the dam. There are currently 16 high hazard dams, 41 significant hazard dams and 138 low hazard dams classified. The remaining 370 dams, whose size is below the minimum criteria used to define a Small dam (as explained above), have not been assigned a hazard classification but are assumed to be Low Hazard. These hazard classifications were assigned in the late 1970's and early 1980's. However, due to additional development downstream of dams, some of the classifications are most likely no longer accurate.

Location of High & Significant Hazard Dams

A map of high and significant hazard dams depicts points over Rhode Island (see next page). The location of low hazard dams was not included so as to minimize map clutter. The Rhode Island Division of Dam Safety, under the Department of Environmental Management (DEM) maintains a database of all publicly and privately owned dams in

Rhode Island. This database includes all high hazard, significant hazard and low hazard dams including all of the high hazard dams currently listed in the National Dam Inventory which has been developed as part of the National Dam Safety Program under the U.S. Army Corps of Engineers (per Public Law 92-367).



In terms of dam inundation maps, they have never been developed for Rhode Island. This is a critical planning tool, because many of the high and significant hazard dams, since built, now have densely developed areas in what may be areas of inundation should the dam fail. However, due to a severe lack of funding, resources and staff at both DEM's Dam Safety Division and RIEMA, dam inundation mapping initiatives have not taken place. This data deficiency has been addressed in Mitigation Action Item 3.3.3

History of Dam Failures

There is no database that has information on past dam failures. This data deficiency has been addressed under Mitigation Action Item, 3.3.3

Probability of Future Occurrences

This information is not readily available. Without information on past dam failures and location of potential dam failures or dam inundation maps, or even an accurate updated dam categorization inventory it is impossible to predict the probability of future dam failures with any accountability. To address this data deficiency a mitigation action item has been added, see Action Item 3.3.3.

<u>Inspection Program</u>
Each dam's classification and size determines the frequency of inspection. The higher the classification and size, the more frequently the inspection is conducted. A dam of any classification would also be inspected upon request by the owner, a town/city official, or

by a person owning or representing property liable to damage from the dam. The inspections performed by DEM are visual inspections and are conducted under a general inspection format based on guidelines established in 1976 by the United States Army Corps of Engineers (ACOE) for the National Program for the Inspection of (Non-Federal) Dams.

Following a visual inspection, a dam inspection report is prepared, identifying specific deficiencies and, when warranted, recommending corrective measures. A copy of the report is forwarded to the owner, with the expectation that the deficiencies will be corrected. However, unless the Department has determined that a dam is unsafe, the current law only authorizes the Department to recommend corrective measures, rather than requiring them. If a dam is determined to be unsafe, then the Department may order corrective actions.

Significant Hazard Dam Inspections

In 1999, a review of the Department's records indicated that many of the significant hazard dams had not been inspected for many years. Given the potential for loss of life and/or property damage in the event of failure of a significant hazard dam, the Department began inspections of these dams in 1999. The remaining 10 significant hazard dams were inspected in 2000 (see Table 4-1).

As part of each visual inspection, the conditions of the major components of the dam were subjectively rated as Good, Fair or Poor. The major components of a dam are the embankment, the spillway and the drawdown gate. “Good” is defined as meeting minimum guidelines, whereas no irregularities are observed and the component appears to be maintained properly. “Fair” pertains to a component which requires maintenance which has

Significant Hazard Dam Inspections
TABLE 4-1

Dam Name	City/Town	Embankment	Spillway	Gate
Woonsocket Falls	Woonsocket	N/a	Good	Good
Woonsocket No. 1	Lincoln./ N. Smithfield	Good to fair	Fair	N/A
Waterman Lake	Glocester/ Smithfield	Poor	Poor	Good
Slack	Smithfield	Fair	Good	Fair
Greystone	N.Providence/ Johnston	Good to fair	Fair	Good
Barden	Scituate	Good to Fair	Good to Fair	Not Inspected
Wyoming Upper	Hopkinton/ Richmond	Good to Poor	Fair	Poor
Locustville	Hopkinton	Fair	Fair	N/A
Lawton Valley	Portsmouth	Good to Fair	Good	Not Inspected
Watson, Harold E.	Little Compton	Good to Fair	Good	Not Inspected

not led to the requirement of repairs (i.e. missing mortar in a masonry wall that has not yet caused displacement of the masonry units). “Poor” indicates a component that has progressed beyond improper maintenance and requires repair; the component no longer functions as it was originally intended (i.e. a drawdown gate with a removed lifting mechanism and a blocked outlet, or an earthen embankment with extensive, deep rooted vegetation). A component rated as poor requires an engineering evaluation and extensive work to return it to proper order.

Low Hazard Dam Inspections
State law requires the Department to inspect any dam following a request by the owner or some other interested party which could receive harm by the failure of the dam. Table 4-2 is a list of low hazard dams were inspected based on such requests.

Low Hazard Dam Inspections
TABLE 4-2

Dam Name	City/Town	Embankment	Spillway	Gate
Cherry Valley	Glocester	Fair	Good	N/A
Yorker Mill	Exter	Fair to Poor	Fair to Poor	Poor
Alton	Hopkinton/Richmond	Fair	Good	Not Inspected
Shannock Mill	Richmond/Charlestown	N/A	Fair	Poor
Potter Hill	Hopkinton	N/A	Fair	Fair
New	Glocester	Poor	Poor	N/A
Standard Oil	East Providence			Failed
Mill	North Kingstown	Breached		
Mowry Meadow	Glocester	Poor	Poor	Fair to Poor

In 1999, neighborhood concerns following Hurricane Floyd prompted DEM to inspect Dam no. 177 - Tiogue Lake in Coventry. The inspection was part of an ongoing investigation to determine if the dam, which is owned and operated by three separate parties, is maintained in a safe manner. The investigation has continued through 2000, and in July, the Department issued an informal enforcement action requiring a return of the spillway to its designed operation. Compliance has not yet been attained.

Dam Safety and Maintenance Task Force
On May 31, 2000 the Governor signed an executive order to create a Dam Safety and Maintenance Task Force. The Task Force was charged with developing recommendations for a comprehensive program of monitoring, maintenance and repairs that will enhance upkeep and safety of the dams in the State.

The Task Force, co-chaired by the Directors of DEM and of the RI Emergency Management Agency (RIEMA), and the State National Floodplain Program Manager was comprised of representatives from the RI Budget Office, the RI Clean Water Finance Agency, the Natural Resources Conservation Service, Public Works Directors for three Rhode Island municipalities, five dam associations, two dam owners, and four members of the General Assembly (not all General Assembly members were officially appointed to the task force). The Task Force convened for 12 two hour sessions over a six month period, and finalized their recommendations in a report dated January 2001. The recommendations included legislative, regulatory, administrative and policy proposals designed to protect public safety, create an efficient approach to dam repairs and ensure a timely response should a community be threatened by a dam failure. The report was forwarded to the Governor and the General Assembly, and dam safety legislation was introduced in February 2001 but failed to pass.

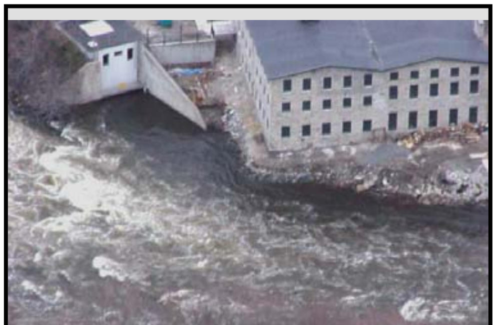
Professional Associations
Rhode Island has been a member of the Association of State Dam Safety Officials (ASDSO) since its inception in Denver, Colorado in 1984. ASDSO membership consists of state representatives along with corporate and individual members representing dam owners and professional engineering firms. ASDSO was formed to serve these initial functions:

- Improve efficiency and effectiveness of state dam safety programs;
- Foster public awareness;
- Facilitate inter-organizational, intergovernmental and interstate cooperation;
- Assist the dam safety community and provide a forum for the exchange of information;
- Provide representation of dam safety interests before state legislatures and before Congress; and
- Manage the association effectively through internal policies and procedures.

ASDSO has helped to improve dam safety in Rhode Island mainly through its sponsorship of regional dam safety workshops and its national annual conferences. In addition, various grants have provided funds for the purchase of computers, camera and video equipment and various types of field equipment to aid in the inspection and inventory of dams. These grant programs have also been supported, in part, by FEMA. To further promote dam safety in Rhode Island and to foster interstate cooperation with our neighboring New England states, Rhode Island has been a member of the New England Association for Dam Safety (NEADS) since its inception in 1982. NEADS is comprised of delegates from each of the six New England states, each of whom is responsible for administering and/or managing the respective state's dam safety program.

Location and History of Flooding in Rhode Island

Coastal, Riverine Flooding and Urban/Stormwater Runoff


Woonsocket Mill March 31, 2001

There has not been a disaster declaration for flooding; the last two were for hurricanes in which the issue was wind and debris. Information listed in Table 4-3 was collected from the National Climatic Data Center from NOAA. The information is helpful in that it does give dates, however damage costs and other detailed data is not available. Any other information may be in the local plans which are currently being developed. One of the priority mitigation actions in the next two years is to integrate all local mitigation plan data into the state plan. Because flooding is a much localized problem in Rhode Island, any available information related to flooding in communities will be very important to retrieve and compile into a statewide database. The information below has been collected from the files of the previous State Floodplain Manager, various state agencies' records, and all information gathered from NFIP Community Assistance Visits (CAVs).

Anecdotal Flood Information

Record tidal flooding occurred along Narragansett Bay and the south coast as a result of the September 1938 hurricane. Damage from the 1938 hurricane resulted from a combination of sustained heavy rainfall, high tides, and intense hurricane winds that caused record tidal surges in the coastal areas, plus near record runoff in the interior streams. Personal injuries were exacerbated by the complete lack of forecast of the storm. Many of the fatalities occurred within municipal and shore line areas where individuals were drowned, crushed under falling debris, or swept away within structures and vehicles and washed out to sea. Disastrous losses were also experienced from coastal flooding caused by Hurricanes Carol and Edna in August and September 1954.

Flood Events from 1950 to 2004
Table 4-3

Location	Date	Type	Property Damage	Precip Amount	Comments
Statewide	3/30/93 – 4/2/93	Coastal, riverine & urban flooding	N/A	N/A	Blackstone crested at 1 foot below flood stage, flooding from Pawtuxet River onto Woodbury Ave, Wellington and Marine Rd in Cranston, flooding in Natic section of West Warwick, flooding in Charlestown from Pawcatuck River
Statewide	1/28/96	Coastal, riverine & urban flooding	N/A	2"	Heavy winds & rainfall combined with low temps and snow melt
Statewide	4/17/96	Coastal, riverine & urban flooding	N/A	N/A	Heavy rains combined with snow melt , ground saturated. Blackstone crested above one foot flood stage, Paxtuxet crested above flood stage
Statewide	10/21/96	Riverine & urban flooding	N/A	N/A	Slow moving Nor'easter, brought heavy rain and winds. Blackstone crested .3 foot above flood stage
Newport Tiverton, Portsmouth, Barrington, Providence	1/10/97	Coastal storm surge	N/A	N/A	High moon tides and heavy winds created 2-4' storm surge levels. Water came within one foot of topping the hurricane barrier, some coastal roads flooded out in other communities

Statewide	8/29/97	Coastal, riverine & urban flooding	N/A	3 – 6”	Slow moving front, heavy rain fell within 2 hours
Statewide	1/24/98	Coastal, riverine & urban flooding	N/A	3.5” in 12 hours	Pocassett River overflow banks by 2 feet
Central and southeast	2/18/98	Dam breech, riverine flooding	$400,000	3.5” in 12 hours	Dam break in S.Kingstown, extensive basement flooding in SE, Maidford River overflowed banks in Middletown
Statewide	3/10/98	Riverine & urban flooding	$50,000	2 – 4 “ in 30 hours	Serious urban street flooding, basement flooding, and river flooding, Blackstone flooded over 3 feet in Woonsocket and Cumberland
Statewide	6/13/98	Coastal, riverine & urban flooding	N/A	7 – 8 “	Slow moving storm with heavy rains, Ponaganset Pond flooded over in Glocester & Foster, Woonasquatucket hit flood stage in N. Providence, Pawtuxet went beyond flood stage in Warwick, Blackstone hit flood stage
Statewide	6/30/98	Riverine & urban flooding	N/A	3-6” in 8 hours	Louquisset River flooded out of banks, Woonasquatucket River flooded banks in Smithfield and N. Providence, Ponganset flooded and Pawtuxet River flooded
Johnston	8/26/99	Riverine flooding	N/A	4-6” in 2 hours	Series of thunderstorms heavy rains, Pocassett River overflowed, severe urban street flooding, bridge over Pocassett damaged
Statewide	9/10/99	Riverine flooding	N/A	5-7” rain	Woonasquatucket River out of banks
Statewide	9/16/99	Coastal, riverine & urban flooding	N/A	Up to 8”	Pawtuxet River rose out of banks in Cranston and Warwick
Cranston	4/22/2000	Riverine & urban flooding	N/A	3” in 6 – 12 hours	Pawtuxet River flooding in Cranston, some roads covered by 12 inches of water

Cranston	3/22/01	Riverine & urban flooding	$3 million affecting 1,400 homes and 147 businesses	N/A	Heavy rainfall combined with melting snow. Blackstone at Woonsocket crested and Pawtuxet River crested in Cranston
Statewide	3/30/01	Riverine & urban flooding	N/A	3 – 5"	Renewed flooding to already saturated areas. Blackstone, Pawtuxet Rivers surpassed flood stages
Glocester	5/29/01	Stormwater flooding	N/A	2" in 1 hour	Road washout on Route 102
Statewide	6/17/01	Stormwater flooding	N/A	5-7"	Remnants of Tropical Storm Allison, road washouts in Foster from runoff, building foundations washed out from runoff in Coventry
Statewide	4/14/04	Urban & Stormwater flooding	N/A	2-4"	Accumulated rain over past week caused Blackstone and Woonasquatucket Rivers to hit flood stages. Roadways in low lying areas flooded

Urban/Stormwater Flooding

The flood of March 1968 constitutes the record flood for much of the state, except for main-stem flooding along the Blackstone River in August 1955 and local flooding along headwater streams in the Pawtuxet and Pawcatuck Basins in November 1927, January 1964, February 1965, and August 1967. The March 1968 flood resulted from heavy rainfall that followed a period of sustained snowmelt which had caused stream flows to be much above normal. The August 1955 flood, which caused a record flooding along the main rivers in the Blackstone River Basin in Rhode Island and Massachusetts, and the Thames River Basin (predominantly in Connecticut), resulted from torrential rainfall accompanying Hurricane Diane.

Damages from the 1955 flood were estimated at approximately $28 million for the state, with the Woonsocket area hardest hit in Rhode Island. Except for a small local protection project at Blackstone, Massachusetts, there were no federal flood control projects in operation at the time of the flood. Subsequently two projects in Rhode Island - for Upper and Lower Woonsocket - and two in Massachusetts, were constructed for Blackstone River Basin flood protection. The U.S. Corps of Engineers estimates that these projects prevented about $8 million in damages in the flood of March 1968.

The rivers of the Narragansett Bay Drainage Basin are susceptible not only to storms of local origin and continental storms borne by the "prevailing westerlies" but also to coastal storms and hurricanes of tropical origin. The situation is somewhat different for the Pawcatuck River Basin in southwestern Rhode Island. The Corps of Engineers observed in 1981 that, "River flooding has not been a major problem to date, as the vast amount of swampland within the basin has made for very slow flood formation with only minor flood peaks." In the past decade and continuing today, communities in the Pawcatuck River Basin have been and are forecast to continue to experience significant development pressure that, if not appropriately controlled, could seriously affect the water-absorbing capacity of the land that has minimized flooding in the area to date.

Repeated flooding in certain inland areas of the state has required various site-specific hazard mitigation measures. Most dramatic in scope, to date, was the situation in the Belmont Park section of the city of Warwick. Flooding occurred most recently in January 1979 when a combination of above-normal temperatures and rainfall caused the Pawtuxet River to overflow its banks, inundating about 30 acres of land in the Belmont Park area, a residential section built in and adjacent to a flood hazard area. Flooding had worsened with increased upstream development. To prevent repeated flooding, some 60 homes were purchased and demolished. Currently, frequent flooding of the Pawtuxet River in the Natick Flats section between Warwick and West Warwick has occasioned investigation of potential flood control measures by the Corps of Engineers.

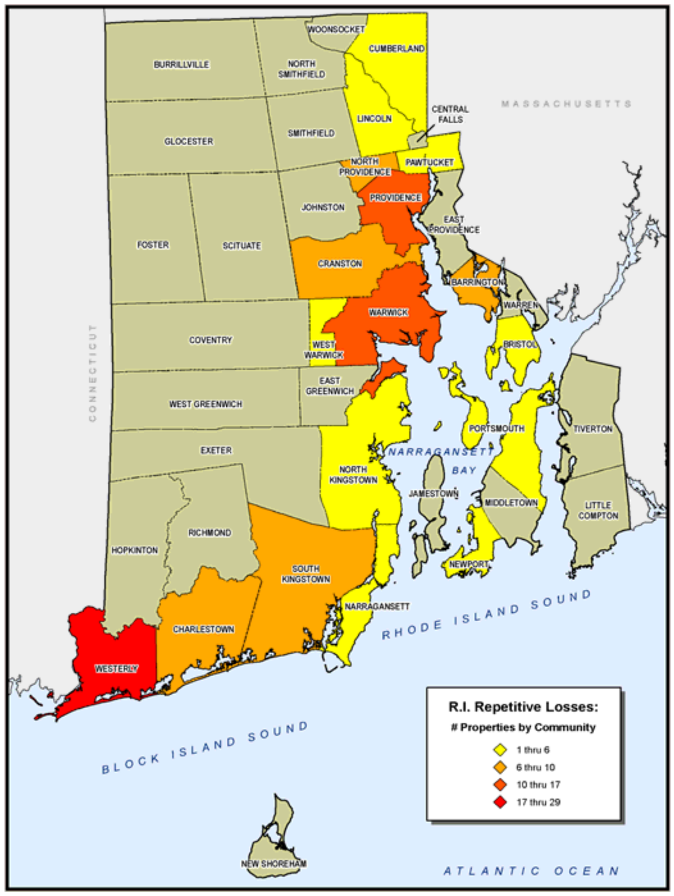
Urban flooding has been a recurrent problem in Providence, Pawtucket, North Providence, West Warwick and densely developed sections of other cities and towns. Urban flooding involves the overflow of storm sewer systems and is usually caused by inadequate drainage following heavy rain or rapid snowmelt. Attention to reducing or delaying storm runoff can help to mitigate such flooding.

Location of Coastal Erosion-related Flooding

RIEMA does not have access to any comprehensive statewide database of information containing shoreline profiles of areas of the greatest erosion rates throughout the state. Past attempts to seek FEMA funding on this issue have been refused with the explanation that FEMA does not fund coastal erosion studies. Alternate sources of funding such as the State Coastal Program or even NOAA have been unavailable as the funding for those agencies have experienced severe funding cuts. It is hoped that funding could become available to complete a statewide assessment of the impact of coastal erosion, particularly since Rhode Island has the most densely developed coastline in the country (for its size).

Aside from a statewide coastal erosion assessment lacking, any additional information on this issue will be collected from the local hazard mitigation plans as they receive FEMA approval and data related to coastal erosion in their community will be aggregated for a statewide assessment. Additionally, there is a mitigation action item addressing the need to develop a statewide coastal erosion database and mapping initiative of coastal erosion rates, see mitigation action item 3.3.4.

Probability of Future Flooding



Coastal and Riverine Flooding
The term 100-year flood (also called the Base Flood) is a flood having a one percent chance of being equaled or exceeded in magnitude in any given year. Contrary to popular belief, it is not a flood occurring once every 100 years. The 100-hundred year flood could, and frequently does, occur more than once within 100 years. The National Flood Insurance Program (NFIP) and most Federal and state agencies use the 100-year flood as a standard for floodplain management and to determine the need for flood insurance. In terms of the probability of a structure located in special flood hazard areas being flooded, these structures have a 26 percent chance of suffering flood damage during the term of a 30-year mortgage.

Repetitive Losses
Repetitive losses refer to those flood insured properties that have experienced more than 1 flood loss within a 10 year period. The map on the above “RI Repetitive Losses” depicts the number of losses per community. The darkest shade refers to those communities that have 17 to 29 repetitive loss properties down to the bright shade of yellow in which communities have 1 to 6 repetitive loss properties. Note that each property can experience more than 2 losses and most have.

Urban Stormwater Flooding
In Rhode Island, most of the repetitive loss properties are the result of stormwater runoff and urban flooding. Much of the storm water runoff and urban flooding problems are in direct proportion to the amount of wetlands, floodways and floodplains that have been filled in. As these areas are filled in by development, roads and parking lots and other impermeable surfaces, the water has no where else to go and therefore floods whatever lands are left. Also impacted are roads crossing under sized culverts. The greatest majority of complaints and areas flooded are those properties in close proximity to areas where rivers, ponds and streams have been filled in over the years. Therefore, as wetlands, rivers, streams and ponds continue to get filled in and as natural areas that previously stored flood waters are filled in, there is a greater probability that not only will urban flooding continue, but the frequency of these occurrences will increase. As depicted in the map “Rhode Island Repetitive Flood Losses” the areas experiencing the

greatest number of repetitive loss properties are those communities that have filled areas of land that otherwise, if left undeveloped, could have stored flood waters, rather than flood adjacent commercial and residential properties. Therefore, it is most probable that flooding in these areas will continue to occur on a more frequent basis with lower storm events as development continues in areas that should not be filled. However, more detailed analyses of urban flood probability will be addressed as funds become available and as information from local hazard mitigation plans are approved by FEMA and forwarded to RIEMA for further review and assessment. This data deficiency is addressed in Mitigation Action Item 3.1.3.

Probability of Future Occurrences of Coastal Erosion

The vulnerability of many of Rhode Island's beaches and shoreline areas to coastal erosion and flooding tends to dramatically increase as manmade structures are allowed to be built along the shoreline thus impeding the natural, dynamic system of the beach. Coastal armoring, construction of jetties and groins may save the beach of one private property owner, but it severely impacts those owners down shore of the manmade structure of sediment deposits from occurring, thus accelerating erosion activity.

For example, sediment impoundment accompanies coastal armoring. Sands that would normally be released into coastal waters during high wave events and with seasonal profile fluctuations are trapped behind walls and revetments and prevented from adding to the beach sediment budget. One wall may have minimal impact, but along the Rhode Island coastline myriad armoring types combine to reduce sand availability to nearly zero. Natural coastal erosion does not damage beaches that have access to a robust sediment budget. Beaches on chronically eroding coasts that are not armored remain healthy even during shoreline retreat because sands are released from eroding coastal lands that nourish the adjoining beach. However, armoring traps those sands and a sediment deficiency develops, such that the beach does not withstand seasonal wave stresses and begins to narrow with time. Chronic beach erosion and beach loss eventually results. Many beaches eventually disappear simply because they are starved of sand.

Therefore, in those FEMA special flood hazard areas or velocity zones (V-Zones) the increase of armored shorelines, or any other man made 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.

A more detailed discussion about frequency, area of impact and intensity is located in the following section 4.3 Flood Vulnerability. In this discussion the vulnerability is linked to the FEMA flood zone (A, V, 500, etc) and can therefore also be used as a basis for the potential probability of a flood event.

In terms of giving specific locations and erosion rates for future coastal erosion events, that is not possible as there is not enough specific information available. However the issue of coastal erosion is critical and the need for more resources to address this issue is In Mitigation Action Item 3.3.4.

4.2.2 Wind-Related Hazards (Hurricanes and Tornadoes)

Hurricanes

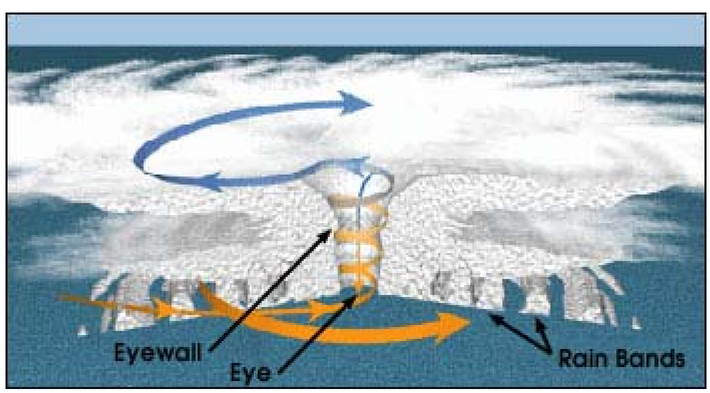
Hurricanes are a classification of tropical cyclones which are defined by the National Weather Service as non-frontal, low pressure synoptic scale (large scale) systems that develop over tropical or subtropical water and have definite organized circulations. Tropical cyclones are categorized based on the speed of the sustained (l:-minute average) surface wind near the center of the storm. These categories are: Tropical Depression (winds less than 33 knots), Tropical Storm (winds 34 to 63 knots inclusive) and Hurricanes (winds greater than 64 knots).

The geographic areas affected by tropical cyclones are called tropical cyclone basins. The Atlantic tropical cyclone basin is one of six in the world and includes much of the North Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico. The official Atlantic hurricane season begins on June 1 and extends through November 30 of each year, but occasionally tropical cyclones occur outside this period. Early season tropical cyclones are almost exclusively confined to the western Caribbean and the Gulf of Mexico. However, by the end of June or early July, the area of formation gradually shifts eastward, with a slight decline in the overall frequency of storms. By late July, the frequency gradually increases, and the area of formation shifts still farther eastward.

By late August, tropical cyclones form over a broad area that extends eastward to near the Cape Verde Islands located off the coast of Africa. The period from about August 20 through about September 15 encompasses the maximum of the Cape Verde type storms, many of which travel across the entire Atlantic Ocean. After mid-September, the frequency begins to decline and the formative area retreats westward. By early October, the area is generally confined to the western Caribbean. In November, the frequency of tropical cyclone occurrences declines still further.

How are Hurricanes Formed?

Hurricanes begin as tropical storms over the warm moist waters of the Atlantic and Pacific Oceans near the equator. As the moisture evaporates it rises until enormous amounts of heated moist air are twisted high in the atmosphere. The winds begin to circle counterclockwise north of the equator or clockwise south of the equator. The relatively peaceful center of the hurricane is called the eye. Around this center winds move at speeds between 74 and 200 miles per hour. As long as the hurricane remains over waters of 79F



or warmer, it continues to pull moisture from the surface and grow in size and force. When a hurricane crosses land or cooler waters, it loses its source of power and its wind gradually slows until they are no longer of hurricane force--less than 74 miles per hour.

High Winds

Wind is defined as the horizontal component of natural air moving close to the surface of the earth. (David Ludlum1982) Wind pressure, not wind speed, causes wind damage. (IIPLR, 1994) There are three types of wind pressure: positive, negative, and internal.

- *Positive wind pressure* is what one feels when the wind is blowing in one's face. It is the direct pressure from the force of the wind that pushes inward against walls, doors and windows.

- *Negative wind pressure* occurs on the sides and roof of buildings. It is the same pressure that causes an airplane wing to rise. This negative pressure is also known as lift. Negative pressure causes buildings to lose all or a portion of their roofs and side walls, and pulls storm shutters off the leeward side of a building.

- *Interior pressure* increases dramatically when a building loses a door or window on its windward side. The roof feels tremendous internal pressures pushing up from inside of the building together with the negative wind pressure lifting the roof from the outside.

Wind is one of the most costly insured property perils, causing more damage than earthquakes, freezing, or other natural perils. (IIPLR, 1994) In most wind storms, but especially in hurricanes, windborne debris can be a major factor in causing damage. Flying objects such as tree limbs, outdoor furniture, signs, roofs, gravel, and loose building components from progressively failing adjacent buildings can impact the building envelope, creating openings that allow internal pressure to build within.

<u>Wind Pressure</u>

Internal pressures develop within a building when the building envelope is breached. The breach in the envelope is commonly caused by the breakage of window glass or the failure of an overhead door. The internal pressures add to the external pressures producing more severe pressures on the building components of the structure. (IIPLR, 1994) The roof then feels tremendous internal pressure building from inside, together with the negative wind pressures lifting the roof from outside. The resulting combined forces may be too large, even for good roofs if the roof has not been designed for them. After the roof is gone, high winds and rain destroy the inside of the structure.

<u>Wind Speed</u>

It is often difficult to obtain accurate and consistent wind speed measurement during most storms. Wind speed measuring devices, anemometers, often become damaged from wind and airborne debris when severer wind storms occur. It is important to understand the effect of winds on buildings. Wind speeds vary with height above ground, the higher the elevation, and the stronger the wind (IIPLR, 1994)

- *The Fastest Mile Wind* is the wind speed used in the American Society of Civil Engineers (ASCE) national wind speed standard. This measurement is taken at an elevation of 33 feet in open terrain and is the highest recorded speed during a time interval in which one mile of wind passes a fixed measuring point. At 60 miles per hour this is a 1-minute average wind.

- *Sustained Wind* is the wind speed averaged over 1 minute.

- *Peak Gusts* are averaged over two to five seconds. They are approximately 30% larger than the fastest mile measurement.

High Winds

Wind sweeps around the dome of water and induces currents that spiral toward the center of the storm. In deep water, as water is piling up, it creates pressure on water at lower depths. Here, the water at lower depths can escape rather easily, reducing water height. Closer to the coasts, however, there is less opportunity for water at lower depths to escape, the water is forced to rise, and storm surge results. Of these two forces, the wind is the dominant force at landfall.

Low barometric pressure

Low barometric pressure in the center of the storm reduces the weight of the air on the ocean surface. Water reacts to the decrease in pressure by rising slightly (1 to 2 feet) to create a dome-and a new balance of forces. This phenomenon of rising water caused by decreasing pressure is called the "inverted barometer" effect.

Measuring Hurricane Intensity

Hurricane damage comes not only from wind, but also from rain, tornadoes, floods, and the effects of very low air pressure. So a system that would rank hurricanes by wind force alone would not tell the whole tale. Many of the effects from hurricanes such as heavy rains, storm surge and coastal flooding were covered in the previous section on flooding. This section will focus primarily on the impacts of wind.

In the 1970s the Saffir-Simpson hurricane intensity category system was developed to characterize the destructive potential of hurricanes. In addition to maximum sustained wind speed and central pressure, the Saffir-Simpson hurricane categorization includes storm-surge height and coastal destruction potential. The Saffir-Simpson system sets the levels for hurricanes to five intensity categories, described in Table 4-4.

Saffir-Simpson Scale
Table 4-4

Category	Winds	Effects
One	74-95 mph	No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Also, some coastal road flooding and minor pier damage.
Two	96-110 mph	Some roofing material, door, and window damage to buildings. Considerable damage to vegetation, mobile homes, and piers. Coastal and low-lying escape routes flood 2-4 hours before arrival of center. Small craft in unprotected anchorages break moorings.
Three	111-130 mph	Some structural damage to small residences and utility buildings with a minor amount of curtain wall failures. Mobile homes are destroyed. Flooding near the coast destroys smaller structures with larger structures damaged by floating debris. Terrain continuously lower than 5 feet ASL may be flooded inland 8 miles or more.
Four	131-155 mph	More extensive curtain all failures with some complete roof structure failure on small residences. Major erosion of beach. Major damage to lower floors of structures near the shore. Terrain continuously lowers than 10 feet ASL may be flooded requiring massive evacuation of residential areas inland as far as 6 miles.
Five	greater than 155 mph	Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Major damage to lower floors of all structures located less than 15 feet ASL and within 500 yards of the shoreline. Massive evacuation of residential areas on low ground within 5 to 10 miles of the shoreline may be required.

A hurricane warning is issued by the National Weather Service when sustained winds of 74 mph or higher are reached and are expected in a coastal area within 24 hours or less. A hurricane warning can remain in effect when dangerously high water or a combination of dangerously high water and exceptionally high waves continue, even though winds may be less than hurricane force. A hurricane watch is announced for specific coastal areas that hurricane conditions are possible within 36 hours.

On average, there are about 10 named tropical storms off the east coast of the United States each year. Of these, 6 are likely to develop into hurricanes, but only 2 to 3 are likely to reach Saffir-Simpson category 3 or greater intensity.

Tornadoes and Severe Wind Events in Rhode Island

Tornadoes may happen any time of the year in just about any location. Through years of study by the National Severe Storms Laboratory (NSSL), it has been determined that there are areas throughout the United States that are more prone to strong and violent tornadoes. According to the NSSL, tornadoes occur most often in the central States, commonly known as “tornado alley.” This area has a consistent season every year from April through mid-June, with the most tornadoes occurring in mid-May. Second, the central plains have a repeatable annual tornado cycle, with the highest probability of tornado occurrence in the springtime. Finally, areas outside of “tornado alley” do not have a typical tornado season.

How Tornadoes are Formed

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 monsters can remain in contact with the earth for well over fifty miles and exceed one mile in width.

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. 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. Even others may be nearly invisible, with only swirling dust or debris at ground level as the only indication of the tornado's presence.

A tornado begins in a severe thunderstorm called a supercell. A supercell can last longer than a regular thunderstorm. The same property that keeps the storm going also produces most tornadoes. 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 sucks 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. Also, the atmosphere needs to be very unstable.

Tornadoes can form any time during the year, but most form in May. The more north you go, the later the peak tornado season is. This is because it takes longer to warm the northern parts of the plains so tornadoes form later. Most tornadoes spin cyclonically but a few spin anti-cyclonically. Because there are records of anti-cyclonic tornadoes, scientists don't think that the Coriolis Effect causes the rotations.

Measuring the Intensity of a Tornado

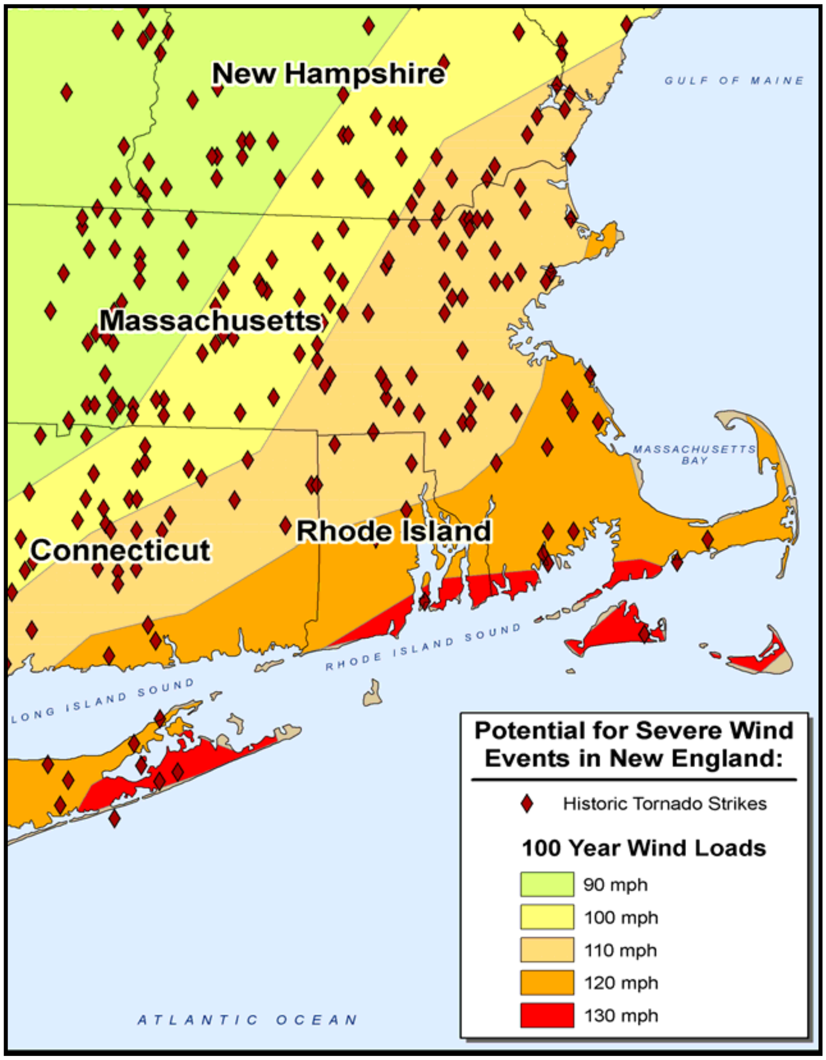
Frequency values were derived from historic tornado data over a 30 year period, culled from the National Weather Service Severe Weather Center. Area impact was computed based on the average length and width of the damage path, as cited also by the National Weather Service. Finally, Intensity scores were based on the Fujita Scale, as illustrated below.

Fujita Intensity Scale
Table 4-5

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage Done
F0	Gale tornado	40-72 mph	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112 mph	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well constructed houses; trains overturned; most trees in fores uprooted
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel re-inforced concrete structures badly damaged.
F6	Inconceivable tornado	319-379 mph	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and F5 wind that would surround the F6 winds. Missiles, such as cars and refrigerators would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl pattern, for it may never be identifiable through engineering studies.

Locations of High Wind Events

Rhode Island obviously does not fall into Tornado Alley; however, tornadoes do occur in but not during a particular time of year or in a particular area. Although they do not occur frequently, tornadoes can and do occur anytime and anywhere in Rhode Island (and the rest of New England). 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.



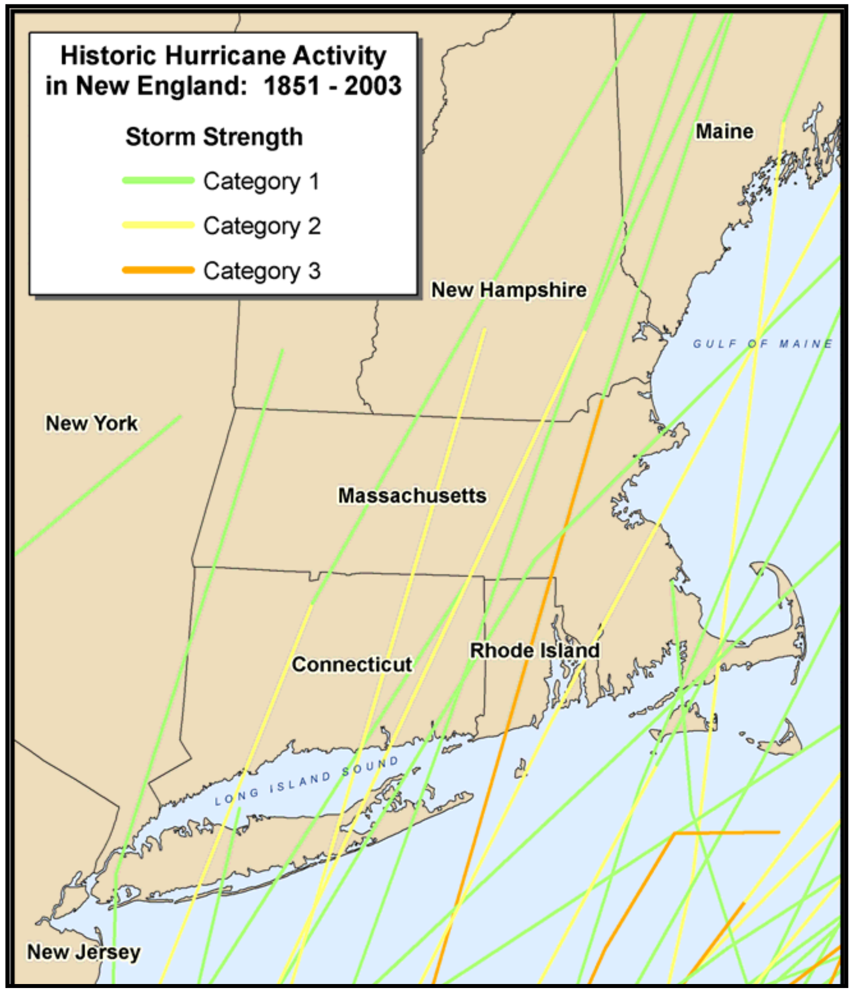
The map depicts point locations of initial tornado touch down areas for the period of record (indicated by a red diamond). Also depicted on the map are 100 year wind loads in shaded gradients, the darkest hue of orange depicts 130 mph winds to the lightest hue depicts 90 mph wind loads. These wind loads are also used as building guidelines or "wind zones" in the state building code. Rhode Island is divided into three separate zones: 130 mph wind zone for some of the southern coastal areas; 120 mph for the middle portion of the state and remaining coastal regions; and 110 mph for the northern section of the state.

Areas at Risk

A tornado may happen anywhere in Rhode Island given the right climatic conditions. Based on past events, as depicted in the above map, it appears that the areas at greatest risk for touchdowns run from north-western to north-eastern northern Rhode Island.

History of Wind-Events in Rhode Island

Based on Army Corps of Engineers and National Weather Service records, Rhode Island is known to have experienced some 30 hurricanes, with 14 in the twentieth century to date. The hurricane of September 21, 1938 brought major devastation to the state, with 262 persons losing their lives and damage estimated at $100 million. Another major hurricane occurred on September 14, 1944; no lives were lost, but property damage was over $2 million. The coastal area from Westerly to Little Compton experienced the heaviest damage, but there was no tidal wave, since the storm hit at ebb tide. Ten years later, however, on August 31, 1954, Hurricane Carol swept into Rhode Island with little warning. The result was 19 deaths and $200 million in property damage. The storm center passed to the west of Providence and came at high tide. The central area of Providence was flooded to a depth of 13 feet, and 3,500 cars were inundated in the downtown areas.



A second hurricane, Edna, occurred 12 days later with heavy rain and major river flooding. In 1955, remnants of the August hurricane Diane swept over Rhode Island, but its wind velocities were far below hurricane force because of its long inland trip over North Carolina, Virginia, and Pennsylvania. Damage to power lines was high, and at one time 82% of Rhode Island's homes were without electricity. Ample warning permitted people to return home from school and work early, and as a result, only two lives were lost. Property damage amounted to $170 million, most resulting from torrential rains which caused serious river flooding.

History of Rhode Island Major Hurricanes
Table 4-6

HURRICANE	DESCRIPTION
'38 Hurricane September 21, 1938	Sustained winds of 95 mph recorded; damage estimated at $100 million; 262 fatalities. Tide 15 feet above mean sea level (at USGS gage in Westerly). Virtually all the state was without power. Ten percent of electric customers still without power 12 days after hurricane.
Unnamed September 14, 1944	Affected Rhode Island and southeastern Massachusetts; $2 million property damage, no loss of life.
Hurricane Carol August 31, 1954	19 fatalities; $200 million property damage; 13' flooding. in Providence; wind speed 90 mph, with 115 mph gusts; nearly 3,800 homes destroyed. Tide 12.2 feet above mean sea level (at USGS gage in Westerly). Most of state without power. Four days after storm approximately 50% had power restored; 90% after seven days.
Hurricane Edna September 11, 1954	Heavy rain and major flooding in Blackstone River valley.
Hurricane Diane August 17-20, 1955	Heavy rain; Blackstone River crests 15' above normal; $170 million property damage. Heavy rain and 6 foot tidal surge; $5 million property damage; 82% of electric customers lose power.
Hurricane Donna September 12, 1960	Heavy rain and major flooding in Blackstone River Valley
Hurricane Esther September 21, 1961	Heavy shore damage at Sakonnet Point in Little Compton, and Misquamicut in Westerly
Hurricane Gloria September 27, 1985	Two fatalities; property damage estimated at $19.8 million; 8596 of electric customers lose power; an estimated 23,700 people evacuated.

Areas at Risk

The entire state is vulnerable to hurricanes and tropical storms, depending upon the storm's track (see map of Historic Hurricane Tracks). The coastal areas are more susceptible due to the combination of both high winds and tidal surge, as depicted on the SLOSH maps. Inland areas, especially those in the floodplains, are also at risk for flooding and wind damage. The majority of damage following hurricanes and tropical storms often results from residual wind damage and inland flooding, as was recently demonstrated during Hurricane Floyd and Tropical Storm Allison in 1999 and 2001.

History of Tornadoes in Rhode Island

No statewide database currently exists by any agency or organization in Rhode Island. The data from the table below was derived from the NOAA National Climatic Data Center. Rhode Island has had nine tornadoes since 1972 with property damages amounting to $3.5 million. Thankfully, there were no deaths, however there were 23 injuries reported.

Location or County	Date	Time	Mag	Dth	Inj	PrD	CrD
Bristol	9/14/72	1545	F0	0	0	0	0
Providence	8/26/85	1300	F1	0	0	0	0
Providence	8/7/86	1430	F1	0	0	$250,000	0
Providence	8/7/86	1515	F2	0	20	$2.5 mil.	0
Providence	8/8/86	0915	F1	0	0	$250,000	0
Providence	9/23/89	1430	F0	0	0	$250,000	0
Kent	10/18/90	2210	F1	0	3	$250,000	0
Coventry	8/13/94	1730	F0	0	0	0	0
Foster	8/16/2000	1400	F0	0	0	0	0
TOTALS				**0**	**23**	**$3.5 mil.**	0

Information from the NOAA National Climatic Data Center http://www4.ncdc.noaa.gov

Mag: Magnitude
Dth: Deaths
Inj: Injuries
PrD: Property Damage
CrD: Crop Damage

Probability of Future Wind-related Events

The State of Rhode Island, as with other New England states, is particularly vulnerable to hurricanes. One reason is due to the geography of southern New England in relation to the Atlantic seaboard. Historically, most hurricanes which have struck the New England region re-curved northward on tracks which paralleled the eastern seaboard maintaining a slight north-northeast track direction. The fact that the States of Connecticut, Rhode Island, and Massachusetts geographically project easterly into the Atlantic and have southern exposed shorelines place them in direct line of any storm which tracks in this manner. Therefore, even though New England is a relatively far distance from the tropics, its susceptibility to hurricane strikes can statistically be greater than other states closer to the tropics.

Another explanation giving evidence to New England's unique vulnerability to hurricanes is the fact that hurricanes which eventually strike the region undergo significant increases in forward speed. Historically, it can be shown that hurricanes tend to lose their strength and accelerate in a forward motion after pasting the outer banks of Cape Hatteras, North

Carolina. The increase in forward speed that usually occurs simultaneously as the hurricane weakens with further northward movement can often compensate for any discounting in hurricane intensity. Consequently, surge flooding, wave effects, and wind speeds accompanying a faster moving, weaker hurricane may exceed conditions caused by more intense hurricanes. This means that for some locations, depending on the meteorology of the storm, the affects from a Category 2 hurricane traveling at 60 miles per hour (mph) might be worse than that from a Category 4 hurricane moving at 20 mph.

The vulnerability of Rhode Island to hurricane surges is further increased by the presence of Narragansett Bay. The Bay's configuration can exhibit a funneling phenomenon on tidal surges as they flood the East and West Passages and the Sakonnet River. Ocean waters entering these inlets become more restricted causing higher flood levels with continued movement into the upper reaches of the Bay. The funneled ocean waters along the shores of the Bay's northern most points tend to result in higher storm surge elevations causing a greater amount of coastal and tidal riverine flooding. Consequently, these northern reaches of Narragansett Bay are the most urbanized and densely developed areas in the state.

There is not sufficient data available to accurately predict the probability of future wind-related events in Rhode Island. There have been very few tornadoes in Rhode Island as depicted on the map on page 4-29. Of those events, there is little information available, so it is difficult to accurately predict the likelihood of future tornado events. In regard to hurricanes, there have been relatively few hurricanes that have hit Rhode Island in the past 75 years. Even Dr. Gray (nationally renowned meteorologist who gives annual hurricane season forecasts) will not predict the future probability of hurricanes to any more specific location than the Atlantic Seaboard from Maine to Florida. However, this data deficiency will be addressed in mitigation action item 3.1.6.

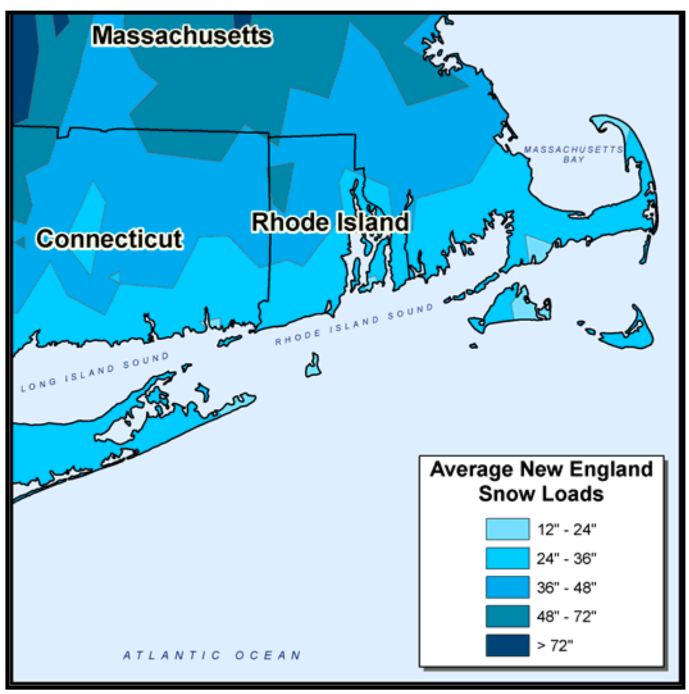
4.2.3 Winter-Related Hazards

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 and is often unpredictable, except that Rhode Island residents can count on several nor'easters which usually bring coastal erosion and could bring either a blizzard or heavy rainstorms dependent, of course on the temperature.

In Rhode Island there is no single database or repository of consistent, detailed descriptions of the types of ongoing "normal" winter hazards that occur. Detailed information only exists for the unusual events which cause an exceptional amount of hardship (i.e. snow and ice removal), threats to public safety and major damage to public and private property, such as the Blizzard of 1978, the 1991 Halloween Storm, the 2003 President's Day Storm and the 2005 Blizzard.

Location

Winter weather includes heavy snows, ice, and extreme cold and can affect the entire State. Residents of Rhode Island are very familiar with these conditions. 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 designed to withstand the weight of the snow. Repair and snow removal costs can be significant and surpass annual municipal salt and snow removal budgets, often before the end of the season. Ice buildup can collapse utility lines and communications towers as well as make transportation difficult. Ice can also become a problem on roadways if the temperature warms up just enough for precipitation to fall as freezing rain rather than snow. Without electricity, heaters do not work, causing water and sewer pipes to freeze or rupture. If extreme cold conditions are combined with low snow cover, the



ground's frost level can change creating problems for underground infrastructure. Extreme cold can lead to hypothermia and frostbite, which are both serious medical conditions.

Heavy snow, generally more than 8 inches of accumulation in less than 24 hours, can immobilize a community by bringing transportation to a halt. Until the snow can be removed, airports and roadways are impacted, even closed completely, stopping the flow of supplies and disrupting emergency and medical services. Accumulations of snow can cause roofs to collapse and knock down trees and power lines. A quick thaw after a heavy snow can cause substantial flooding, especially along small streams and in urban areas. The cost of snow removal, repairing damages, and the loss of business caused by power outages can have severe economic impacts on cities and towns. Injuries and deaths related to heavy snow usually occur as a result of vehicle accidents. Casualties also occur due to overexertion while shoveling snow and hypothermia caused by overexposure to the cold weather. Heavy snow can affect the entire State of Rhode Island but the highest amounts occur in the northern and northwestern areas of the State.

Ice Storms
The term “ice storm” is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. They can be the most devastating of winter weather phenomena and are often the cause of automobile accidents, power and communication system outages, personal injury and death. Moreover, they can hinder the delivery of emergency services needed in response to these catastrophes and endanger the responders. Ice storms accompanied by wind gusts cause the most damage.

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.

The greatest threat from ice storms is to essential utility and transportation systems, also known as lifelines. It coats power and communications lines, trees, highways, bridges and other paved surfaces. Ice-weighted wires, antennae, and structures holding them can break and collapse. Downed trees and limbs can also damage lines and block transportation routes. Both pedestrians and automobiles are at risk.

Extreme cold
What is considered 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. Excessive cold may accompany winter storms, be left in their wake, or can occur without storm activity. 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 (wood, kerosene, etc. for heat, and fuel burning lanterns or candles for emergency lighting).

General observations by the National Oceanic and Atmospheric Administration (NOAA), indicated that in winter deaths related to exposure to cold: 50% were over 60 years old, over 75% were male and about 20% occur in the home. Of winter deaths related to ice and snow: about 70% occur in automobiles, 25% of the people were caught out in the storm and the majority was males over 40 years old (heart attacks from snow shoveling). Winter storms, ice storms and extreme cold can adversely affect people, some more than others. Those persons 65 years of age or more are especially vulnerable.

History of Winter-Related Hazards

According to the National Climatic Data Center (NCDC) there have been 60 snow and ice events in Rhode Island between 1950 and 2004.

Winter Hazards in Rhode Island 1993 – 2004
Table 4-7

County	Date	Type
Northwest Providence	02/21/1993	Snow
Northwest Providence	03/04/1993	Heavy Snow
Northwest Providence	03/13/1993	Blizzard
Southeast Providence	03/13/1993	Heavy Snow
Southeast Providence	03/13/1993	Blizzard
Statewide	12/29/1993	Heavy Snow
Washington, Newport	01/07/1994	Heavy Snow
Providence, Bristol, Kent, Washington	01/07/1994	Heavy Snow
Kent, NW Providence, Washington	01/07/1994	Ice Storm

Bristol, SE Providence	01/08/1994	Glaze
Statewide	02/08/1994	Heavy Snow
Statewide	02/11/1994	Heavy Snow
Northwest Providence	03/03/1994	Heavy Snow
Statewide	02/04/1995	Heavy Snow
Northwest Providence	02/28/1995	Ice Storm
Kent, Providence	12/14/1995	Heavy Snow
Statewide	12/19/1995	Heavy Snow
Kent, NW Providence	01/02/1996	Heavy Snow
Statewide	01/07/1996	Heavy Snow
Statewide	02/02/1996	Heavy Snow
Kent, Providence, Washington	02/16/1996	Heavy Snow
Statewide	03/02/1996	Heavy Snow
Bristol, Providence, Kent	03/07/1996	Heavy Snow
E. Kent, Providence	04/07/1996	Heavy Snow
Kent, Bristol, Providence	04/09/1996	Heavy Snow
Providence, W. Kent	12/06/1996	Heavy Snow
NW Providence, NW Kent	12/07/1996	Heavy Snow
Providence, Kent, Bristol	01/11/1997	Heavy Snow
Bristol, Kent, Providence	01/31/1997	Freezing Drizzle
Statewide	03/31/1997	Heavy Snow
Statewide	04/01/1997	Heavy Snow
Northwest Providence	12/23/1997	Heavy Snow
Statewide	02/25/1999	Heavy Snow
Statewide	03/15/1999	Heavy Snow
Kent, Providence	01/13/2000	Snow
Northwest Providence	01/25/2000	Heavy Snow
Bristol, Kent, Washington, Providence	02/18/2000	Heavy Snow
NW Providence, W. Kent	11/26/2000	Freezing Rain
NW Providence, W. Kent	12/30/2000	Heavy Snow
Statewide	01/20/2001	Heavy Snow
NW Providence, W. Kent	01/30/2001	Freezing Rain

Providence	02/05/2001	Heavy Snow
Statewide	02/25/2001	Freezing Rain
Kent, Providence	03/05/2001	Heavy Snow
Northwest Providence	03/09/2001	Heavy Snow
Newport	03/26/2001	Heavy Snow
Newport	01/19/2002	Heavy Snow
Kent, Providence	11/27/2002	Heavy Snow
S. Providence, Kent, Newport	12/05/2002	Heavy Snow
Northwest Providence	12/25/2002	Winter Storm
Northwest Providence	01/03/2003	Winter Storm
Statewide	02/07/2003	Winter Storm
Statewide	02/17/2003	Winter Storm
Statewide	03/06/2003	Winter Storm
Statewide	12/05/2003	Winter Storm
Washington, W. Kent	01/27/2004	Winter Storm
Washington	02/18/2004	Winter Storm
Northwest Providence	03/16/2004	Heavy Snow
Providence	11/12/2004	Heavy Snow
Statewide	12/26/2004	Winter Storm

NOTE: winter storms include ice storms, extreme cold & heavy snow

Probability of Future Winter-related Events

Based on past history and climatic conditions, there is a great probability that winter hazards will continue to occur and impact Rhode Island. Winter-related hazards affect the entire state to varying degrees.

There is not sufficient data available to accurately predict the probability of future snow, extreme cold and ice storm events. However, this data deficiency will be addressed in mitigation action item 3.1.4

4.2.4 Drought

The National Weather Service has documented that historical long-term droughts have begun with lower than normal precipitation during the preceding fall and winters and evolved into major drought status in the summer. Extended droughts, though not common, require statewide monitoring of climactic conditions. Table 4-8 “Rhode Island Historical Droughts and Location of Impacts” on page 4-41 shows that some type of drought occurs about every eleven years in Rhode Island. Rhode Island has had at least six major droughts since 1988.

Drought Defined

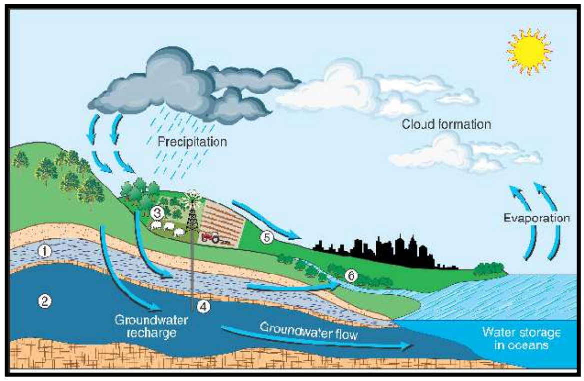
Generally, drought is characterized as a continuous period of time in which rainfall is significantly below the norm for a particular area. The American Meteorology Society defines drought as a period of abnormally dry weather sufficiently long enough to cause a serious hydrological imbalance. A drought is a natural hazard that differs from other natural hazards in that it is not something that occurs suddenly. Rather, a drought evolves over months or even years and, while causing little structural damage, can have profound economic, environmental, and social impacts.

The impacts of drought span economic, environmental and social sectors. According to the National Drought Mitigation Center, the impacts of drought typically cost the taxpayers of the United States at least as much as other disasters. Drought takes a heavy toll on agricultural, the environment, and other areas. During severe droughts, streams and rivers can dry up, affecting wildlife habitat, recreation, and major users dependent upon adequate flow within watercourses (e.g., power generation, sewage treatment systems.) Certain shallow private or community wells could dry up or begin drawing salt water (in coastal communities) as groundwater levels drop, presenting health hazards. Ponds and streams that are used for fire fighting could dry up, increasing fire risks and response times as rural fire fighters seek alternate water sources.

In addition, droughts can raise conflicts between competing interests. For instance, while farmers may seek to increase groundwater withdrawal to maintain their crops, the increased groundwater withdrawal could adversely affect wildlife habitats or the water needs of other well users. Agriculture is often the first to be affected, with drinking water supplies for animals and irrigation sources drying up, affecting livestock, and crops.

The abilities of the state to withstand the effect of droughts are dependent upon numerous factors. The primary use of water in Rhode Island by the general population is for domestic uses, sanitation and drinking water. The vulnerability of the state to drought is increasing as water use increases. People tend to assume that plentiful water is the norm for Rhode Island, when, in fact, occasional droughts of at least moderate intensity and duration have occurred here. Drought can have wide-ranging effects but, unlike fast-moving natural disasters, such as hurricanes or blizzards, drought as a disaster lacks drama. Though droughts give plenty of warning, the perception of drought's consequences by the average person may only occur when they directly affect him or her.

Economic impacts can result from a drought itself or, more indirectly, through conservation measures implemented because of a drought. Farmers can lose livestock or crops or pay substantially more to produce a year's crop. Water suppliers may lose income if they impose restrictions or face increased costs for developing alternate water supplies. Economic impacts to industries can include loss of production due to use restrictions or increased costs for alternate water supplies (e.g., for cooling). Rhode Island relies heavily on tourism. Use restrictions on water dependent uses at beach communities, and restrictions on fishing and canoeing in rivers or on golf courses could reduce the state's appeal to visitors causing reduced revenues from tourism. Drought's impacts can be moderated through mitigation planning and preparedness. Because droughts are a normal part of any climate, it is important to have a plan in place providing for response actions.

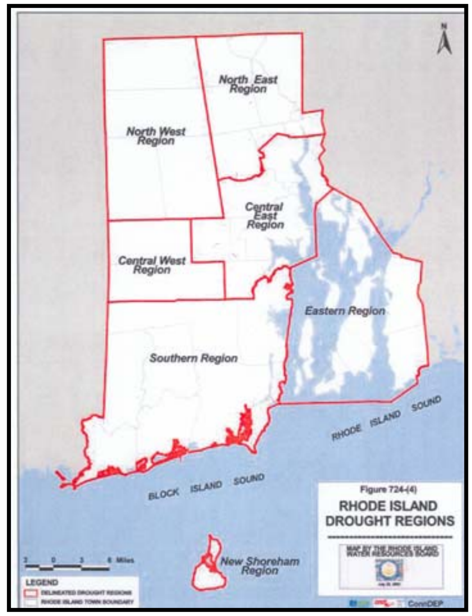


Drought Impacts in Rhode Island

Under normal conditions, the State of Rhode Island can be considered a water-rich state. According to the Rhode Island Department of Environmental Management world-wide-web page, Rhode Island enjoys an abundance of water resources that support vital uses such as drinking water, recreation, habitat and commerce, among others. The state has approximately 1,383 miles of rivers, 21,800 acres of lakes and ponds, and approximately 15,500 acres of freshwater swamps, marshes, bogs and fens as well as close to 72,000 acres of forested wetlands. Estuaries, including Narragansett Bay and various coastal ponds, cover one hundred and fifty square miles. Underlying the state are twenty-two major stratified drift aquifers as well as usable quantities of groundwater in almost all other locations from bedrock aquifers.

According to the National Weather Service, the state receives, on average, between thirty-nine inches (on Block Island) to fifty-four inches of rain (in Foster) annually. In contrast, the average annual precipitation for the United States is 29.53 inches. Even though the state receives more rain annually than the average for the United States, Rhode Island does experience extended periods of dry weather. Summer dry spells, during which crops and lawns may require irrigation, are fairly common. Droughts, while less frequent, do occur. Past planning efforts, including the two previously adopted state guide plan elements dealing with water supply policies and the water emergency response plan, did not directly address specific measures to be taken in the event of a drought.

Consequently, prior to the creation of the Rhode Island *Drought Management Plan,* there was no mechanism for coordinating responses to drought by water suppliers throughout the state because of the decentralized nature of water suppliers and the variability of water supply sources. According to the Rhode Island Water Resources Board, there are thirty-one major municipal and private water suppliers that provide water for approximately 90% of the population of the state. Areas served by major public water suppliers, shows generalized areas currently served by major public water systems and their source of water.



Unlike some states, Rhode Island has not developed a systematic regulatory procedure for the allocation of water on a statewide or regional basis. Water allocation is currently based on riparian rights, traditional usage, and *ad hoc* permit approvals. Each water supplier imposes use restrictions when necessary based on the limitations of their system. Generally this has worked because water supply has traditionally exceeded demand throughout most of the state's history. However, when drought conditions occur, shortages develop which may affect water suppliers and individual wells (private or community) differently because of regional hydrology, water demand, differing water supply sources, and infrastructure. For example, southern Rhode Island relies on extensive groundwater aquifers for water supply, while much of the rest of the state relies on surface water reservoirs for water supply.

According to *the* Rhode Island Department of Environmental Management's Section 305(b) *State of the State's Waters Report,* approximately two-thirds of Rhode Island municipalities utilize groundwater from public and/or private wells for all or a portion of their water supply needs. It is estimated that twenty-six percent of Rhode Island's population (roughly 262,000 people) depends on groundwater for domestic water use. Domestic water use includes water for normal household purposes such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets and watering lawns and gardens. In 1999, there were six hundred and seventy-one public wells in Rhode Island according to the Rhode Island Department of Health, Division of Drinking Water Quality. One hundred and sixty-eight of these wells are community wells, which serve residential populations of twenty-five persons or more. The remaining five hundred and three wells are non-community wells that supply schools, places of employment, hotels, restaurants, etc. It is estimated that there are an additional 112,000 people served by an on-site water supply source.

Rhode Island Historical Droughts

For the major historical drought events, the National Weather Service noted that the precipitation during the preceding fall and winter months was below normal to much below normal which is typically defined as 90% and 75% less than levels through the spring and led to the most severe drought episodes, including the 1965-67 long-term droughts. The 1965-67 drought episodes lasted for three summers and included long periods of below normal precipitation through the winter, spring, and summer months. This drought period serves as the classic model of a long-term drought in Rhode Island. Though short-term droughts, such as 1999, may not pose a significant impact for the state's public water systems; no water system will be immune to periods of long-term drought.

Rhode Island Historical Droughts and Location of Impacts
Table 4-8

Date	Area Affected	Remarks
1930-31	Statewide	Estimated stream flow about 70% of normal
1941-45	Statewide. Particularly severe in the Pawtuxet and Blackstone Rivers	Estimated stream flow about 70% of normal
1949-50	Statewide	Estimated stream flow about 70% of normal
1963-67	Statewide	Water restrictions and well replacements common
1980-81	Statewide. Groundwater deficient in eastern part of State	Considerable crop damage in 1980
1987-88	Southern part of State	Crop damage, $25 million

Probability of Future Events

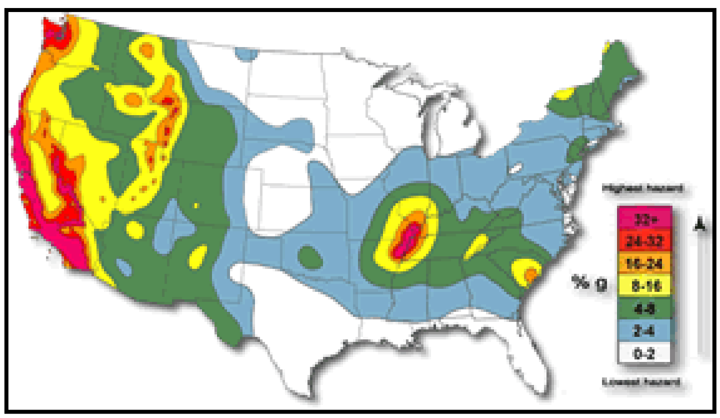
There is not sufficient data available to accurately predict the probability of future droughts. However, this data deficiency will be addressed in mitigation action item 3.1.5.

4.2.5 Geologic-Related Hazards

Earthquakes

New England has had a history of earthquakes including those recorded by the first settlers, and by the Plymouth Pilgrims in 1630. Of the 4,738 earthquakes recorded in the Northeast Earthquake Catalog through 1989, 1,215 occurred with the boundaries of the six New England States, with 31 earthquakes recorded in Rhode Island between 1766 and 1978. Between 1924 and 1989, there have been 96 earthquakes in the Northeast with a magnitude of 4.5 or greater on the Richter scale. Out of these 96 earthquakes, 8 were within the six New England States and the other 88 within New York State or the Province of Quebec. Many of these earthquakes were so strong that they were felt throughout New England. More information on specific locations on earthquakes that have occurred in Massachusetts and New England can be found in the Section 4.3, Assessing Vulnerability by Jurisdiction.

Two-thirds of all earthquake activity in the United States have occurred in the Pacific Coast States and nearby portions of Nevada. Within this region, the area of greatest earthquake frequency is in the coastal ranges of central and southern California, extending from the San Francisco Bay area southeastward to the vicinity of Los Angeles. Elsewhere along the Pacific coast, earthquake activity is relatively great along the coast of northern California and in the Puget Sound lowland of the State of Washington.



Within the states of the western interior, a zone of earthquake activity extends from Montana southward into northern Arizona. The central part of the United States is not an area of great earthquake frequency. The greatest concentration of shocks has been in eastern Missouri and nearby states. In the eastern United States, earthquakes have been scattered widely, and most have been only minor.

How Earthquakes Happen

An earthquake is caused by a sudden displacement within the earth. Displacement at relatively shallow depths may be caused by volcanic eruptions, or even by avalanches. The resultant earthquakes are usually light and do little damage. 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 motion we feel 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. The fast moving P waves are the first waves to cause the vibrations of a building. The S waves arrive next and may cause a structure to vibrate from side to side. Rayleight (R) and Love (1) waves (surface waves), which arrive last, mainly cause low-frequency vibrations which are more likely than P and S waves to cause tall buildings to vibrate. Surface waves decline less rapidly than body waves, so as the distance from the fault increases, tall buildings located at relatively great distances from the epicenter can be damaged.

The Components of an Earthquake

Geologists have found that earthquakes tend to reoccur along faults, which reflect zones of weakness in the Earth's crust. *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. Another earthquake could still occur.

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 event 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 and the focus is the area of the fault where the sudden rupture takes place. The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth. Earthquakes beneath the ocean floor sometimes generate immense sea waves or tsunamis (Japan's dreaded "huge wave"). 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. During the 1964 Alaskan earthquake, tsunamis engulfing coastal areas caused most of the destruction at Kodiak, Cordova, and Seward and caused severe damage along the west coast of North America, particularly at Crescent City, California. Some waves raced across the ocean to the coasts of Japan.

Liquefaction, which happens when loosely packed, water-logged sediments lose their strength in response to strong shaking, causes major damage during earthquakes. During the 1989 Loma Prieta earthquake, liquefaction of the soils and debris used to fill in a lagoon caused major subsidence, fracturing, and horizontal sliding of the ground surface in the Marina district in San Francisco.

Measuring the Severity of an Earthquake

The severity of an earthquake can be expressed in terms of both *intensity* and *magnitude.* However, the two terms are quite different, and they are often confused.

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 (MMI) Intensity 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 which 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.

Earthquakes with magnitude of about 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 about 4.5 or greater--there are several thousand such shocks annually 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.

Another measure of the relative strength of an earthquake is the size of the area over which the shaking is noticed. This measure has been particularly useful in estimating the relative severity of historic shocks that were not recorded by seismographs or did not occur in populated areas. The extent of the associated felt areas indicates that some comparatively large earthquakes have occurred in the past in places not considered by the general public to be regions of major earthquake activity. For example, the three shocks in 1811 and 1812 near New Madrid, Missouri were each felt over the entire eastern United States. Because there were so few people in the area west of New Madrid, it is not known how far it was felt in that direction. The 1886 Charleston, South Carolina earthquake was also felt over a region of about 2 million square miles, which includes most of the eastern United States. As more and more seismographs are installed in the world, more earthquakes can be and have been located. However, the number of large earthquakes (magnitude 6.0 and greater) has stayed relatively constant.

Other Earthquake-Induced Hazards

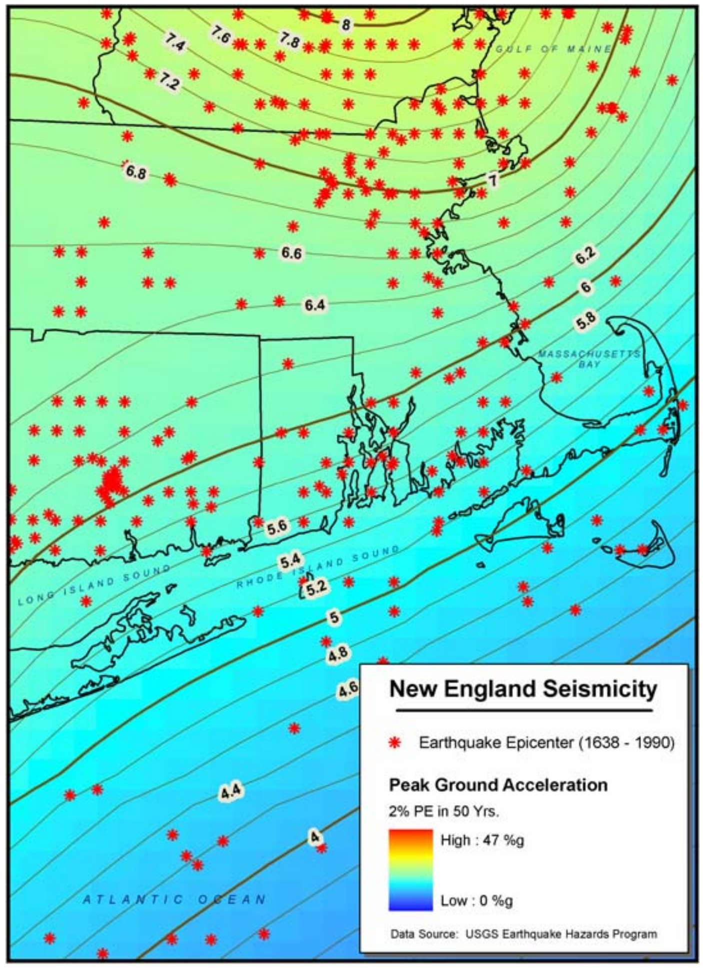
Earthquakes can cause flooding due to the tilting of the valley floor; dam failure and seiches in lakes and reservoirs. Flooding can also result from the disruption of the rivers and streams. Water tanks, pipelines and aqueducts may be ruptured or canal and streams altered by ground shaking surface faulting,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

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. As many as 25,000 people could be displaced from their homes as a result of these fires. Other types of fires may include oil refineries, electrical, gasoline stations and chemical spills.

A little discussed earthquake hazard with significant consequences is a hazardous materials spill. This type of hazard may start as a liquid spill and develop into an airborne hazard. At home there are household products that when combined create toxic gases. It is important to know what chemicals you have at home and the proper first aid procedures to reverse their effects. For additional information about household products and their effects, you can contact your local fire department or emergency management office.

Location and History of Earthquakes in Rhode Island and the Region

Only three shocks (intensity V or greater, Modified Mercalli Scale) have centered in Rhode Island, although several earthquakes in New England and St. Lawrence Valley have been felt in the State, including the 1638 Trois-Rivieres Earthquake, near Quebec. The strong earthquakes centered near Lake Ossipee, New Hampshire on December 20 and 24, 1940, caused some damage in the epicenter area and intensity V effects (pictures knocked from walls) at Newport, Rhode Island. Additional reports included intensity IV effects at Central Falls, Pascoag, Providence, and Woonsocket, and intensity I-III effects at Kingston, New Shoreham, and Wakefield. Minor intensities were also reported from a September 4, 1944, shock in the, Massena, NY - Cornwall, Ontario, Canada, area. Kingston, Lonsdale, Providence, Wakefield, and Woonsocket reported intensity I-III. A magnitude 4.5 earthquake on October 16, 1963, near the coast of Massachusetts caused some cracked plaster (MMI V) at Chepachet, Rhode Island.



A small earthquake was felt in the Narragansett Bay region on December 7, 1965 with a MMI V. Both windows and doors were reported to be shaking slightly. Moreover, some fourteen months later another small earthquake (MMI V) was felt in the Lower Bay area.

A magnitude 5.2 earthquake in western Maine on June 14, 1973, caused some damage in the epicenter region and was reported felt over an area of 250,000 square kilometers of New England and Quebec. The intensities in Rhode Island were IV at Charlestown and I-III at Bristol, East Providence, Harmony, and Providence.

A February 27, 1883, earthquake that probably was centered in RI was felt from New London, Connecticut to Fall River, Massachusetts. Within Rhode Island, it was felt (MMI V) from Bristol to Block Island.

A large area, estimated at over 5,000,000 square kilometers of eastern Canada and the United States (south to Virginia and west to the Mississippi River) was affected by a magnitude 7 shock on February 28, 1925. The epicenter was in the St. Lawrence River region; minor damage was confined to a narrow belt on both sides of the River. Intensity effects were felt on Block Island and at Providence; intensity IV, at Charlestown. The major submarine earthquake (magnitude7.2) in the vicinity of the Grand Banks of Newfoundland on November 18, 1929, was felt throughout the New England states. Moderate vibrations were felt on Block Island and at Chepachet, Newport, Providence, and Westerly.

Another widely felt earthquake occurred on November 1, 1935, near Timiskaming, Quebec, Canada. Measured at magnitude 6.25, the shock was felt (MM IIV) on Block Island and at Providence and Woonsocket. The total area affected was about 2,500,000 square kilometers of Canada and the United States.

Location and Earthquake History in Rhode Island
Table 4-9

DATE			EPICENTER*	MAGNITUDE	MMI
Aug.	25,	1766	Newport-Middletown	Unknown	V
Feb.	7,	1776	Warwick	Unknown	II
Oct.	24,	1843	Rhode Island Sound	Unknown	IV
Feb.	4,	1849	Newport-Middletown	Unknown	
Jan.	10,	1852	Rhode Island Sound	Unknown	IV
Mar.	9,	1875	Warwick-West Warwick	Unknown	
Sep.	22,	1876	Newport-Middletown	Unknown	
May 1,		1882	Narragansett Bay	Unknown	II
Feb.	28,	1883	North/South Kingstown	Unknown	V
Nov.	26,	1905	North/South Kingstown	Unknown	IV
Nov.	3,	1913	North/South Kingstown	Unknown	IV
Jan.	13,	1928	Block Island Sound	Unknown	IV
Jan.	3,	1940	Block Island Sound	Unknown	II
Ma y 15,		1948	Westerly	Unknown	
Apr.	17,	1949	North Kingstown	Unknown	IV
Jun.	10,	1951	North Kingstown/Exeter	3.9	V
Jan.	22,	1960	Undetermined	3.4	?
Aug.	17,	1962	Coventry	Unknown	II
Oct.	18,	1963	Coventry	Unknown	II
Dec.	8,	1965	Warwick	Unknown	V
Feb.	2,	1967	Narragansett Bay	2.4	V
Oct.	1,	1974	East/ West Greenwich	2.5	II
Mar.	11,	1976	Tiverton-Little Compton	3.5	VI
Jul.	26,	1978	Rhode Island Sound	2.8	?
Aug.	10,	1978	Rhode Island Sound	3.5	?
Sep.	3,	1978	Rhode Island	2.8	?

New England Earthquake Record
Table 4-10

New England's Earthquake Record to 1988

STATE	YEARS	NUMBER OF EARTHQUAKES
Connecticut	1668 - 1988	134
Maine	1766 - 1988	385
Massachusetts	1627 - 1988	313
New Hampshire	1728 - 1988	262
Rhode Island	1766 - 1988	31
Vermont	1843 - 1988	69
TOTAL		1,194

Source: New England States Emergency Consortium (NESEC)

New England Earthquakes with Magnitude Greater than 4.5
Table 4-11

New England Earthquakes of Magnitude 4.5 or Greater (since 1924)

LOCATION	DATE	MAGNITUDE
Ossipee, NH	December 20, 1940	5.8
Ossipee, NH	December 24, 1940	5.8
Dover-Foxcraft, ME	December 28, 1947	4.5
Kingston, RI	June 10, 1951	4.6
Portland, ME	April 26, 1957	4.7
Middlebury, VT	April 10, 1962	5.0
Near NH-Quebec Border	June 15, 1973	4.8
West of Laconia, NH	January 19, 1982	4.7

Probability of Future Earthquakes

The State of 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.

There have been numerous tremors in the New England area over the years, the latest of significance occurring on October 6, 1992, at 11:38 a. m., a magnitude 3.4 earthquake occurred about 5 miles south of Franklin, New Hampshire; at 1:06 p.m. an aftershock of magnitude 2.3 occurred at the same location. Although these were not damaging earthquakes, they serve to remind us all that seismologists have estimated that there is now about a 50% probability of a very damaging magnitude 5.0 earthquake occurring anywhere in New England, in a fifty-year period.

Seismologists and geologists agree that earthquakes are impossible to predict with any degree of accuracy. Over a period of months, years, and centuries, gravitational, rotational, and other pressures to which our planet is subject, begin to build along many of the earth's innumerable fault lines. The accumulated stress overcomes the strength of one of a very few of the planet's "active" faults, and the breakage and sliding motion of the opposite surfaces of the fault creates an earthquake.

Although Rhode Island has not suffered a major quake in modern times, seismicity is occurring and any strong earthquake, in the northeast region, is sure to affect our area to some degree. Inherent risks to life and property are: the increase in population since the strong quake (magnitude 6.25) of 1755 (off Cape Ann, north of Boston), buildings which were built prior to seismic building code regulation, older infrastructure which is vulnerable to any ground shaking, and any construction in "filled areas" which would be victim to liquefaction (i.e. marine district in the Loma Prieta quake of October 17, 1989).

4.3 Vulnerability Assessment & Loss Estimates

In this section the methodology of scoring hazards' vulnerability will be explained as it relates to each separate hazard. The results of the vulnerability scoring in this section will be listed for each hazard and includes a description of how the natural hazard might impact that community. The discussion of the methodology is critical to understanding how and why natural hazards are prioritized differently in Rhode Island's 39 cities and towns. It is also critical to understand how the hazards' impacts have been scored because each hazard utilizes a different scoring system based upon the various scales of intensity, frequency and magnitude of the event.

Also included is a description of potential losses to state facilities and when information available, critical facilities. In some instances, information is available as to the number, location and value of state facilities. In those cases a better estimate is given as to what the potential losses may be. In many instances, however, there is no information available as to the value of the structure or the building type in hazard areas such as high wind load zones, or soils that may be more susceptible to seismic damage. As important, although there is data available (in a very rough format) as to the building type which will be helpful in counting state structures built from concrete or brick for a rough seismic structural vulnerability assessment, there is no data as to the roof design (if it is flat) which would indicate potential susceptibility to damage and/or failure from heavy snow loads.

Regarding potential losses by jurisdiction, PLEASE NOTE, there is no information available at this time as to what the losses by jurisdiction are because the communities did not complete their local hazard mitigation plans by the date prescribed in order for inclusion into the State Plan (June 2004).

Hazard, Vulnerability and Combined Risk Scoring Methodology

For the purposes of completing the State Multi-Hazard Mitigation Plan, a Statewide Hazard Risk and Vulnerability assessment was completed working with the services of Odeh Engineers. The study was funded by the National Oceanic and Atmospheric Administration Coastal Services Center (NOAA CSC) in order to build upon prior efforts to develop a community risk and vulnerability assessment model. These prior efforts are published in an interactive CD-ROM prepared by the NOAA CSC entitled "Community Vulnerability Assessment Tool", NOAA Publication NOAA/CSC/99044-CD. The existing Community Vulnerability Assessment Tool was developed for individual communities, such as cities, towns, or counties.

The NOAA CSC sought to expand the existing methodology for application on a statewide and basis. This expanded geographic study area requires a modified approach, since both the input data and the required results of the study are of a different nature than for an individual community. This study marks the first time that local information was collected in order to establish a statewide database with aggregate data.

The approach used for this Plan involves three types of risk and vulnerability scores: hazard scores, vulnerability scores, and combined scores (combining the risk and the vulnerability). Each of the three risk scores describes different aspects of the vulnerability (social, critical facilities, economic and environmental) for each natural hazard in a given region.

Natural Hazard Risk Scores: Frequency, Area Impact & Intensity

Hazard scores measure the average impact of different hazard types in a region. The hazard score in a region is a function of the geography and natural recurrence of disasters over time in an area. Thus, hazard scores are inherent to a region and theoretically cannot be lowered through mitigation or other intervention. A hazard score is computed for each hazard type and each subregion considered. Hazard scores can be combined within a subregion or across multiple subregions to evaluate aggregate hazard risk levels. The individual factors in the hazard score are: the *frequency score; area impact score; relative impact score; and absolute area impact score*. Each of these factors is described below.

Frequency Score
This score is a measure of how often a given hazard occurs, in terms of number of events per year. Frequency scores are based on the average number of events per year of the hazard type. Five levels of frequency are considered, based on commonly used benchmarks in both the insurance and building design fields. Table 4-12 summarizes the frequency score and subjective description of each frequency level.

Frequency Lookup Table
Table 4-12

Return Period (years)	Frequency Score	Number of events per year	Subjective Description
1	5	1	Frequently recurring hazards, multiple recurrences in one lifetime
50	4	0.02	Typically occurs at least once in lifetime of average building
100	3	0.004	25% chance of occurring at least once in lifetime of average building
500	2	0.002	10% chance of occurring at least once in lifetime of average building
1000	1	0.001	Highly infrequent events, like maximum considered earthquake

Area Impact Score
This score is a measure of how much geographic area would be affected by a hazard event, in terms of either gross area or relative area. Two methods of determining area impact score were used, depending on the type of hazard distribution (see description of individual hazards).

Relative Area Impact
This method relates the area impact score to the percentage of a subregion impacted by the event considered (such as the % area of a census tract). Scoring for this method is shown in Table 4-13.

Area Impact Lookup Table, Relative Method
Table 4-13

Relative Area Impact (% subregion covered)	Score	Subjective Description
0	0	No affected area - 0% impact
0.1	1	10% tract impact
0.25	2	25% tract impact
0.5	3	50% tract impact
0.75	4	75% tract impact
1	5	100% tract impact

Absolute Area Impact.
This method relates the area impact score to the average impact in square miles of the event considered. The scores used are shown in Table 4-14.

Area Impact Score, Absolute Method
Table 4-14

Absolute Area Impact (sq. miles)	Score
0	0
0.001	1
0.01	2
0.1	3
1	4
10	5

Intensity Score
This score is a measure of the level of intensity of a hazard. For each hazard, a different measure is used, based on the type of forces that characterize the hazard (e.g. wind for a hurricane, ground shaking for an earthquake). To determine intensity scores, an intensity measure was selected for each hazard type, as follows:

- Extreme Wind (Nor'easters and Hurricanes): 3-sec gust windspeed (mph) and wind pressure on buildings (psi)
- Earthquake: Spectral acceleration (1-sec), %g

- Tornado: Fujita scale
- Flood: Base Flood Elevation (ft)
- Hail: Particle size (in)
- Snow: Snowfall (in)
- Extreme Temperature: Heating and cooling degree days

For each hazard type, the intensity measure was related to a lookup table of intensity scores ranging from 1 (lowest intensity) to 5 (highest intensity). The intensity scores therefore provided a somewhat uniform method of relating intensities from very different hazards.(NOTE: These intensity measures are intended for use in the Northeast region of the U.S. only. Different relative intensities should be considered for other regions of the country.)

Intensity Scores for Flooding
Table 4-15

Base Flood Elevation	Intensity Score	Subjective Description
0	0	No effect
14	1	Light flooding
18	2	Moderate flooding
20	3	Moderate-heavy flooding
22	4	Heavy Flooding
24	5	Severe Flooding

Overview of Hazard Scoring Procedure

The hazard score for each hazard type is computed using the following formula:

HAZARD SCORE = (FREQUENCY SCORE) * (AREA IMPACT SCORE)* (INTENSITY SCORE)

4.4 Scoring Vulnerability: Critical Facilities; Populations at Risk; Environmental Resources and Economic Values

Vulnerability includes all populations and assets (environmental, economic and critical facilities) that may be at risk from the natural hazards. Vulnerability scores measure the level of assets, populations, or resources within a given region, city or town. The vulnerability score is a function of the built environment, local economy, demographics, and environmental uses of a given region. Vulnerability scores can be combined within a subregion or across multiple subregions to evaluate aggregate levels of vulnerability to a given hazard or hazards.

In considering Rhode Island's vulnerability to natural hazards, four major groups were used: Critical Facilities; Populations at Risk; Environmental Resources/Threats and Economic Values.

Critical Facilities

Critical facilities include public infrastructure, utilities, marinas, emergency shelters, schools, hospitals, fire and rescue stations, police stations, water treatment or sewage processing plants, railroad stations and airports, and government facilities. The damage to and destruction of the built environment, particularly public infrastructure such as transportation, utilities, and communications often represents enormous economic, social, and general functional costs to a community, while also impeding emergency response and recovery activities. More and more people live in the areas most vulnerable to hurricanes, within 50 miles of the Gulf of Mexico or the Atlantic Ocean. It is here where, for many coastal states, tremendous amounts of valuable infrastructure exist, especially transportation lifelines. A nonfunctional road can have major implications for a community: general loss of productivity; disruption of physical access preventing residents from getting to work or other daily activities, prevention of emergency vehicles from reaching their destinations, with the associated health and safety implications and the potential access difficulties causing the disruption of important lifeline supplies such as food and other deliveries to the community. (Heinz Report, 2000)

Damaged or destroyed utility lines and facilities - including electricity, computer and satellite links, gas sewer, and water services - can cripple a region after a disaster. Power lines are often badly damaged or destroyed resulting in the loss of power for days, weeks or even months. This is particularly critical considering modern societies' dependence on electricity. In addition to basic modern households appliances being affected, public water supplies, water treatment and sewage facilities can also be impacted. Electric pumps cannot pump drinking water into an area without power, and even if they could, the water delivery system could be breached in several areas. The loss of even elevated water tanks also results in a lack of safe drinking water. Even disaster victims who do get water may have to boil it to eliminate waterborne pathogens introduced to the supply in breached areas.

Nonfunctional sewer systems also prevent a unique set of problems. Most systems need pumps to deliver the effluent to the treatment facilities. If there is a loss of power, and if many of the sewer lines are broken, a very serious health problem can rapidly develop. This problem, combined with the interruption of the public water supply could potentially cripple a community's recovery effort.

Overview of Vulnerability Scoring Procedure for Critical Facilities

The exposure score for each subregion was calculated using the following formula:

VULNERABILITY SCORE = (VULNERABILITY TYPE SCORE) * (IMPORTANCE FACTOR)

The two factors that make up the vulnerability score are:

Vulnerability Type Score
For each type of vulnerability a lookup table was developed to relate some measure of the vulnerability value (such as population, dollar value, or number of facilities) to a common exposure index. In each case, a score of 1 corresponds to the lowest amount of exposure, and a score of 5 corresponds to the highest amount of exposure. Table 4-16 summarizes the different exposure type scores used in this study.

Importance Factor
A factor, ranging from 0.85 to 1.3, was used to account for the critical nature of some types of vulnerability. This approach was developed such that it was consistent with national building code standards, which assign a higher importance factor to critical facilities.

Importance Factors for Vulnerability Scores
Table 4-16

Occupancy Category	Importance Factor
I	0.85
II	1
III	1.2
IV	1.3

Occupancy Categories
Table 4-17

Occupancy	Category
Fire, Police, Medical Facilities	IV
Emergency Shelters	IV
Environmental CERCLA sites	III
Major industrial sites	III
Schools	III
Other public utilities	II
Other structures	II

Once the scores for each sub-category of vulnerability were calculated, they were added together to evaluate the overall score for the exposure type. For example, to determine the overall Environmental Resources score, the scores of each of its subcomponents (scenic vistas, CERCLA sites, and endangered species scores) were added. The end result is an absolute score that allows comparison of relative environmental vulnerability factors between census tracts.

Using this method, summary scores must be normalized by the number of sub-categories considered in order to compare the overall scores from different exposure types. Because each category has a varying number of sub-categories, each of which adds to the tract's final score, the summary scores are higher for those exposure types with more sub-categories considered. In other words, if there were 12 types of critical facilities counted and only 2 social factors counted, the absolute score for critical facilities would be much higher than the social score. Thus, the overall scores were divided by the number of sub-categories considered in order to provide normalized exposure scores for environmental, critical facilities, social vulnerability, and economic vulnerability.

Lookup Tables for Vulnerability Scoring

Number of Sites
Table 4-18

Number of Sites	Vulnerability Score
0	0
1	1
2	2
3	3
4	4
5	5

Property Value
Table 4-19

Property Value	Vulnerability Score
0	0
500000	1
1000000	2
5000000	3
10000000	4
25000000	5

Percentage of Population Table 4-20

% Total Population	Vulnerability Score
0.00	0
5.00	1
15.00	2
25.00	3
35.00	4
45.00	5

Population Density Table 4-21

Population Density (people/sq. mile)	Vulnerability Score
0	0
100	1
500	2
1500	3
5000	4
10000	5

Description of the Critical Facility Categories

1. **Marinas**: The number of marinas was determined from the RIGIS "Marinas.shp" file and then assigned a vulnerability score based on the number of sites from Table 4-18. The Occupancy Code for marinas is II, resulting in a score of 1. This value was then multiplied by the exposure score resulting in a total vulnerability score.

2. **Shelters**: Shelter information came from the RIGIS file, "Public Safety.shp". The number of shelters was used to determine the basic exposure score in Table 4-18. This value was then multiplied by the shelter's Occupancy Code score of 1.3, resulting in a total vulnerability score.

3. **Schools**: School information came from the RIGIS file, "Schools.shp". The number of schools was used to determine the basic exposure score in Table 4-18. This value was then multiplied by a school's Occupancy Code modifier score of 1.2, resulting in a total vulnerability score.

4. **Hospitals**: Hospital information came from the RIGIS file, "Hospitals.shp". The number of hospitals was used to determine the basic exposure score in Table 4-18. This value was then multiplied by the hospital's Occupancy Code modifier score of 1.3, resulting in a total vulnerability score.

5. **Fire and Rescue Stations**: Fire and Rescue information came from the RIGIS file, "Public Safety.shp". The number of stations was used to determine the basic exposure score in Table 4-18. This value was then multiplied by the station's Occupancy Code modifier score of 1.3, resulting in a total vulnerability score.

6. **Police Stations**: Police Station information came from the RIGIS file, "Public Safety.shp". The number of stations was used to determine the basic exposure score in Table 4-18. This value was then multiplied by the station's Occupancy

Code modifier score of 1.3, resulting in a total vulnerability score.

7. **Water Supply Points**: Water supply point information came from the RIGIS files, “Sewer Pumping Points.shp” and “Water Pumping Points.shp”. The number of points was used to determine the basic exposure score in Table 4-18. This value was then multiplied by the station’s Occupancy Code modifier score of 1.2, resulting in a total vulnerability score.

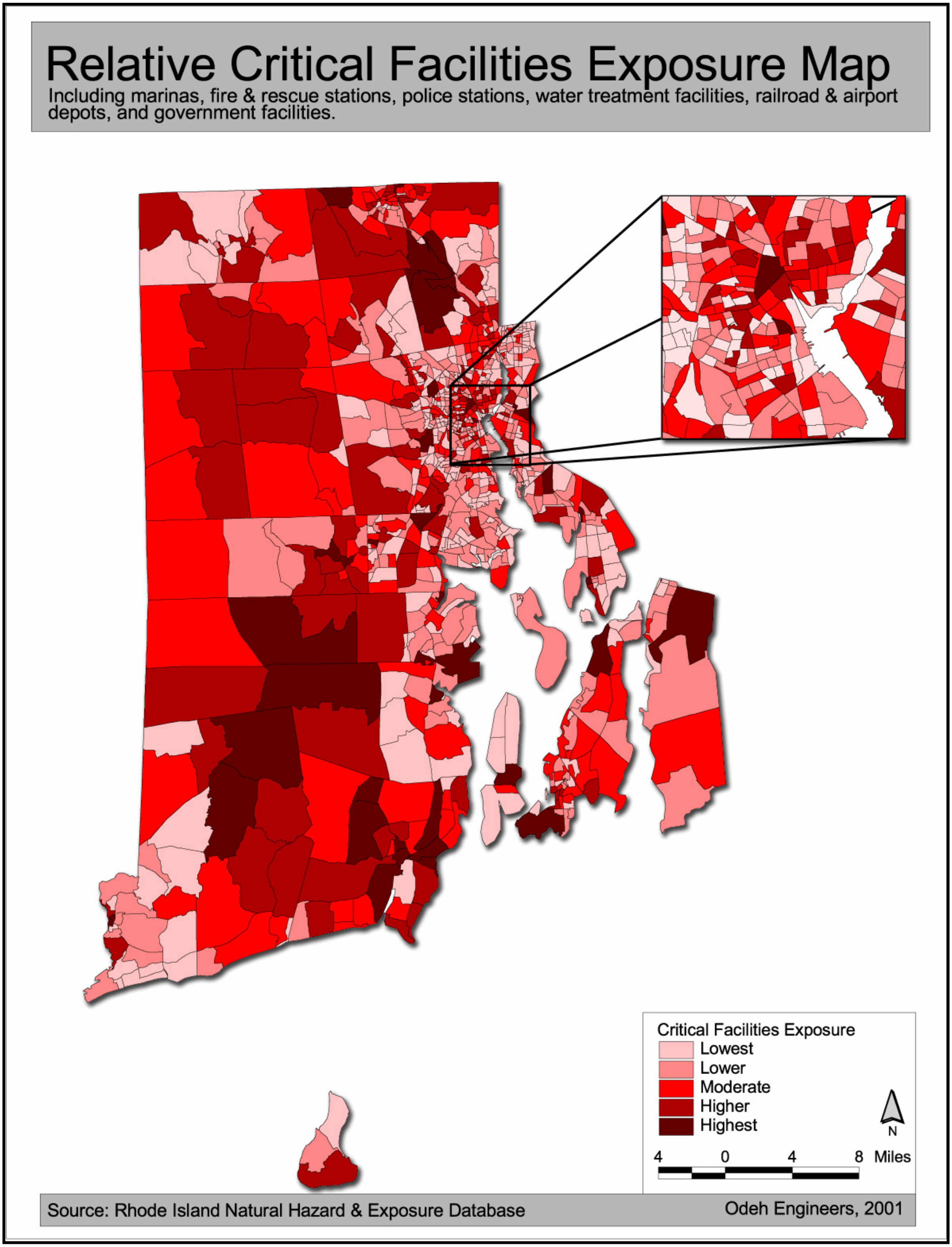
8. **Rail Road Stations and Airports:** Railroad station and airport information came from the RIGIS file, “Airports.shp”. The number of stations was used to determine the basic exposure score in Table 4-18. This value was then multiplied by the station’s Occupancy Code modifier score of 1.2, resulting in a total vulnerability score.

9. **Government Facilities:** This information came from the RIGIS file, “Public Safety.shp”. It includes local, state, and federal office buildings. There is no distinction made between state owned vs. operated structures because it is not relevant as the state is liable for the replacement value of all state structures irregardless of whether the facility is owned or operated. The number of facilities was used to determine the basic vulnerability score in Table 4-18. This value was then multiplied by the station’s Occupancy Code modifier score of 1.2, resulting in a total vulnerability score.

Final Scores: The exposure scores for each of these categories was then added up and divided by 9, the total number of Critical Facility subcategories, for a normalized score.

Mapping Statewide Critical Facilities Vulnerability
On the following page is a GIS map depicting the results of the scoring process for statewide vulnerability of critical facilities to natural hazards. The darkest hue of red represents the highest scores for the most severe cases of vulnerability (e.g. fire houses and/or public shelters located in special flood hazard areas), while the lightest hue, or pink represents the lowest level of vulnerability to critical facilities.

(SEE STATEWIDE CRITICAL FACILITIES MAP ON FOLLOWING PAGE)


Relative Critical Facilities Exposure Map
Including marinas, fire & rescue stations, police stations, water treatment facilities, railroad & airport depots, and government facilities.
Critical Facilities Exposure
Lowest
Lower
Moderate
Higher
Highest
N
4 0 4 8 Miles
Source: Rhode Island Natural Hazard & Exposure Database
Odeh Engineers, 2001

Social Vulnerability

Hurricanes, storms, and other natural events become "hazards" when they affect human society in adverse ways. Communities are vulnerable to these hazards to the extent that they are subject to potential damage to, or disruption of, normal activities. Societal conditions reflect human settlement patterns, the built environment, and day-to-day activities. These conditions include the institutions established to deal with natural hazards during both preparations and response. The impact of hazards on the social environment includes the damages on a human scale such as injuries, deaths, long-term health related problems and emotional issues arising from the event itself and the subsequent damages. Irreplaceable losses such as baby books, mementos, and photo albums cannot be measured in dollars.

Social vulnerability includes the population density, as well as tract-wide percentages on the percent of: non-whites; families below the poverty line; elderly populations; those with no high schooling; disabled adults; people on public assistance; those with no vehicles; renters, and percentage of non-English speakers. These categories correspond to social groups tracked by the U.S. Census, and were selected on this basis only.

The vulnerability of a community includes the potential for direct damage to residential, commercial, and industrial property as well as schools, government, and critical facilities. It also includes the potential for disruption of communication and transportation following disasters. Any disruption of the infrastructure, such as a loss of electric power or break in gas lines, can interrupt business activity and cause stress to affected families, particularly if they are forced to evacuate their residences and are subject to shortages of basic supplies. If the destruction of the infrastructure causes additional damage (e.g., property destroyed by fires caused by breaks in the gas lines), then this vulnerability needs to be taken into account. One also has to consider the exposure of the population to each hazard type and the potential number of fatalities and injuries to different socioeconomic groups.

Other obstacles are typically communication barriers. How do people who do not speak English or have a lower literacy rate handle the complicated paperwork that needs to be completed in order to receive financial compensation? What happens to those living in low-income housing, and/or public assistance that have not purchased flood/hurricane insurance? What happens to those living in rental housing with owners who are off-island and/or who cannot afford to rebuild?

Not just the immediate impact of the disaster creates serious hardship; there are also serious issues and problems with rebuilding after the disaster. Examples include, disreputable contractors either not paying workers, or taking down payments on roof repairs from home owners and either not completing the job, or doing very shoddy work. How can people be protected? How do people who do not speak English or have a lower literacy rate handle the complicated paperwork that needs to be completed in order to receive financial compensation? What happens to those living in low- income housing, and/or public assistance that have not purchased flood/hurricane insurance? What happens to those living in rental housing or those who cannot afford to rebuild?

Then there are the critical complications resulting from the interruption of governmental and social services. What happens if the locations where these services took place is damaged or destroyed and no alternative location had been identified ahead of time? What happens when the centers are damaged beyond repair? Or if clients receiving these services do not know where the new location is? What if the paperwork, files, database or box of information on the casework or clients has been destroyed? What happens when public shelters for the homeless have been destroyed-where do the homeless go? What happens to congregations/parishes whose churches and places of worship have been destroyed?

Categories of Populations at Risk

1 **Population Density:** Persons per square mile figures were extracted from the RIGIS database. This value was then compared to the Percent Population in Table 4-20 to yield a vulnerability score.

2 **Non-White**: This score represents the percentage of non-white persons relative to the total population in each tract. This value was compared to the Percent Population in Table 4-20 to yield a vulnerability score.

3 **Family Below the Poverty Level:** This score represents the percentage of families in each tract whom are below the poverty level. This value was compared to the Percent Population in Table 4-20 to yield a vulnerability score.

4 **Over 65**: This score represents the percentage of elderly people in each tract. This value was compared to the Percent Population in Table 4-20 to yield a vulnerability score.

5. **Disabled Adults:** This score represents the percentage of disabled adults in each tract. This value was compared to the Percent Population in Table 4-20 to yield a vulnerability score.

6. **No High School**: This score represents the percentage of the total population in each tract that has not completed high school. This value was compared to the Percent Population in Table 4-20 to yield a vulnerability score.

7. **Public Assistance**: This score represents the percentage of the total population of each tract who are on public assistance. This value was compared to the Percent Population in Table 4-20 to yield a vulnerability score.

8. **No Vehicle:** This score represents the percentage of the total population of each tract who do not have access to a private vehicle. This value was compared to the Percent Population in Table 4-20 to yield a vulnerability score.

9. **Rental Units**: This score represents the percentage of the total population of each tract who live in rental units. This value was compared to the Percent Population in Table 4-20 to yield a vulnerability score.

10. **Non-English Speaking:** This score represents the percentage of the total population of each tract who cannot speak English. This value was compared to the Percent Population in Table 4-20 to yield a vulnerability score.

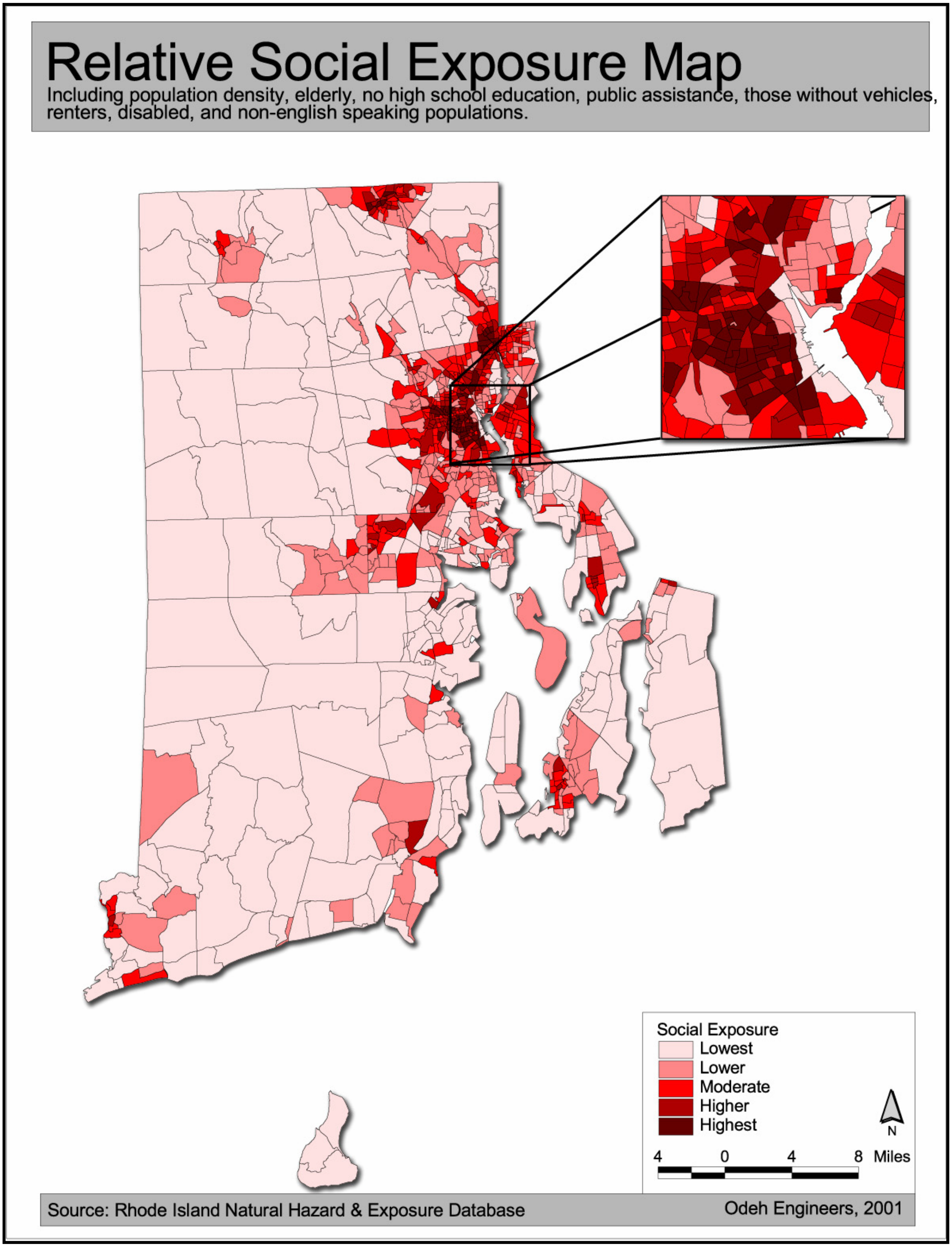
NOTE: All Social Factor scores were derived from the RIGIS file "Census1.shp". Social categories were chosen to represent different types of populations that would be at risk in a natural hazard situation.

Final Scores: The exposure scores for each of these categories was then added up and divided by 10, the total number of Social Factors subcategories, for a normalized score.

Mapping Statewide Social Vulnerability

The GIS map on the following page depicts, statewide, the populations at risk in the event of a natural disaster. The inset provided is of Providence where the greatest levels of vulnerability are throughout the state. Heavily urbanized and densely populated, Providence has the highest rates of non-English speaking, renters, those without vehicles and on public assistance.

The darkest hues of red indicate the greatest amount of populations at risk in a given area to the impact of a natural hazard (e.g. the greatest vulnerability could be a single, non-English speaking parent living in a rental property with no individual means of transportation.)


Relative Social Exposure Map
Including population density, elderly, no high school education, public assistance, those without vehicles, renters, disabled, and non-english speaking populations.
Social Exposure
Lowest
Lower
Moderate
Higher
Highest
N
4
0
4
8
Miles
Source: Rhode Island Natural Hazard & Exposure Database
Odeh Engineers, 2001

Environmental Resources

Environmental resources include the presence of rare species and habitats, scenic vistas, and protected areas sites. Hurricanes, earthquakes, coastal and riverine flooding, coastal erosion, or any weather-related hazard event will have unique impacts on the natural environment. Differences in storm size, speed of movement, wind speeds, storm surge heights, timing with respect to tides, and landfall location relative to vulnerable natural resources make for high variability in impacts and costs. (Heinz Center, 1999) Major climatic events, such as severe storms, are part of the natural and ecological processes that constantly shape coastal lands and vegetation. According to the 2000 Heinz Center Study on the costs of coastal hazards, the extent of the risk that coastal hazards pose to natural systems and the built environment is related directly to the degree that land uses alter and degrade the environment.

Direct and Indirect Costs
When the natural environment is impacted, there are both direct and indirect costs. Some of the direct costs may include the erosion of recreational beaches, loss of buffering dunes and upland property; destruction of agricultural crops due to flooding, winds and salt water intrusion; and loss of urban landscaping due to high winds and water damage.

Indirect costs, as described by the 1999 Heinz Center Study, include the widespread distribution of debris, accidental spills of fuel, sewage and industrial waste, household chemicals, or other contaminants onto the land or into the marine environment; in addition to environmental damage associated with storm debris or material cleanup, including illegal filling of wetlands in low-lying areas and the loss of landfill capacity. As experienced after Hurricane Bob post-storm debris management can be another problem. This occurs when vast amounts of vegetation, including potentially toxic-treated building materials from destroyed buildings, as well as other materials are burned at different sites with little management. Even with the burning, vast amounts of landfill capacity was used up with storm debris, meaning new sites would need to be developed at significant expense.

To analyze this risk, it is necessary to assess the characteristics and resilience of the natural environment. More specifically, natural features such as soils, elevations above sea level, and vegetative cover need to be inventoried. The intensity of land use, and the extent that hydrology, water quality, and habitats are altered, must all be evaluated. Land uses that extensively modify natural systems make these systems much more vulnerable to coastal hazards than do those that preserve and perpetuate natural ecological processes. The natural environment may be affected adversely immediately after the disaster as well as over the long term. Some of the damage may be irreversible, whereas other adverse impacts may be only temporary.

<u>Beach and Dune Loss</u>
Hurricanes, nor'easters and chronic erosion can, and often do, cause extreme damage along the shoreline, including a loss of beach sand offshore or downdrift, undermining or overwashing of the dunes that protect uplands, or, in extreme cases, the cutting of new

ocean inlets. Once a beach or dune is lost, its capacity to buffer the next storm is reduced dramatically. Following major erosion events, the recreational value of beaches declines sharply, because of both reduced beach area and loss of aesthetic appeal. Local tourist dollars are lost altogether or transferred elsewhere.

Water Quality and Other Pollution Impacts and Costs

Weather-related storm events have the potential to affect water quality in a number of ways and, thus, also affect human and ecosystem health. Hazardous materials discharge to standing water bodies and ground- water are another threat during disasters. For

example, accidental spills of sewage, propane tanks and underground tank displacements and failures of treatment plants and household septic systems are other major water-quality and health concerns associated with natural disasters. The location of the Narragansett Bay Treatment plant, pumping stations and the various chemical storage facilities throughout Rhode Island pose a serious threat to the densely developed residential areas in close proximity to these facilities. Additionally, saltwater inundation associated with storm surge can contaminate wells, particularly shallow ones.

Wildlife and Habitats

In South Carolina, Hurricane Hugo dramatically altered the coastal forests, beaches, wetlands, and estuaries. Some changes were relatively short-lived, such as lowered salinity and increased freshwater flows into estuaries. Other changes in fish and wildlife habitat were more permanent and resulted in dramatic losses of local flora and fauna. Loss of these habitats severely impacted the species populations dependent on these areas. Many of the species populations might be more significantly impacted, principally because of continuing human alteration of coastal and forest ecosystems. The effects of hurricanes, nor'easters and other storms on wildlife and fishery resources may also adversely affect the economy of Rhode Island by impeding several forms of

outdoor recreation. Access to fishing, boating, and the beaches may be eliminated in - a direct impact on the tourist economy of Rhode Island. Support facilities and the cottage businesses associated with these activities take a direct hit.

Environmental Categories

1. **CERCLA Sites**: Information for this category came from the "CERCLAS.shp" RIGIS file. This value then used the Number of Facilities Lookup in Table 4-18 to determine a preliminary score. This score was then multiplied by the lookup table value of the Occupancy Categories in Table 4-16 and 4-17, which is 1.2 for CERCLA sites, resulting in a final CERCLA environmental resources vulnerability score.

2. **Rare Species:** Information for this category came from the RIGIS file, "Rare Species.shp". This is described as the "estimated habitat and range of rare species and noteworthy natural communities." This file is a polygon file, which often overlapped many census tracts. To quantify this, it was necessary to clip the habitat polygons along the lines of each census tract border, resulting in a number of smaller habitat polygons contained within each tract. The number of polygons was counted and used as a rough proxy for the rare species habitat in a given tract. This value was recorded was compared to the Number of Facilities Lookup in Table 4-18 to determine the vulnerability score.

3. **Scenic Vistas:** Information for this category came from the RIGIS file, "Scenic Areas.shp". This file is described as defining "areas in RI designated by the RIDEM as noteworthy or distinctive landscapes or views". Similar to the Rare Species file, this came in polygon format. The same method was used to break it apart and quantify their influence on a given tract as above. These values were recorded, and then compared to the Number of Facilities Lookup in Table 4-18 to determine the vulnerability score.

Final Scores: The vulnerability scores for each of these categories were then added up to calculate an absolute Environmental Resources exposure score. This score was then divided by 3 to compute a normalized score.

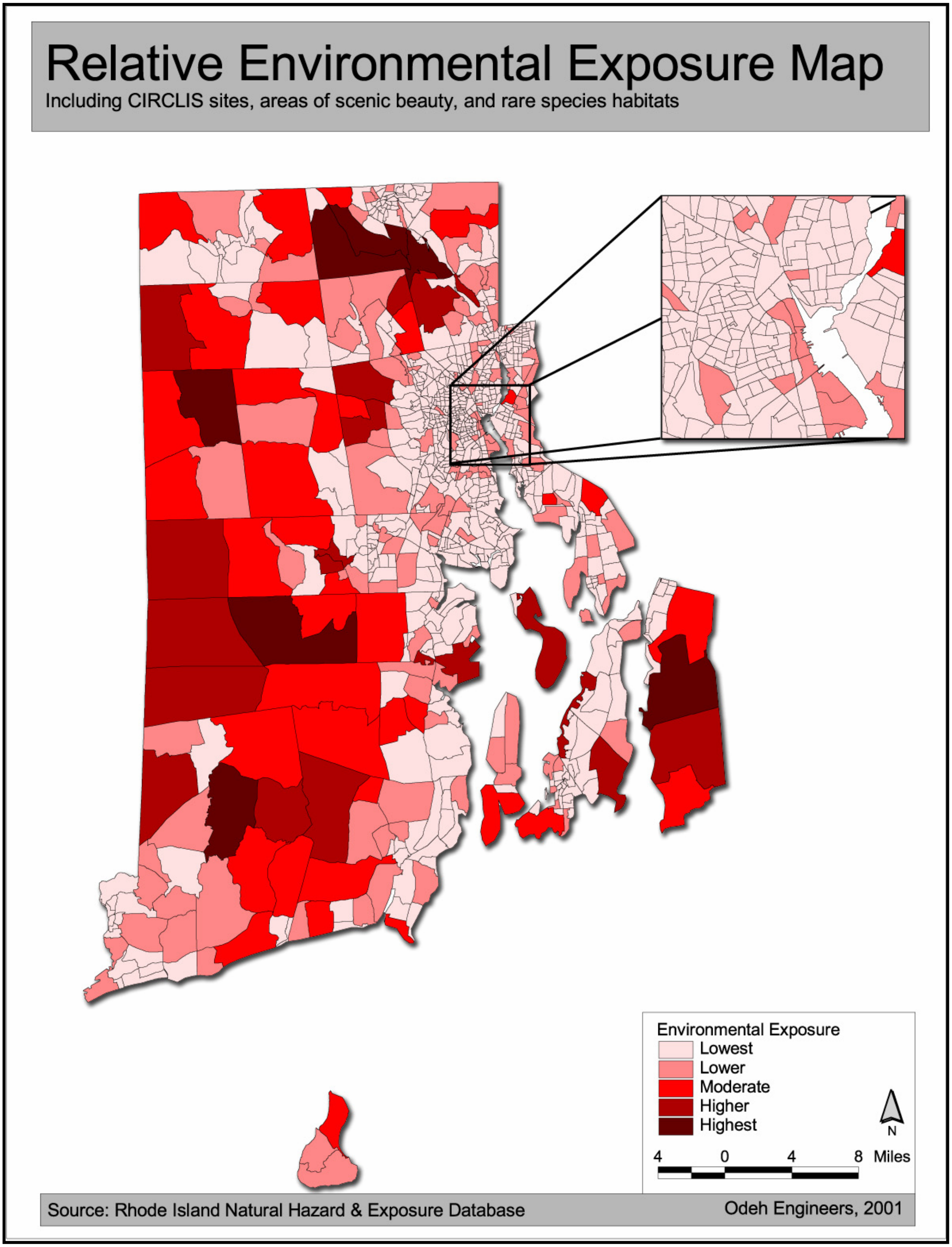
Mapping Statewide Environmental Vulnerability

On the following page is a GIS map depicting statewide vulnerability of environmental resources to the potential impacts of natural hazards. This type of vulnerability can cause confusion because it is important to remember that two environmental factors are being measured in terms of potential vulnerability: the fragility and/or potential of an environmental resource to be damaged by a natural hazard; and the potential of a secondary impact of a natural hazard creating damage to an environmentally fragile eco-system (e.g. a SUPERFUND site in close proximity to a fragile coastal estuary experiencing a 100 year flood and resulting in hazardous chemical leaking into the estuary).

The same mapping legend applies, those areas of the darkest hue of red depict the greatest vulnerability of environmentally sensitive areas being damaged by natural hazards, either by a direct impact, or a secondary effect posed by something in close proximity to an environmentally fragile area.

(SEE GIS MAP OF ENVIRONMENTAL VULNERABILITIES ON NEXT PAGE)

(SEE GIS MAP OF ENVIRONMENTAL VULNERABILITIES ON NEXT PAGE)


Relative Environmental Exposure Map
Including CIRCLIS sites, areas of scenic beauty, and rare species habitats
Environmental Exposure
Lowest
Lower
Moderate
Higher
Highest
N
4
0
4
8
Miles
Source: Rhode Island Natural Hazard & Exposure Database
Odeh Engineers, 2001

Economic Values

Economic values include the value of construction, light manufacturing, wholesale, hotels and motels, agricultural lands, professional / technical programs, retail, banking, and domestic properties. In determining the statewide economic exposure it was necessary to determine how many and which census tracts were in each zip code and then divide the total figure for a code by the number of tracts within it. Thus if a zip code had $1 million dollars of construction property in it, and it contained 10 census tracts, then the value for each tract would be $100,000 for the purposes of this analysis. Because the resolution of this data is lower, the figures included should not be taken as absolute.

Economic Categories
The following categories are those used by the U.S. Census Bureau to code business types across the country.

1. **Construction**: The US Census defines this category as "establishments primarily engaged in the construction of buildings and other structures, heavy construction (except buildings), additions, alterations, reconstruction, installation, and maintenance and repairs."

2. **Manufacturing**: The US Census defines this category as "establishments that are engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products."

3. **Wholesale**: The US Census defines this category as "establishments engaged in wholesaling merchandise, generally without transformation, and rendering services incidental to the sale of merchandise."

4. **Hotels/Motels**: The US Census defines this category as "establishments providing customers with lodging and/or prepared meals, snacks, and beverages for immediate consumption."

5. **Agriculture**: This category is defined as "businesses that are involved with or dependant upon the growing, harvesting, producing, or processing food and food-stuffs from the land."

6. **Professional/Technical Services:** The US Census defines this category as "establishments with payroll that specialize in performing professional, scientific, and technical activities for others." These activities require a high degree of

expertise and training. The establishments in this sector specialize according to expertise and provide services to clients in a variety of industries and, in some cases, to households. Activities performed include: legal advice and representation; accounting, bookkeeping, and payroll services; architectural, engineering, and specialized design services; computer services; consulting services; research services; advertising services; photographic services; translation and interpretation services; veterinary services; and other professional, scientific, and technical services.

7. **Retail**: The US Census defines this category as "establishments engaged in retailing merchandise, generally without transformation, and rendering services incidental to the sale of merchandise."

8. **Financial**: The US Census defines this category as "establishments of firms with payroll primarily engaged in financial transactions (transactions involving the creation, liquidation, or change in ownership of financial assets) and/or in facilitating financial transactions."

9. **Domestic**: Domestic property is all privately owned property within which people reside.

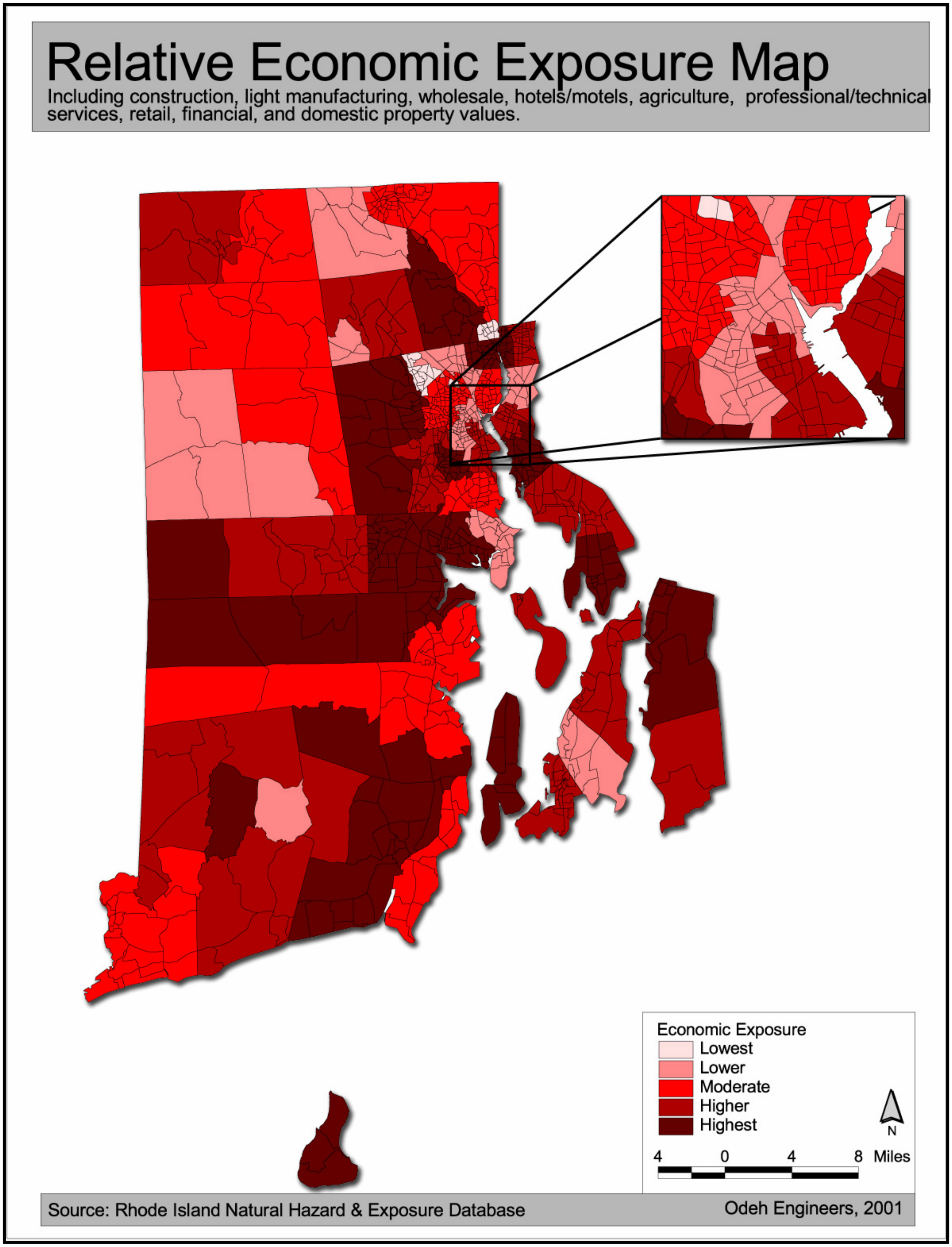
The procedure for calculating the scoring of each sub-category is identical. For each category, there are 4 quantities considered.

1. Number of establishments in each tract
2. Total value for all establishments in that category, for the entire zip code.
3. Total value of establishments divided by the number of census tracts found within the zip code, resulting in a per tract valuation of each category.
4. The final value is the actual exposure score, which was determined by taking the valuation per tract and using the Property Value Lookup in Table 4-19 shown above.

Final Scores: The vulnerability scores for each of these categories were added up to obtain an absolute Economic Value exposure score. This score was then divided by 9 to achieve a normalized score.

Mapping Statewide Economic Vulnerability

The GIS map on the following page depicts those areas statewide that will experience the greatest difficulty if severely impacted by a natural hazard. The darkest hues indicate that those areas will be the most severely affected in the event of a natural hazard. Keep in mind the broad categories included in this analysis. For example, hotel/motel and retail values are used, which would account for the highest levels of vulnerability if a severe natural disaster such as a hurricane were to hit, critically impacting the South County and Aquidneck Island, both critical areas for tourism. Likewise, were a severe flood event to hit, many areas inland critical to manufacturing, wholesale and professional/technical services would be hardest impacted.


Relative Economic Exposure Map
Including construction, light manufacturing, wholesale, hotels/motels, agriculture, professional/technical services, retail, financial, and domestic property values.
Economic Exposure
Lowest
Lower
Moderate
Higher
Highest
N
4 0 4 8 Miles
Source: Rhode Island Natural Hazard & Exposure Database
Odeh Engineers, 2001

Combined Vulnerability Scores

Combined scores represent the effects of hazards on the vulnerability of a given region. Combined scores are useful results for policymaking and risk mitigation, as they indicate the key hazard/vulnerability combinations that exist in a region. Combined risk scores are calculated for each community and can then be aggregated to measure overall scores for the state or other combinations of subregions by summation (South County, Aquidneck Island, Upper Narragansett Bay Metropolitan Area).

Note that the significance of the scores is relative in nature. A given score does not correspond to a dollar loss level or other direct measure of risk. Instead, the risk scores are intended to provide a framework for understanding the aggregate distribution of hazard and vulnerability combinations across the state. Detailed analysis of direct risk measures, such as dollar loss, can be conducted for the key hazard/vulnerability combinations identified by this approach, using software like HAZUS.

Combined scores were determined using the following formula:

COMBINED SCORE = (HAZARD SCORE) * (VULNERABILITY SCORE)

A combined score was determined for each hazard/vulnerability combination at the city/town level and then aggregated to provide state scores. Statewide combined scores for each hazard/vulnerability combination were then determined by summing the combined scores. To study combined scores, tables and maps were created for the following quantities in each census tract:

1. Total Absolute Hazard Score * Total Absolute Vulnerability Score
2. Individual Hazard Scores * Total Absolute Vulnerability Score (i.e., seven tables, one for each hazard type)
3. Individual Exposure Scores * Total Absolute Hazard Score (i.e., four tables, one for each vulnerability category)
4. Individual Hazard Score * Individual Vulnerability Score (for several select groupings of hazards/vulnerabilities)

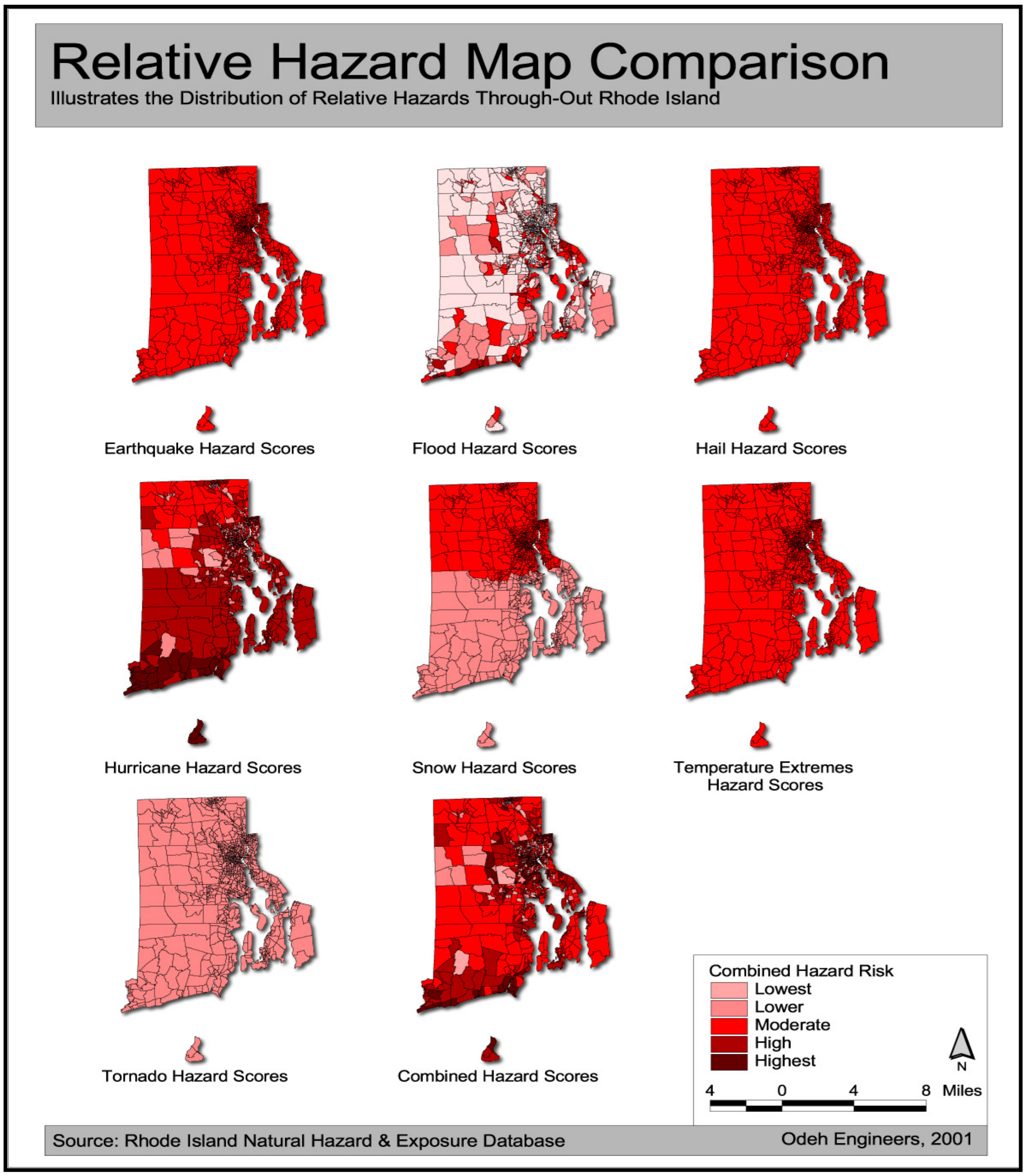
These tables allow the user to study the geographic distribution of combined scores for each individual vulnerability (subjected to all combined hazards), for each individual hazard (impacting all combined vulnerability), and for several key hazard/ vulnerability combinations. In addition, the following tables were created for the entire state, aggregating census tract scores to the statewide level:

1. Individual Hazard Score * Individual Vulnerability Score (for every combination)
2. Total Absolute Vulnerability * Total Absolute Hazard

These tables can be sorted and allow the user to determine the maximum individual hazard/vulnerability combinations on a statewide basis.

Mapping and Scoring Statewide Vulnerability to Natural Hazards
In the previous section of this chapter GIS maps were used to depict the statewide vulnerability for critical facilities; populations at risk, economic values and environmental resources/threats. Detailed Excel tables for each of these maps are located in the appendix.

"Relative Hazard Map Comparisons" are GIS maps depicting the impact of various natural hazards statewide. In the following section on vulnerability of the State to each natural hazard a table is listed that scores the impact of various natural hazards on each city/town in Rhode Island.



4.5 Summary of the Impacts of Natural Hazards throughout the State

Table 4-22 is the culmination of the hazard scores (flood, wind, earthquake, tornado and snow) broken down by hazard and categorized by city or town. Immediately following this table are GIS statewide maps illustrating the relative impact of each natural hazard throughout the state. In the following section, there is a discussion as to where areas throughout the state are more impacted for each natural hazard. In addition to the GIS maps depicting relative locations of hazard impacts, there is also data (as is available) for the number and locations of structures vulnerable to each natural hazard. Under each natural hazard section an overall state map depicts the relative impact of the hazard statewide.

In a future update of the of the Plan, data will be collected to enable RIEMA to complete a statewide hazard risk and vulnerability assessment for coastal erosion, drought, dam failure, ice storm, extreme cold and urban flooding. The lack of specific data for these hazards has been addressed in the following Mitigation Action Items:

- Coastal erosion – Mitigation Action Item 3.3.4
- Drought – Mitigation Action Item 3.1.5
- Dam Failure – Mitigation Action Item 3.3.3
- Ice Storm, Extreme Cold – Mitigation Action Item 3.1.4
- Urban/Stormwater Flooding – Mitigation Action Item 3.1.3

Rhode Island's Natural Hazards Score by Jurisdiction
Table 4-22

TOWN	AREA (sq.miles)	Wind Score	Flood Score	EQ Score	Tornado Score	Snow Score	Total Score
Barrington	10.3	860.0	234.0	420.0	112.0	600.0	3066.0
Bristol	11.2	1200.0	135.0	480.0	128.0	400.0	3303.0
Burrilville	57.1	960.0	63.0	510.0	136.0	850.0	3539.0
Central Falls	1.3	740.0	36.0	300.0	80.0	500.0	2256.0
Charlestown	41.7	680.0	144.0	210.0	56.0	175.0	1685.0
Coventry	62.3	1160.0	81.0	480.0	128.0	550.0	3359.0
Cranston	28.9	3820.0	360.0	1950.0	520.0	3250.0	13800.0
Cumberland	28.1	1180.0	117.0	600.0	160.0	1000.0	4257.0
East Greenwich	16.3	720.0	63.0	270.0	72.0	225.0	1890.0
East Providence	13.9	2720.0	225.0	1410.0	376.0	2350.0	9901.0
Exeter	58.3	240.0	0.0	90.0	24.0	75.0	609.0
Foster	51.8	180.0	18.0	120.0	32.0	200.0	790.0
Glocester	56.8	500.0	27.0	240.0	64.0	400.0	1711.0
Hopkinton	44.0	600.0	54.0	210.0	56.0	175.0	1515.0
Jamestown	13.8	480.0	54.0	180.0	48.0	150.0	1272.0
Johnston	24.3	1180.0	18.0	510.0	136.0	850.0	3714.0
Lincoln	19.0	740.0	45.0	360.0	96.0	600.0	2561.0
Little Compton	23.0	160.0	18.0	60.0	16.0	50.0	424.0
Middletown	13.7	800.0	36.0	300.0	80.0	250.0	2066.0

Narragansett	16.9	1180.0	198.0	390.0	104.0	325.0	2977.0
New Shoreham	11.0	300.0	27.0	90.0	24.0	75.0	696.0
Newport	9.2	1880.0	306.0	720.0	192.0	600.0	5138.0
North Kingstown	45.3	1760.0	297.0	690.0	184.0	575.0	4886.0
North Providence	5.8	1400.0	81.0	690.0	184.0	1150.0	4885.0
North Smithfield	24.7	480.0	27.0	210.0	56.0	350.0	1543.0
Pawtucket	8.8	4880.0	117.0	2160.0	576.0	3600.0	15653.0
Portsmouth	27.3	1120.0	216.0	420.0	112.0	350.0	3058.0
Providence	18.7	10980.0	486.0	5850.0	1560.0	9750.0	40326.0
Richmond	40.7	200.0	18.0	90.0	24.0	75.0	587.0
Scituate	54.7	500.0	99.0	270.0	72.0	450.0	1931.0
Smithfield	27.7	920.0	72.0	420.0	112.0	700.0	3064.0
South Kingstown	63.5	1580.0	171.0	540.0	144.0	450.0	3965.0
Tiverton	30.8	880.0	54.0	330.0	88.0	275.0	2287.0
Warren	7.5	800.0	198.0	330.0	88.0	275.0	2351.0
Warwick	36.9	5400.0	684.0	2400.0	640.0	2875.0	16799.0
West Greenwich	51.4	240.0	0.0	90.0	24.0	75.0	609.0
West Warwick	8.1	1480.0	99.0	660.0	176.0	925.0	4660.0
Westerly	31.5	1880.0	189.0	570.0	152.0	475.0	4406.0
Woonsocket	7.9	2260.0	99.0	1110.0	296.0	1850.0	7835.0

4.5.1 Flood Vulnerability Assessment and Loss Estimates

Estimating Potential Losses by Jurisdiction

There is no information on potential losses (for all hazards) based on estimates provided in local risk assessments because no local plans were approved by the deadline (June 2004) in order to be included in the State Plan. As stated in Mitigation Action Item 2.1.1 local risk assessments, vulnerability and potential loss estimate data will be collected and assimilated into a statewide database for incorporation into the next update of the State Hazard Mitigation Plan.

Scoring State Flood Vulnerability

Criteria for Severity
Flood scores were determined by considering two separate flooding events and averaging the score from these events. All data was taken from the FEMA National Flood Insurance Program maps as available on RIGIS. The lookup tables for severity and frequency are Table 4-12 and Table 4-15 respectively.

1. The first event considered was a 100 year flood. The frequency score for this event was determined from Table 4-12 and was equal to 3. The area impact was determined by computing the relative area within FEMA flood zone A within a

census tract and finding the corresponding area impact score from Table 4-13. Finally, the intensity score was determined by taking the average base flood elevation within the 100 year flood zones and looking up a score using Table 4-15. For each census tract, a hazard score was then computed by multiplying frequency score * area impact score * intensity score.

2. The second event considered was a 500-year flood. The frequency score for this event was determined from Table 4-12 and was equal to 2. The area impact was determined by computing the relative area within FEMA flood zones X500 and A within each census tract and finding the corresponding area impact score from Table 4-13. Finally, the intensity score was determined by taking the average base flood elevation within the 500 year flood zones and looking up a score using Table 4. For each census tract, a hazard score was then computed by multiplying frequency score * area impact score * intensity score.

The flood hazard score for each census tract was then determined by taking the average of the hazard scores for these two events.

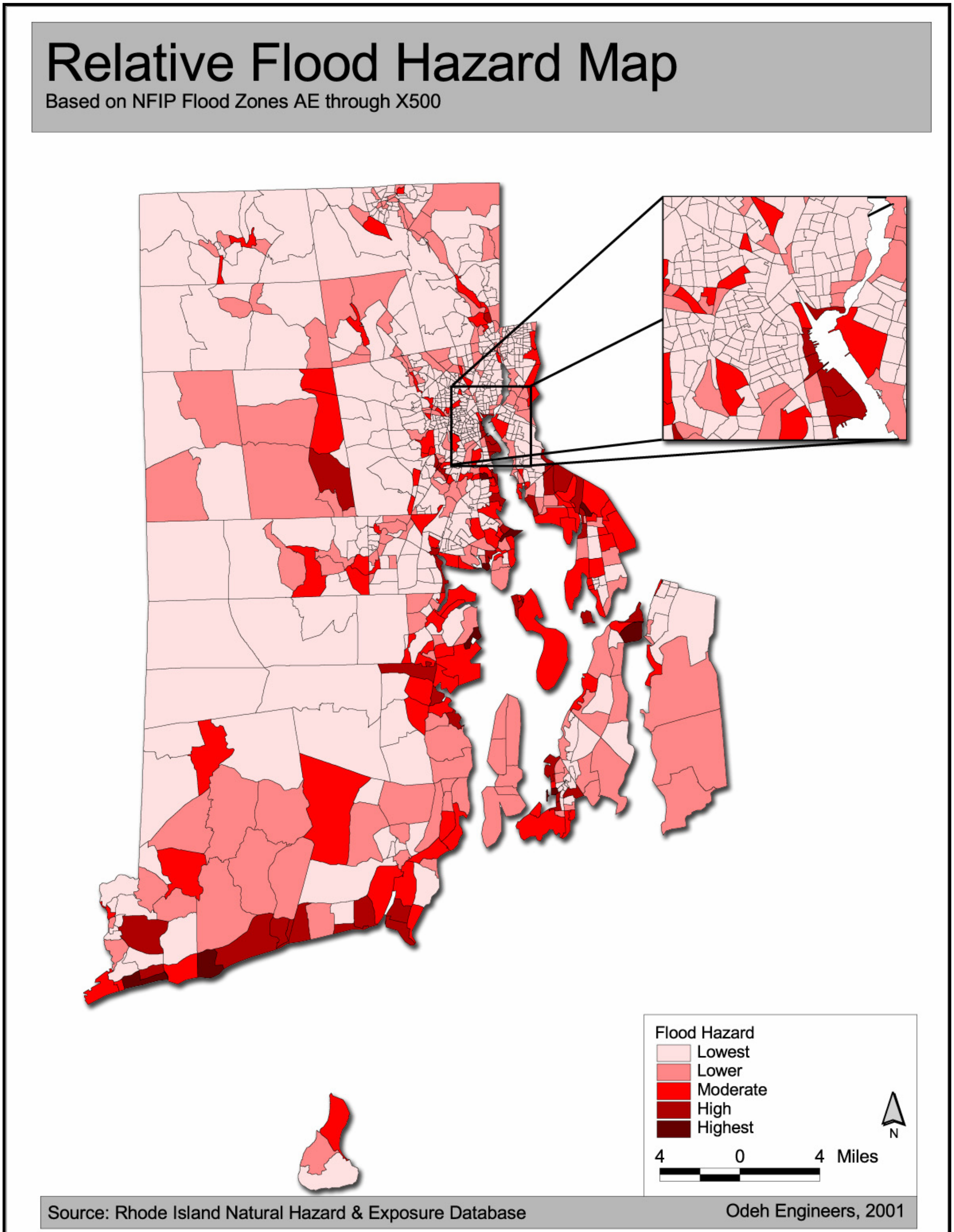
Criteria for Flood Frequency
Flood frequency was based on the 100 and the 500 year flood events as follows:

1. A 100-year frequency flood score was determined for each census tract by taking the percentage of the area covered by flood zone A (for the area impact score) and the average base flood elevation (for the intensity score)

2. A 500-year frequency flood score was determined for each census tract by taking the percentage of the area covered by flood zone X500 (for the area impact score) and the average base flood elevation (for the intensity score)

Areas of Vulnerability to Flooding

No Rhode Island community is completely safe from the threat of flooding. All 39 communities in the state have areas identified as "flood prone" by the Federal Emergency Management Agency (FEMA), and all 39 have elected to participate in the National Flood Insurance Program (NFIP) in order to make federally-subsidized flood insurance available to their residents. As of August 1, 2004, there are a total of 11,250 NFIP flood insurance policies in force statewide, providing a total coverage of $1,829,118,800.00 in protection against financial loss in future floods.


Relative Flood Hazard Map
Based on NFIP Flood Zones AE through X500
Flood Hazard
Lowest
Lower
Moderate
High
Highest
N
4 0 4 Miles
Source: Rhode Island Natural Hazard & Exposure Database
Odeh Engineers, 2001

The term 100-year flood (also called the Base Flood) is a flood having a one percent chance of being equaled or exceeded in magnitude in any given year. Contrary to popular belief, it is not a flood occurring once every 100 years. The 100-hundred year flood could, and frequently does, occur more than once within 100 years. The National Flood Insurance Program (NFIP) and most Federal and state agencies use the 100-year flood as a standard for floodplain management and to determine the need for flood insurance. A structure located within a Special Flood Hazard Area (SFHA) shown on an NFIP Flood Insurance Rate Map (FIRM) has a 26 percent chance of suffering flood damage during the term of a 30-year mortgage.

Floodplains are divisible into areas expected to be inundated by spillovers from stream flow levels associated with specific flood-return frequencies. A two-year return period event will generally inundate the entire two-year zone of the floodplain, and a 100-year flood will inundate the 100-year zone of that floodplain. Floodplains may be divided into as many as six levels of flood class, corresponding to six different hazard zones (A through F).

- Zone A represents the areas flooded by a 2-5 year flood;
- Zone B, a 5-10 year flood;
- Zone C, a 10-25 year flood;
- Zone D, a 25-50 year flood;
- Zone E, a 50-100 year flood; and
- Zone F, a greater than 100 year flood.

The Army Corps of Engineers calls a 100-year flood an Intermediate Regional Flood, while a Standard Project flood describes a major flood that could be expected to occur from a combination of severe meteorological and hydrologic conditions. Most dam and flood-related structures have been designed to meet 100-year flood conditions.

Coastal, Riverine and Urban/Stormwater Runoff Areas
The flood hazard varies by location and type of flooding. 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. Consequently, 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.

Location and Amount of Special Flood Hazard Areas throughout Rhode Island
The Rhode Island Statewide Planning Program's Environmental Inventory, a computerized land use information system that identified land use characteristics by 10-acre cell, unit, shows a state total of approximately 17,070 acres within the flood hazard velocity "V" zone (coastal areas subject to wave action) and another 84,012 acres within the flood hazard "A" zone (areas that would be inundated by the 100-year flood, but are not subject to velocity wave impact.) The l00-year flood is one having a one percent chance of occurring in any single year. Table 4-23 shows flood hazard acreage by city and town from the 2000 Rhode Island Population Census and the total percentage of the community’s total land.

Vulnerability Based on Local Risk Assessments

Unfortunately, this information is not complete because as of November 1st, 2004 only one community had a federal approved local hazard mitigation plan and therefore, the information needed to synthesize into the State Hazard Mitigation Plan is not available. Once the local plans have received FEMA approval all information relating to local areas of vulnerability and potential loss estimates, this data will be collected, synthesized and the geographical locations and extent of impact will be inventoried, described and remapped. (See Mitigation Action Item 2.1.1)

What is available is anecdotal information gathered from past flood events, a consistent pattern of LOMA requests (letters of map amendment) and data gathered at the time of a Community Assistance Visit (CAV).

Coastal Flooding

Warwick: The areas of Nausauket, Oakland Beach, Buttonwoods, and Conimicut are all fairly flat and have dense residential development and frequently flood from relatively minor rain storms, combined with snow melt and nor’easters.

Providence: Allens Avenue flood zones are not extensive, but there is a risk because the industrial development at the Port of Providence includes major oil and coal storage facilities located within a V-zone.

Newport: Flood zones do not progress far inland due to topography, but there is much at risk within the flood zone. Thames St. and Goat Island are especially at risk due the dense development present there. The Newport Fire Station is located in a V-zone across the street from the Newport Harbor area. First

Beach is subject to 18-19 foot storm elevations which could potentially travel across the pond and destroy the pavilion on First Beach.

North Kingstown: FEMA V zones along parts of Quonset Point, cramped industrial development present, major center for shipments of cars to the area.

Westerly: Misquamicut Area has extensive coastal development all the way to the Weekapaug Breech way, all are of extremely high values and are located in dynamic V-zone areas subject to high levels of coastal erosion.

Barrington**:** Bay Spring and Nyatt areas, Rumstick Point are all low lying densely developed residential areas subject to extremely high storm surge levels from the upper reaches of Narragansett Bay and are also subject to riverine and coastal pond flooding

Narragansett: Galilee area is extremely developed. Supports the Block Island Ferry, numerous hotels and restaurants, as well as being a major port for recreational and commercial fishing. Redevelopment has been completed to improve Galilee. Project includes a hotel by George's Restaurant, better facilities for Block Island travelers, and better roads.

Bristol: The topography continues to be steep along the shoreline of most of Bristol. The most vulnerable areas are Bristol Harbor, which is adjacent to downtown Bristol. The area has V zones along Hope St. and Rt. 114, both heavily developed areas.

Charlestown: Foster Cove area located on the backside of Ninigret Pond is also an area that could be impacted in the event of a strong coastal storm. High value residential property.

New Shoreham: Northern section of the island is flat and would be inundated during a severe storm, but there is little development or permanent residents there. The southern part of the island possesses steep south facing cliffs that while not subject to flooding, are subject to severe erosion The greatest risk on New Shoreham comes from the immense summer tourism population. If a hurricane struck during the summer, a much greater amount of people would be at risk with an extreme shortage of shelter spaces

Riverine Flooding

Riverine flooding in Rhode Island may be associated with hurricanes, the aftermath of winter storms, spring snow melts combined with heavy rains or take place independently of major storm activity. The Blackstone River basin and the Pawtuxet River watershed of Narragansett Bay Drainage Basin have had long histories of flooding, with records dating as far back as 1818.

Providence River: is a very shallow river but has not flooded. River is being dredged

Pawcatuck River: Cranston and Warwick areas, very little buildup near river, therefore not subject to damage from flooding.

Cumberland: subject to repetitive flooding of commercial property (manufacturing and wholesale) but not repetitive loss because most of the properties do not carry flood insurance.

Urban Flooding/Stormwater Runoff
Urban flooding in Rhode Island (or stormwater flooding) is a very common problem. However, there is no map, nor is there a database or even accurate or reliable information as to where there is repeated urban flooding. The data simply does not exist. To address this data deficiency a mitigation action will be added to develop a statewide database on the locations of urban/stormwater flooding throughout Rhode Island (Mitigfation Action Item 3.1.3). Additionally, information on areas of urban/stormwater flooding may be given in local hazard mitigation strategies. Once these strategies have received FEMA approval and are available to RIEMA for review and integration into the Statewide Plan (see Mitigation Action Item 2.1.1) any relevant data on areas of urban/stormwater flooding will be added to the statewide urban/stormwater database to be developed.

Specific Areas of past flooding

Pawtuxet River: Cranston and Warwick areas, due to its shallow depths from sediment buildup frequent floods occur. Leads to lack of water storage, also because much of the shoreline and adjacent wetlands have been filled for development.

Woonasquatucket River: from Smithfield to Providence, densely developed small lots mixed use of residential and commercial

Natick Area: West Warwick area, flat area, has mixed uses, commercial, industrial, and residential.

East Providence: Riverside, Marsh Street off Waterman Avenue

Quantifying Flood Areas by Jurisdiction

According to the statewide risk assessment located on the GIS map, flooding is a localized problem in Rhode Island. In the accompanying table, all of Rhode Island's 39 communities have been ranked by severity/frequency of their flood risk. Three indicators that will be used in assessing local vulnerability to flooding: hazard risk assessment scores; data from the repetitive loss statewide data base; and the FEMA NFIP database on the number and amount of payouts and claims for flood losses.

Table 4-23 is a tabularized format of what is depicted in the RI GIS flood maps. For this table, there is no separate breakout of A & V zones. While FEMA A & V zones inherently include coastal and riverine flooding, urban flooding areas and more accurate information will be forthcoming. Future studies to assess areas of vulnerability will be pursued. As of this point in time, there is a data deficiency relating to specific locations of urban/storm water flooding (see Mitigation Action Item 3.1.3) What is important to realize, is the total percentage of flood hazard coverage for each city and town. Although the NFIP flood policy and claim information may provide some indicator of the areas in Rhode Island that have flooded, it should be noted that many of the areas in Rhode Island that flood most frequently are not covered by NFIP flood insurance and therefore do not show up on NFIP flood loss or repetitive loss data.

Amount of Flood Hazard Acres in Each Community
Table 4-23

Community	Total Acres	Flood Hazard Acres*	% of Acres in Community
Barrington	5,900	2,417	40.97
Bristol	6,640	1,745	26.28
Burriville	37,440	2,394	6.39
Central Falls	830	121	14.58
Charlestown	27,220	9,276	34.08
Coventry	40,780	2,147	5.26
Cranston	18,680	1,541	8.25
Cumberland	18,310	2,098	11.46
East Greenwich	10,690	1,500	14.03
East Providence	9,270	1,610	17.37
Exeter	37,910	2,190	5.78
Foster	33,470	2,659	7.94
Glocester	36,620	2,271	6.20
Hopkinton	28,780	3,412	11. 86
Jamestown	6,410	766	11.95
Johnston	15,670	1,677	10.70
Lincoln	12,280	752	6.12
Little Compton	14,990	2,516	16.78
Middletown	8,C70	499	5.63
Narragansett	10,580	4,224	39.92
Newport	5,580	2,078	37.24
New Shoreham	7,120	1,220	17.13
North Kingstown	28,960	5,538	19.12
North Providence	3,780	238	6.30
North Smithfield	16,240	1,727	10.63
Pawtucket	5,850	392	6.70
Portsmouth	15,910	4,238	26.64
Providence	12,290	1,669	13.58
Richmond	25,950	2,945	11. 35
Scituate	35,410	6,368	17.98
Smithfield	17,830	1,201	6.74

South Kingstown	41,230	12,168	29.51
Tiverton	20,290	2,335	11.51
Warren	4,210	1.,431	33.99
Warwick	23,760	3,923	16.51
Westerly	21,430	5,604	26.15
West Greenwich	33,090	1,197	3.62
West Warwick	5,150	629	12.21
Woonsocket	5,120	35	6.95
Total	**710,700**	**101,082**	

* Includes both FEMA flood A and V zones

NFIP Total Claim Amounts from 1978 – 2003

Table 4-24 and the accompanying repetitive loss map contains the values of the National Flood Insurance Program (NFIP) insurance claims, aggregated by municipality, for the period of January 1, 1978 to December 31, 2003. This information provides an overview of where the majority of insured flood damage occurs as well as an approximate dollar value on damages. It should be noted that these maps and corresponding figures, do not take into account any of the uninsured losses caused by flooding.

NFIP Repetitive Loss Properties/Claims, NFIP Policies, Properties & Claims Since 1978
Table 4-24

Community	RL prop /# of claims	# of Policies	Premiums Paid	Rep Loss Claims Paid
Westerly	29/100	977	$1,018,066	$ 484,524.59
Providence	17/65	157	$ 268,828	$3,312,848.89
Warwick	16/35	1,672	$1,128,736	$ 161,875.15
Cranston	10/30	366	$ 296,968	$ 368,596.73
Charlestown	9/23	691	$ 600,801	$ 307,099.99
Barrington	9/24	755	$ 628,844	$ 131,894.27
North Providence	8/26	118	$ 75,967	$ 581,501.07
South Kingstown	7/17	808	$ 555,690	$ 358,007.61
West Warwick	6/16	110	$ 58,604	$ 361,084.84
Narragansett	5/15	1,136	$ 723,184	$ 774,408.76
Lincoln	4/10	189	$ 21,312	$ 128,775.14
Newport	4/10	1,143	$ 816,093	$ 75,669.00
Bristol	3/7	380	$ 344,785	$ 76,410.70
North Kingstown	3/7	695	$ 485,039	$ 64,904.69
Pawtucket	3/7	96	$ 21,349	$ 165,012.98
Portsmouth	3/7	652	$ 495,928	$ 28,943.35
Cumberland	2/4	27	$ 36,953	$ 43,095.18
East Greenwich	2/5	116	$ 88,563	$ 100,233.11
Tiverton	2/4	150	$ 117,604	$ 20,437.39
Burriville	1/2	15	$ 7,398	$ 55,488.31
Coventry	1/3	67	$ 39,562	$ 13,623.87
East Providence	1/3	219	$ 133,172	$ 8,52.22

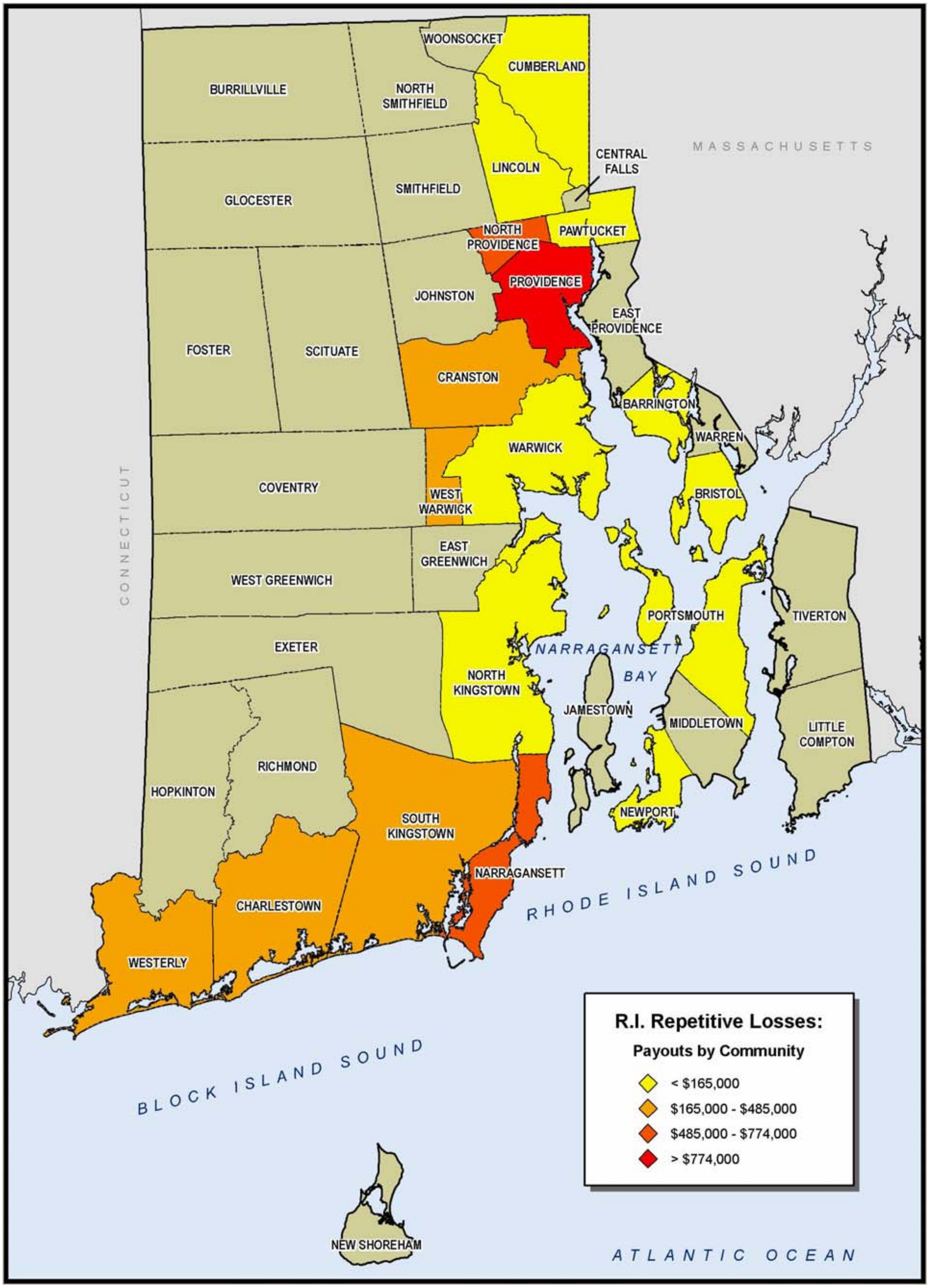
Scituate	1/2	8	$ 2,331	$ 29,804.73
Smithfield	1/2	38	$ 42,767	$ 58,693.48
Warren	1/2	393	$ 246,901	$ 119,801.83
TOTAL	**151/450**	**11,520**	**$ 8,666,306**	**$1,991,904.05**

NFIP Repetitive Losses

Another measure of an area's vulnerability to flooding is the location of "repetitive loss" properties. The NFIP identifies a repetitive loss property as one which has received flood insurance claim payments greater than $1,000, twice in any given 10 year period. The top repetitive loss communities and the NFIP payments made since 1978 are listed in the table above.

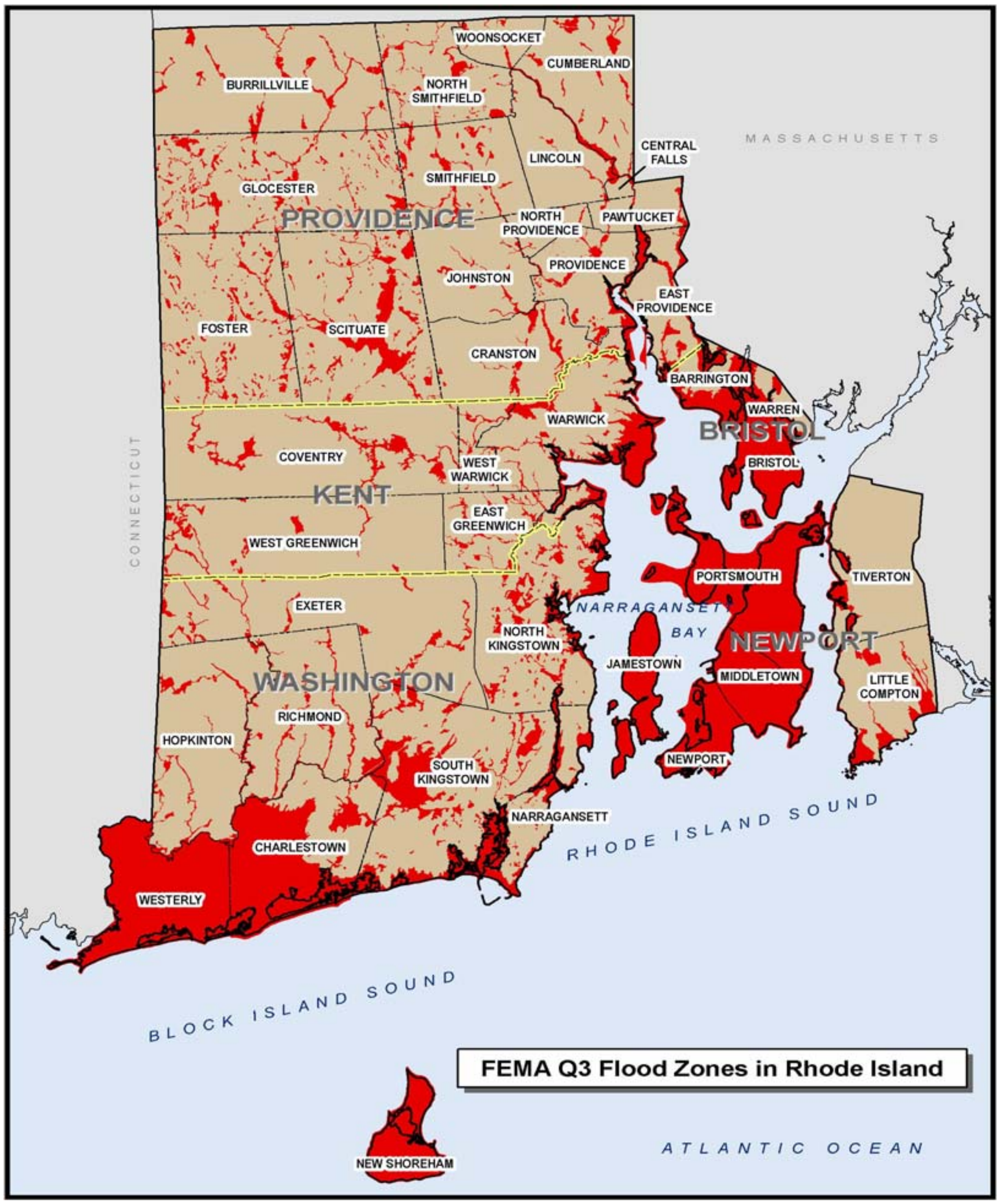
The highest claim payments to repetitive loss properties are in the communities of Providence, Westerly, West Warwick, South Kingstown Cranston and Charlestown.

(SEE STATE REPETITIVE LOSS MAP ON FOLLOWING PAGE)


WOONSOCKET
CUMBERLAND
BURRILLVILLE
NORTH SMITHFIELD
MASSACHUSETTS
CENTRAL FALLS
LINCOLN
GLOCESTER
SMITHFIELD
NORTH PROVIDENCE
PAWTUCKET
PROVIDENCE
JOHNSTON
EAST PROVIDENCE
FOSTER
SCITUATE
CRANSTON
BARRINGTON
WARREN
WARWICK
CONNECTICUT
COVENTRY
WEST WARWICK
BRISTOL
EAST GREENWICH
WEST GREENWICH
PORTSMOUTH
TIVERTON
EXETER
NARRAGANSETT BAY
NORTH KINGSTOWN
JAMESTOWN
MIDDLETOWN
LITTLE COMPTON
RICHMOND
HOPKINTON
NEWPORT
SOUTH KINGSTOWN
NARRAGANSETT
RHODE ISLAND SOUND
CHARLESTOWN
WESTERLY
BLOCK ISLAND SOUND
R.I. Repetitive Losses:
Payouts by Community
< $165,000
$165,000 - $485,000
$485,000 - $774,000
> $774,000
NEW SHOREHAM
ATLANTIC OCEAN

Flood Zones – National Flood Insurance Rate Maps (FIRMS)

FEMA's Flood Insurance Rate Maps, or FIRMs are available for all of Rhode Island's NFIP communities. These maps, produced for the National Flood Insurance Program, depict the highest riverine and coastal flood risk areas. For the purposes of this plan, an overview of the state flood map is below in order to give a state perspective of Rhode Island's flood risk. It should be noted, however, that while at this time the FEMA FIRMs are the best available flood risk maps, many of the panels are woefully out of date (most have an average age of 20 years) and do not depict many areas that experience storm water and urban flooding an increasing problem resulting from the development boom in Rhode Island over the past 25 years.



Coastal Flooding or Inundation following Hurricanes, Tropical Storms & Coastal Storms (SLOSH maps)

The Sea, Lake and Overland Surge from Hurricanes (SLOSH) Inundation areas Initially developed by the U.S. Army Corps of Engineers (USACE), depict the areas at highest risk to coastal flooding. USACE produced maps of SLOSH inundation areas for FEMA. The SLOSH inundation mapping for New England considers Category 1 – 4 hurricanes as defined by the Saffir/Simpson Hurricane Intensity Scale. The Saffir Simpson scale categorizes hurricane intensity linearly based upon the maximum sustained winds, barometric pressure and storm surge potential, which are combined to estimate potential damage. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on the slope of the continental shelf in the landfall region. All winds are using the U.S. 1-minute average, meaning the highest wind that is sustained for 1-minute.

The National Weather Service uses the numerical storm surge model called Sea Lake Overland Surge from Hurricanes (SLOSH) to provide information for emergency managers about which areas of a particular community to evacuate from the rising levels of water from storm surge. The model takes several factors into consideration to calculate the potential height of water above mean sea level (MSL) in hurricane warning areas:

1. Low atmospheric pressure created by the hurricane
2. Wind stress combined with increasing elevation of the Continental Shelf
3. The size of the hurricane
4. The angle that the hurricane track makes with the coastline
5. The forward speed of the hurricane when it crosses the coastline
6. The effects of such features as underwater sills, channels, and rivers
7. The effects of obstructions on land such as sand dunes, roads, levees, etc

SLOSH requires that the following specific information be input every 6 hours, over a 72-hour period, beginning 48 hours before anticipated landfall of a hurricane:

- The latitude and longitude of the storm center.
- The minimum sea-level pressure at the hurricane center.
- The radius of the maximum surface wind.

SLOSH then computes water height over a series of more than 5,000 geographic grid squares, which form a network, or *basin.* Computer models representing the varying bathymetry and other factors affecting storm surge have been developed for specific coastal basins to numerically simulate surges from hurricanes. The Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model is the latest and most sophisticated mathematical model developed by the National Weather Service to calculate potential surge heights from hurricanes. It calculates storm surge heights for the open ocean and coastal regions affected by a given hurricane. The model also calculates surge heights for bays, estuaries, coastal rivers, and adjacent upland areas susceptible to inundation from the storm surge.

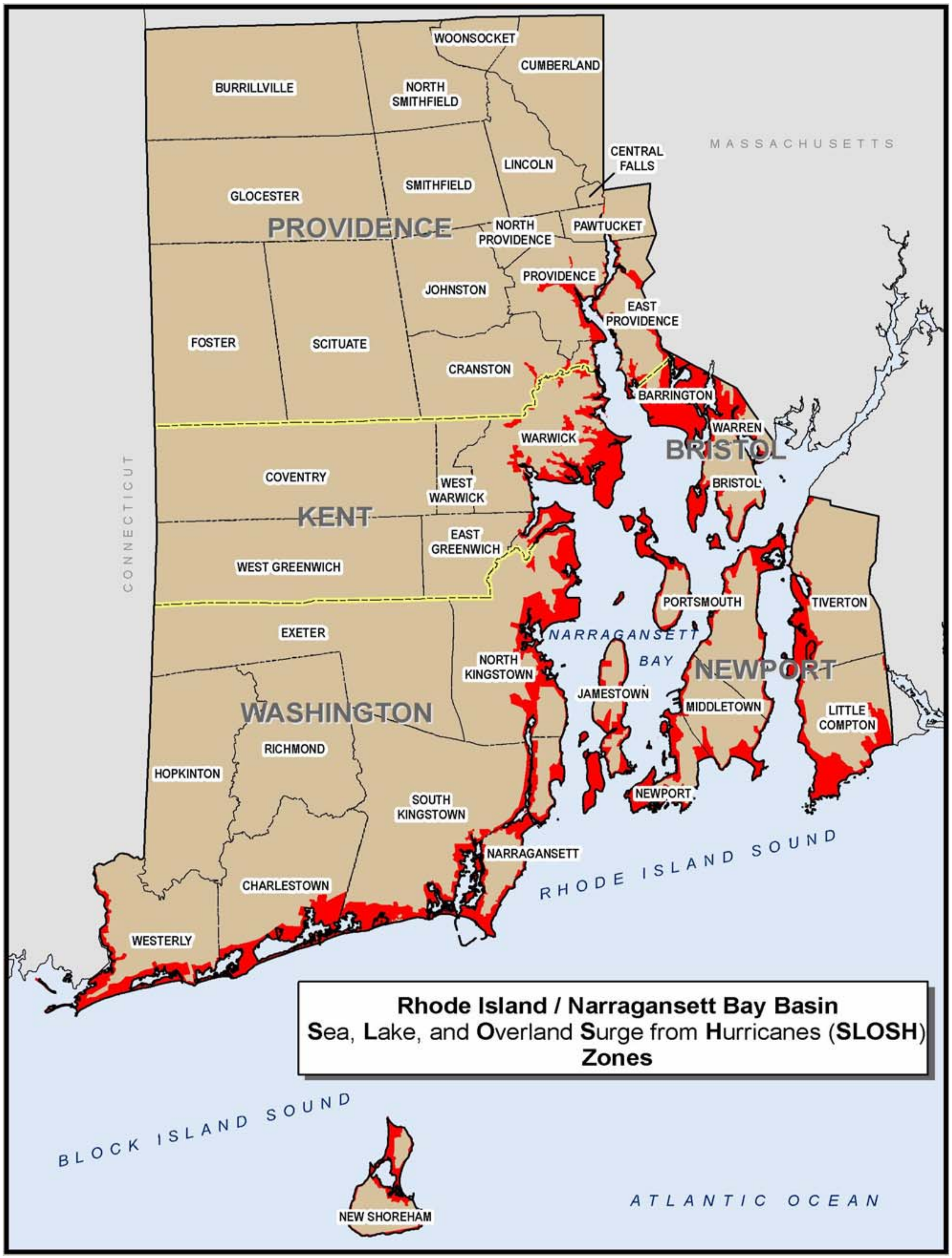
Output from the SLOSH Model for Narragansett Bay

Six storm-track headings were selected as being representative of storm behavior in this region on the basis of observations by forecasters at NOAA's National Hurricane Center. The maps in this atlas summarize surge calculations made using the SLOSH model, when initialized with observed values (depths of water and heights of terrain and barriers) in the region centered on Narragansett Bay, Rhode Island and Buzzards Bay, Massachusetts.

The output for the Narragansett and Buzzards Bays "SLOSH" model consists of maps of water heights. At each grid point, the water height is the maximum value that was computed at that point during the 72 (maximum) hours of model time. Thus, the map displays the highest water levels and does not display events at any particular instant in time. The analyzed envelopes of high water show shaded areas that represent dry land which has been inundated and contours of high water relative to mean sea level (MSL).

Mapped SLOSH Zones

On the next page is the state SLOSH map. Areas in red depict surge zones, or locations subject to higher water levels when storm surge becomes a factor. Of particular note are locations that will experience extreme water heights and have the greatest impact for structural damage and potential loss of life. The areas of concern have been chosen for a number of reasons: susceptibility to high water levels; dense population, lack of flood insurance by most of the property owners in the area; location of aging public infrastructure such as bridges and roads; and limited means of access as surge covers bridges and evacuation routes. Areas particularly vulnerable to this type of flooding include: Barrington; Tiverton; Warwick (Oakland Beach and Conimicut Point; Newport; South Kingstown, Charlestown and Westerly. Of greatest concern in these areas is the fact that there only means of evacuation from their communities are roads that will be under water in a very short time.



WOONSOCKET
CUMBERLAND
BURRILLVILLE
NORTH SMITHFIELD
MASSACHUSETTS
CENTRAL FALLS
LINCOLN
SMITHFIELD
GLOCESTER
PROVIDENCE
NORTH PROVIDENCE
PAWTUCKET
PROVIDENCE
JOHNSTON
EAST PROVIDENCE
FOSTER
SCITUATE
CRANSTON
BARRINGTON
WARREN
WARWICK
BRISTOL
CONNECTICUT
COVENTRY
WEST WARWICK
BRISTOL
KENT
EAST GREENWICH
WEST GREENWICH
PORTSMOUTH
TIVERTON
EXETER
NARRAGANSETT BAY
NORTH KINGSTOWN
NEWPORT
JAMESTOWN
MIDDLETOWN
WASHINGTON
LITTLE COMPTON
RICHMOND
HOPKINTON
NEWPORT
SOUTH KINGSTOWN
NARRAGANSETT
RHODE ISLAND SOUND
CHARLESTOWN
WESTERLY
Rhode Island / Narragansett Bay Basin
Sea, Lake, and Overland Surge from Hurricanes (SLOSH) Zones
BLOCK ISLAND SOUND
NEW SHOREHAM
ATLANTIC OCEAN

SURGE VULNERABLE POPULATIONS
Table 4-25

TABLE 5.2
ESTIMATED PUBLIC SHELTER DEMAND/CAPACITY
SEVERE HURRICANE SCENARIO

	Shelter Demand by Population Type				
Community	Surge Vulnerable Residents	Non-surge Vulnerable Residents	Mobile Homes Residents	Total Shelter Demand	Total Shelter Capacity[1]
Barrington	1,490	20	0	1,510	9,000
Bristol	620	130	20	770	1,400
Charlestown	240	60	330	630	**600**[2]
Cranston	230	560	50	840	**550**[2]
East Greenwich	120	80	110	310	**300**[2]
East Providence	770	320	170	1,260	**400**[2]
Jamestown[3]	400	50	10	460	530
Little Compton	100	20	190	310	350
Middletown	190	130	450	770	2,580
Narragansett	940	80	10	1,030	1,100
New Shoreham	80	10	0	90	500
Newport	1,080	150	0	1,230	1,625
North Kingstown	720	130	540	1,390	4,750
Pawtucket	60	530	880	1,470	5,230
Portsmouth	500	90	1,080	1,670	**1,183**[2]
Providence	130	1,200	0	1,330	20,500
South Kingstown[3]	700	210	460	1,370	5,600
Tiverton	240	90	720	1,050	**500**[2]
Warren	830	30	10	870	**650**[2]
Warwick	3,130	430	210	3,770	4,180
Westerly[3]	760	140	210	1,110	1,900
TOTALS	13,330	4,460	5,450	23,240	63,428

Vulnerable Populations in Areas of Storm Surge

According to the Rhode Island Red Cross, Rhode Island has 63,428 available shelter spaces. (Rhode Island Red Cross Shelter Inventory 2003) The same survey indicates a residential population living in areas susceptible to a worse case scenario of storm surge to be 130,980. (1995 Army Corps of Engineers Hurricane Evacuation Study) Therefore, under a severe hurricane scenario, only 29% of the residents can be sheltered. As the intensity of a storm increases, so too, does the number of people seeking public shelter spaces. According to a 1995 Army Corps of Engineers Study, 60% of the residential population in Rhode Island will seek shelter during a category 1 or 2 event. During a category 3, 4 or 5 event the survey indicates that 90% of the residential population will evacuate to seek public shelter. However, during the weaker storm events, the analysis indicates that 21,844 shelter spaces needed and during stronger storms, 32,765 shelter spaces are in need.

When the visitor population is considered in the analysis, the shelter space shortfalls are even more alarming. According to the 1991 Hurricane Evacuation Study the total seasonal population is 208,526. The total seasonal population located in evacuation zones is 14,990. Combining the number seasonal visitors with the resident population in an evacuation zone is a total of 125,530 people. The most critical areas are where the greatest concentration of tourists stay, are the beach communities of South County and Newport. In the South County evacuation area, the total usable shelter spaces, with some risk, is 4,105 spaces. In the evacuation zone of Newport, the total number of spaces 477 yet the total population (both year round and seasonal) is 10,590 people (see Table 4-27). Table 4-26 lists those shelters that are located in flood hazard areas.

Critical Facilities (Shelters) Vulnerability in Storm Surge Areas

The susceptibility of the shelters to storm surge was assessed using surge limits delineated in the Inundation Map Atlas (part of the 1995 HES). Vulnerability of the shelters to 100-year and 500-year frequency flooding were assessed using the NFIP rate maps published by FEMA. Shelters not located in inundation areas, 500-year and/or 100-year flood zones have been classified as not vulnerable to flooding. In a few instances, public shelters were found to be located adjacent to or within areas that may flood. Unless otherwise noted, the lowest floor elevations of these facilities as reported by community officials were determined to be higher than base flood elevations and may be cautiously used during evacuations. No attempt has been made to verify the first floor elevations of other facilities, or assess the vulnerability of any shelter to effects from hurricane winds.

CRITICAL FACILITES (PUBLIC SHELTERS)
LOCATED IN/NEAR FLOOD AREAS
Table 4-26

Facility Name	City/Town	Capacity	Comments
Sowams School	Barrington	1,000	elevation required
Barrington Middle School	Barrington	3,000	elevation required
Barrington High School	Barrington	3,000	elevation required
Peek Library Comm. Ctr	Barrington	2,000	elevation required
Bristol High School	Bristol	1,000	elevation required
J.Gaudet Middle School	Middletown	1,000	assessment needed
Pier School	Narragansett	400	minor flooding
Davisville Middle School	N. Kingstown	2,500	assessment needed
St. Mary’s Church	Warren	200	Inundation Area C
St. Thomas’ Church	Warren	150	Inundation Area C
Touisset Fire Station	Warren	unknown	Inundation Area C

Warren High School	Warren	unknown	Inundation Area C
CCRI Junior College	Warwick	250 (?)	500 year flood plain
Total for capacity affected		**14,250**	

In most cases the shelters listed in Table 4-26 are also schools and therefore critical facilities. In severe cases, such as Barrington, all of the town's shelters are located within the 100-year floodplain. This is particularly alarming since Barrington is one of the most vulnerable communities to coastal, riverine and stormwater flooding. These properties should be targeted for flood-proofing and/or a retrofit project. Funds for this type of project are available from the FEMA Flood Mitigation Assistance program or the Pre-Disaster Mitigation Program.

VULNERABLE POPULATION
SEVERE HURRICANE SCENARIO
Table 4-27

Community	Permanent Population	Seasonal Population	Total Mobile Home Population	Permanent Population Living in Evacuation Zones	Seasonal Population Living in Evacuation Zones	Total Vulnerable Population
Barrington	15,850	180	0	13,720	170	13,890
Bristol	21,630	400	20	5,230	80	5,330
Charlestown	6,480	4,010	330	1,330	850	2,510
Cranston	76,060	200	50	2,280	0	2,330
East Greenwich	11,870	60	110	1,120	10	1,240
East Providence	50,380	110	170	7,240	20	7,430
Jamestown	5,000	5,001	10	1,950	1,950	3,910
Little Compton	3,340	920	190	760	210	1,160
Middletown	19,460	240	450	1,550	20	2,020
Narragansett	14,990	4,850	10	6,910	2,110	9,030
New Shoreham	840	1,880	0	260	580	840
Newport	28,230	1,640	0	9,680	910	10,590
North Kingstown	23,790	630	540	6,950	330	7,820
Pawtucket	72,640	70	880	670	0	1,550
Portsmouth	16,860	1,380	1,080	5,110	340	6,530
Providence	160,730	330	0	1010	0	1,010
South Kingstown	24,630	10,0002	460	2,920	3,930	7,310
Tiverton	14,310	450	720	2,280	80	3,080
Warren	11,390	270	10	7,330	180	7,520
Warwick	85,430	900	210	28,150	400	28,760
Westerly	21,610	4,003	210	4,090	2,820	7,120

Structures Vulnerable to Flooding and Storm Surge

In an attempt to more accurately pinpoint the number of structures and persons "at risk" the Office of State Planning began the process of transferring flood hazard boundary lines from FEMA maps to the most recent aerial photos of the state taken in 1981. This has been completed to date for sixteen communities, one-third of all communities in the state. Estimates of population in these flood hazard areas were made using 1990 U.S. Census date. Results are shown in Table 4-28 and indicate that in the 16 communities surveyed more than 2,422 V-zone structures and 11,514 A-zone structures are at risk for a 100-year flood event. Comparing 1981 and 1970 aerial photos for the 16 communities revealed that 1,512 structures, predominately homes, are located in flood hazard areas that were not there a decade earlier. This project needs to be completed for the rest of Rhode Island’s communities and the 2000 population census data should be used.

STRUCTURAL COUNT IN SPECIAL FLOOD HAZARD AREAS BY LOCAL JURISDICTION
Table 4-28

COMMUNITY	V-ZONE STRUCTURES	A-ZONE STRUCTURES	TOTAL
Warwick	473	2,121	2,594
Westerly	368	974	1,342
Portsmouth	358	720	1,078
Charlestown	290	548	838
S. Kingstown	179	1,136	1,315
Newport	105	888	993
Bristol	100	383	483
Barrington	67	717	784
Warren	63	471	534
Tiverton	48	143	191
Jamestown	49	59	108
N. Kingstown	44	806	850
Cranston	16	624	640
Providence	15	466	481
New Shoreham	13	7	20
Little Compton	9	178	187
TOTAL	**2,422**	**11,544**	**13,966**

Source: R.I. Statewide Planning Program Environmental Inventory

Assessing Vulnerability and Potential Loss Estimates of State Facilities to Flooding, Coastal Erosion and Hurricanes

In terms of the number and location of state structures vulnerable to flooding, the map "State-Owned/Operated Buildings and Flood Zones" shows the locations of all of these state owned buildings in FEMA A and V flood zones. In terms of potential losses to occur in the event of a serious flood. Table 4-29 below lists a building count, building value and building contents value for each FEMA flood zone: A, V and 500 year zone.

Coastal (V zones) and Riverine (A zones) Flooding

In terms of the number and location of state structures vulnerable to flooding, the map on the previous page, Location of State Facilities Vulnerable To Hurricane/Tropical Storm Impacts: Storm Surge, Inland Flooding, Coastal Erosion" shows the locations of all of these state-owned buildings in locations prone to the impacts of hurricanes and tropical storms. Potential loss estimates are given in Table 4-34 in the form of building counts in A & V & 500 year zones which covers areas of coastal and riverine flooding. Values are assigned in terms of building and content.

Urban/Stormwater Flooding and Dam Breeches

The existing database of state owned/operated facilities does not provide any information as to whether the facility is susceptible to urban flooding and/or storm water runoff. As explained earlier, there are no dam inundation maps, nor have any studies ever been done in Rhode Island. Therefore, there is no vulnerability or potential loss estimate information on state owned/operated facilities to dam breeches. This will be completed under Mitigation Action Item 3.3.3.

Vulnerability Assessment and Potential Loss Estimate of State-Owned or Operated Buildings in Flood Zones
Table 4-34

Flood Zone	Building Count	Building Value	Content Value	Total Value
A zone	112	$42,723,696.00	$3,260,648.00	$45,984,344.00
V-zone	42	$3,856,439.00	$101,180.00	$3,957,619.00
500 Year Zone	30	$21,589,234.00	$2,229,588.00	$23,818,822.00
Total	**184**	**$68,169,366.00**	**$5,591,416.00**	**$73,760,782.00**

NOTE: this table assumes 100% flood loss

Table 4-34 includes all available data on state owned/operated facilities. There is no data on infrastructure available at this time for any hazard. Specific mention has already been made throughout this Plan about the importance of collecting this data to complete a statewide database, see Mitigation Action Items 3.1.1; 3.1.4; 3.1.5; 3.1.6 and 3.3.3; and 3.3.4.

Table 4-30 represents the number of critical facilities (and are broken down by specific use) that occur in both A and V FEMA flood zones. Because A and V zone boundaries are Approximate, a 500 foot buffer was added to see if results were significantly affected. Increased numbers in the buffered zones indicate potential facility losses not readily apparent and need to be considered for severity. Unfortunately, there is no means at this time to cross reference data in order to assign specific building values to each structure.

Number and Location of Critical Facilities in Special Flood Hazard Areas
Table 4-30

Critical Facilities	Total Count	AZone	Azone +500	VZone	VZone + 500
State Facilities	1,668	112	449	42	107
Fire Stations	173	5	58	1	4
Medical Facilities	42	1	8	0	2
Police Stations	45	3	15	0	1
Shelters	127	6	21	0	1
Schools	676	10	153	1	13
TOTAL	**2,731**	**137**	**704**	**44**	**128**

4.5.2 Wind Vulnerability Assessment and Potential Loss Estimates

Estimating Potential Losses by Jurisdiction

There is no information on potential losses (for all hazards) based on estimates provided in local risk assessments because no local plans were approved by the deadline (June 2004) in order to be included in the State Plan. As stated in Mitigation Action Item 2.1.1 local risk assessments, vulnerability and potential loss estimate data will be collected and assimilated into a statewide database for incorporation into the next update of the State Hazard Mitigation Plan.

Scoring State Hurricane Vulnerability

Extreme wind hazards were analyzed using an approach that is consistent with ASCE 7-98, "Design Loads for Buildings and Other Structures." ASCE 7-98 serves as the basis for the Rhode Island Building Code and employs a generally accepted procedure for determining wind force levels for design of buildings.

Intensity, Frequency and Areas of Impact
The frequency of winds used for design is typically 100 years, and therefore this frequency level was selected for wind analysis in this study. Because of the large geographic nature of hurricanes and nor'easters, the area impact score used was 5 in all cases Table 4-27). Extreme wind intensity scores were based on a combination of geographic wind speed distribution and wind pressure figures, both of which are taken from ASCE 7-98.

The scoring process consisted of two steps:

- The first step was to *determine the average wind speed* that a tract was likely to experience in a 100 year hurricane event. This varies across the state and was divided into three categories. These categories were 90-100 miles per hour wind speeds, 100-110 miles per hour wind speeds, and 110 - 120 miles per hour wind speed. The wind speed for each tract was taken from ASCE 7-98 "Basic Wind Speed - Mid and Northern Atlantic Hurricane Coastline", and corresponds to the 3-sec gust wind speed at 33 ft above ground for Exposure C category (see description of categories below).

- The second step was to determine the average degree of vulnerability that a tract experienced. The vulnerability score is determined by the ground cover, topography, and constructed features of a tract and is either A, B, C, or D.

The wind vulnerability categories were taken from the ASCE 7-98 building code, and are standard categories used in the design of buildings nationwide:

1. Exposure A is applied to large city centers with buildings averaging over 70 feet in height. All tracts with a population of over 10,000 people were classified as Exposure A.

2. Exposure B is for urban and suburban areas. Tracts with populations between 2,500 and 10,000 people were classified as Exposure B

3. Exposure C is for open terrain, with populations of less than 2,500.

4. Exposure D is for flat, unobstructed areas exposed to wind flowing over water. All tracts within one mile of the ocean were classified as Exposure D.

Basic Wind Pressure, Simplified Method (based on ASCE 7-98), psf
Table 4-31

	Windspeed (3 sec gust)			
Vulnerability	90	100	110	120
A	12.6	15.3	18.0	21.6
B	14.0	17.0	20	24.0
C	19.6	23.8	28.0	33.6
D	23.24	28.22	33.2	39.84

Intensity Score Lookup Table based on Wind Pressure
Table 4-32

Pressure (psf)	**Intensity Score**
<12	0
12	1
15	2
20	3
25	4
>30	5

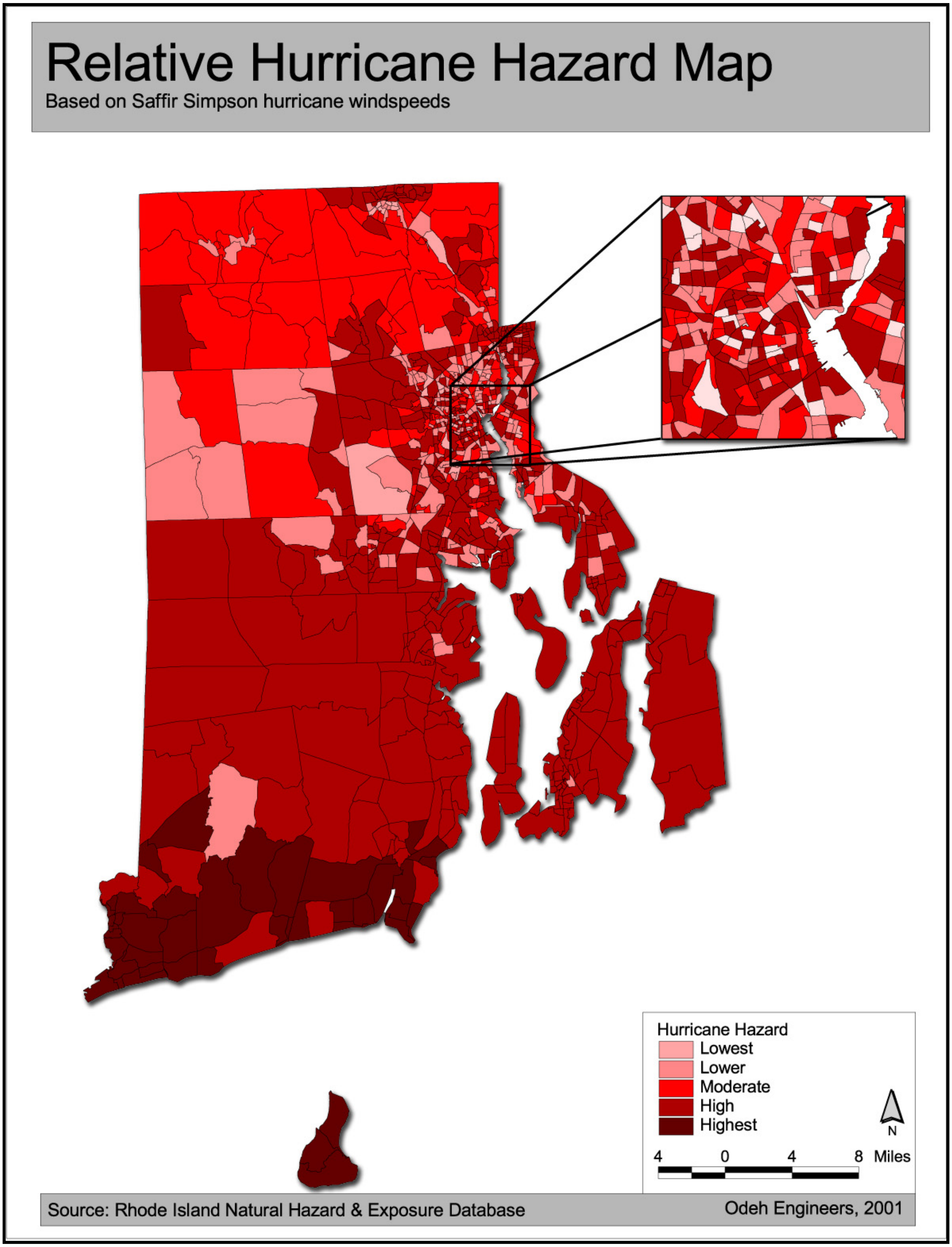
Once the vulnerability category and wind speeds were determined, these values were used in a matrix (Table 4-32) to determine the average force of wind pressure that would affect a typical building, in pounds per square inch. For example, if a tract has an exposure of category B and is in a 110 mile per hour wind speed zone, the average pressure in pounds per square inch is 20. This measurement corresponds to the ASCE 7-

98 method for determining hurricane forces on structures.

Finally, the value of wind pressure determined was entered Table 4-32, which resulted in a score of 1 to 5 for extreme wind intensity score. Higher wind pressure levels are assigned higher intensity scores. Thus, the extreme wind hazard score for a census tract is proportional to the average wind pressure experienced by buildings within that census tract for a building code level wind event.

The results of scoring the statewide vulnerability to high winds are depicted on the state Hurricane Hazard map on the following page.

(SEE STATE HURRICANE HAZARD MAP)



Relative Hurricane Hazard Map
Based on Saffir Simpson hurricane windspeeds
Hurricane Hazard
Lowest
Lower
Moderate
High
Highest
N
4 0 4 8 Miles
Source: Rhode Island Natural Hazard & Exposure Database
Odeh Engineers, 2001

Assessing State Vulnerability to Wind

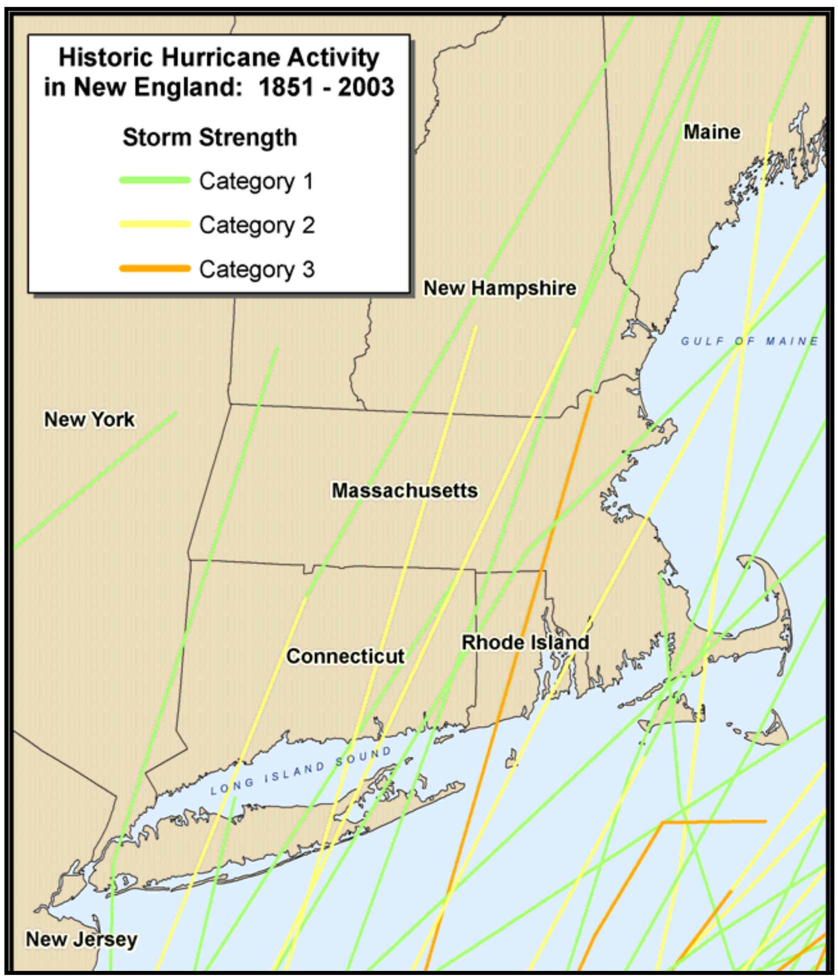
Tropical Storms and Hurricanes

There are primarily three components of statewide vulnerability from the impact of a hurricane: storm surge (coastal flooding); ability to evacuate in a timely manner; and shelter capacity. Storm surge has the potential to create a very serious problem in many Rhode Island coastal communities because in most cases the waters will rise to extremely high levels and cover roads and bridges completely with water. These roads are hurricane evacuation routes and the only way out of danger.

The "Historic Hurricane Activity in New England" map gives an overview of the many storms with high winds that have impacted Rhode Island over the last 150 years. Additionally, the SLOSH maps in the previous section on flood vulnerability give additional information on the susceptibility of coastal areas impacted by hurricanes and tropical storms and coastal storms based on the number of past recorded events due to the combination of high winds and tidal surge, as illustrated on the SLOSH maps. Inland areas, especially those in floodplains, are also at risk for riverine flooding from the impacts of hurricanes and Tropical Storms.

Areas at risk

The entire state is vulnerable to hurricanes and tropical storms, depending on the storm's track. The coastal areas are more susceptible due to the combination of both high winds and tidal surge, as depicted on the SLOSH maps. Inland areas especially those on floodplains, are also at risk for flooding and wind damage. The majority of damage following hurricanes and tropical storms often results from residual wind damage and inland flooding, as was recently demonstrated in Hurricane Charley 2004.



The results of the statewide vulnerability assessment are mapped on the previous page.

Vulnerability by Jurisdictions

Unfortunately this information is not complete because as of November 1st, 2004 only one community had a federal approved local hazard mitigation plan and therefore, the information needed to synthesize into the State Hazard Mitigation Plan is not available. Once the local plans have received approval all information relating to local areas of vulnerability, this data will be collected, synthesized and the geographical locations and extent of impact will be inventoried, described and remapped.

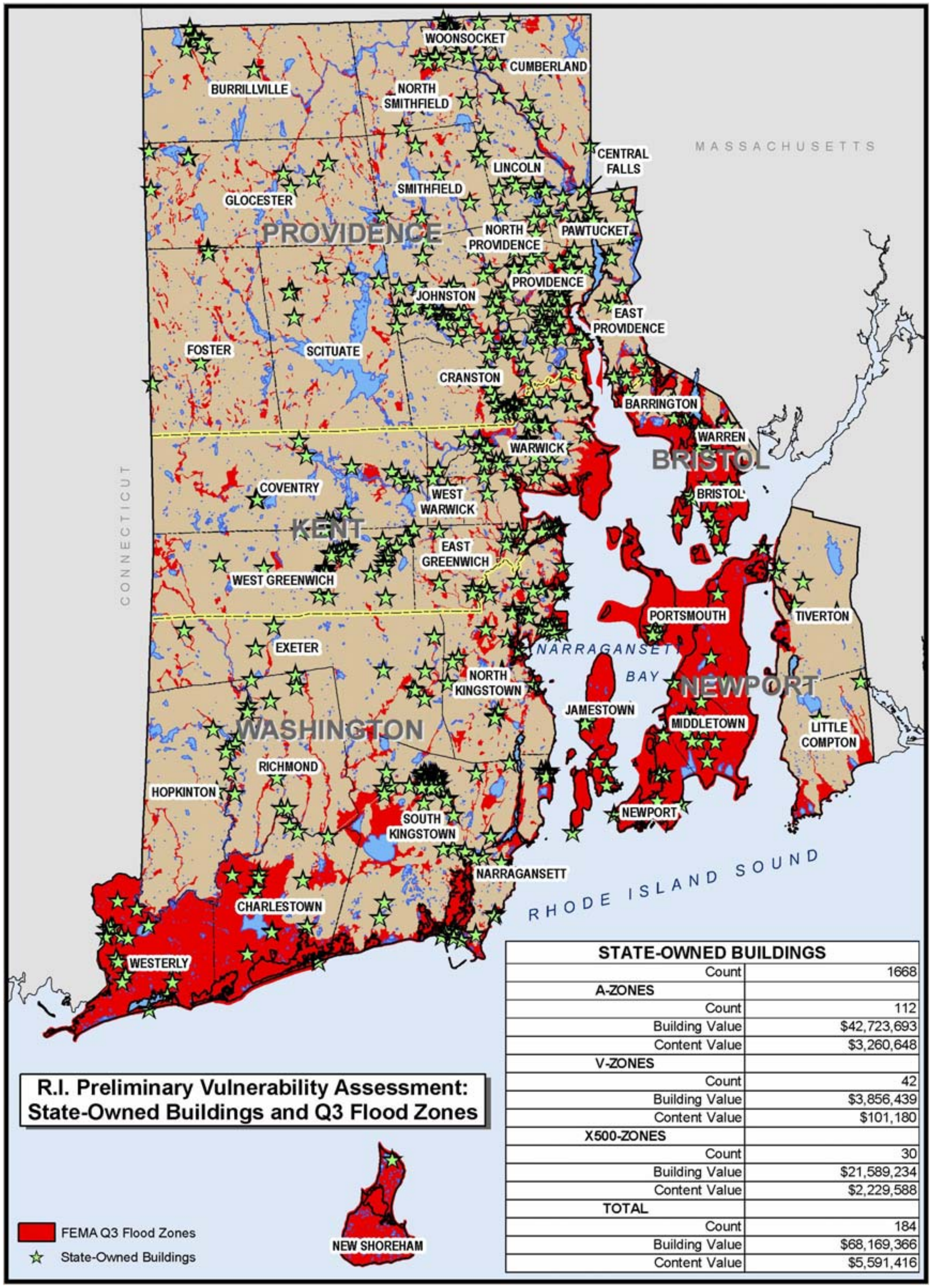
State Structure Vulnerability Assessment and Potential Loss Estimates from Flooding and Storm Surge

The table below represents the number and type of critical facilities that occur in both A and V FEMA flood zones. No other data is available depicting the number and location of state facilities located in wind zones. Impacts from a tropical storm and/or hurricanes will be felt at the coast (in FEMA velocity zones) and inland floodplain areas as rivers, ponds and lakes flood as has happened so frequently in past hurricanes and tropical storms that have impacted Rhode Island. Because A and V zone boundaries are Approximate, a 500 foot buffer was added to see if results were significantly affected. Increased numbers in the buffered zones indicate potential facility losses not readily apparent and need to be considered for severity. Unfortunately, there is no means at this time to cross reference data in order to assign specific building values to each structure, nor is there any way to locate structures in specific wind zones.

Number and Location of Critical Facilities in Hurricanes/Tropcial Storm Vulnerable Areas
Table 4-33

Critical Facilities	Total Count	AZone	Azone +500	VZone	VZone + 500
State Facilities	1,668	112	449	42	107
Fire Stations	173	5	58	1	4
Medical Facilities	42	1	8	0	2
Police Stations	45	3	15	0	1
Shelters	127	6	21	0	1
Schools	676	10	153	1	13
TOTAL	**2,731**	**137**	**704**	**44**	**128**

LOCATION of STATE FACILITIES VULNERABLE TO HURRICANE/TROPICAL STORM IMPACTS



STATE-OWNED BUILDINGS	
Count	1668
A-ZONES	
Count	112
Building Value	$42,723,693
Content Value	$3,260,648
V-ZONES	
Count	42
Building Value	$3,856,439
Content Value	$101,180
X500-ZONES	
Count	30
Building Value	$21,589,234
Content Value	$2,229,588
TOTAL	
Count	184
Building Value	$68,169,366
Content Value	$5,591,416

4.5.3 Assessing Vulnerability and Potential Loss Estimates of State Facilities to Winter-Related Hazards

Estimating Potential Losses by Jurisdiction

There is no information on potential losses (for all hazards) based on estimates provided in local risk assessments because no local plans were approved by the deadline (June 2004) in order to be included in the State Plan. As stated in Mitigation Action Item 2.1.1 local risk assessments, vulnerability and potential loss estimate data will be collected and assimilated into a statewide database for incorporation into the next update of the State Hazard Mitigation Plan.

There is no database of state facilities that indicate vulnerability or potential loss estimates to winter-related hazards. The existing data simply describes building material (e.g. brick, mason, wood frame) but not construction or design. To more effectively assess the vulnerability of state structures to winter-related hazards it would be helpful to know what type of roof (e.g. whether or not it is a flat roof and therefore more susceptible to heavy snow loads). An assessment such as this should be done and is addressed in Mitigation Action Item 3.1.4.

To address the vulnerability of infrastructure to the impacts of ice storms, it would be important to complete an inventory of utility lines as they are very susceptible to breakage when ice forms on the lines, and this of course results in power failure. It would also be important to describe this potential impact in terms of the direct impact (such as a power failure) on Rhode Island's economy. This will be addressed with the Public Utility Commission in a future mitigation action 4.3.4.

4.5.4 Assessing Vulnerability of State Facilities to Geologic-Related Hazards

Estimating Potential Losses by Jurisdiction

There is no information on potential losses (for all hazards) based on estimates provided in local risk assessments because no local plans were approved by the deadline (June 2004) in order to be included in the State Plan. As stated in Mitigation Action Item 2.1.1 local risk assessments, vulnerability and potential loss estimate data will be collected and assimilated into a statewide database for incorporation into the next update of the State Hazard Mitigation Plan.

In assessing vulnerability, a combination of factors must be reviewed: seismicity or the recurrence interval of earthquakes in a particular region (i.e. regional earthquake history); the hazard: regional geologic structure (i.e. soils, rock, etc.); and the risk: built environment in a particular region (i.e. building counts and structure, infrastructure, and lifelines).

Physical Characteristics Relative to Earthquake Vulnerability

In addition to the factors above, there are also physical characteristics that increase earthquake vulnerability and they are:

1. Hard Rock: Due to the geological makeup of New England's base rock, seismic energy is conducted on a greater scale (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 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.

Scoring Statewide Earthquake Vulnerability

Earthquake scoring was computed with the aid of HAZUS-99, FEMA's software for hazard and loss estimation from earthquakes. To determine the earthquake score, the following process was followed:

1. A single earthquake frequency level was selected as a basis for analysis. For the purposes of this study, all scores were based on a 500 year recurrence event. Note that other return periods could also be used to determine earthquake hazard scores, but the 500 year event was selected as most representative of a "design basis" earthquake frequency for the state of Rhode Island based on the judgment of the project team.

2. HAZUS was then used to calculate the average spectral accelerations for each census tract, using a 500 year probabilistic event for the state of Rhode Island. The HAZUS output included maps of spectral acceleration and numerical tables corresponding to the maps. The spectral acceleration values output by HAZUS account for the major factors that influence ground motions in an earthquake, including soil types and distance from earthquake sources.

3. Area Impact scores were taken to be 5 for all Rhode Island census tracts due to the complete coverage which would occur during a statewide earthquake event.

4. Intensity scores were applied using spectral acceleration, in units of gravitational acceleration, for a (0.2) second period building (a typical low rise building in Rhode Island has a natural period of 0.1-0.3 sec). These values were created using judgment, such that they would be consistent with hazard levels used in building codes for earthquake design.

5. Finally, frequency, area impact, and intensity scores were multiplied together to determine the earthquake hazard score for each census tract.

Earthquake Intensity Score
Table 4-35

Spectral Acceleration (.2 sec)	Intensity Score	Subjective Description
0	0	No effects
0.05	1	Felt indoors, light vibration
0.1	2	Indoors, strong vibration
0.2	3	Outdoors, house shakes
0.3	4	Walls crack, ground waves
0.4	5	Violent, building structures damaged

State Earthquake Vulnerability

Contrary to popular opinion, earthquakes do not kill people! However, damaged structures and buildings do kill people. Although large earthquakes do not occur frequently in New England, this is not important in addressing the need for a program of

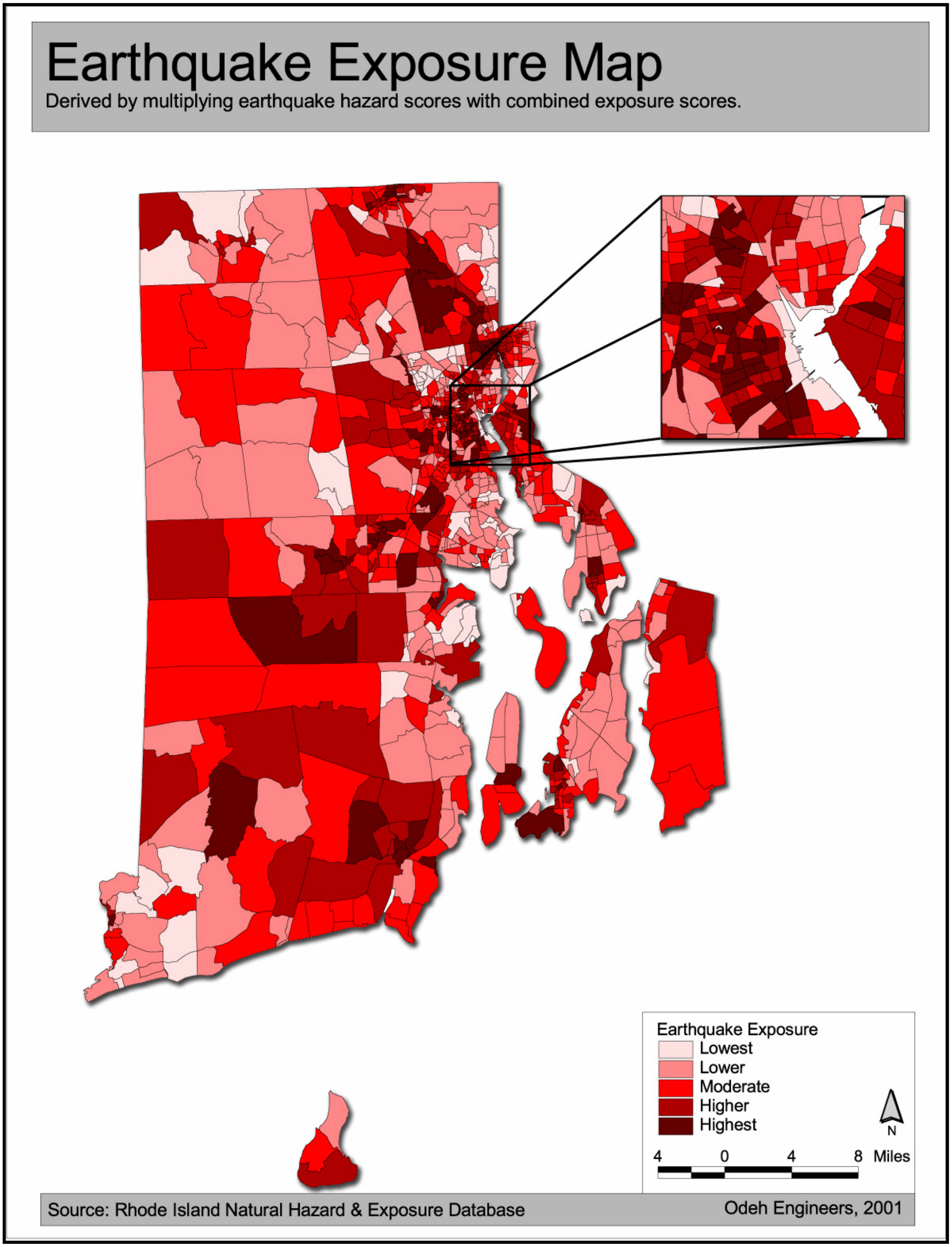
earthquake hazard reduction.
Rhode Island is located in the North Atlantic tectonic plate and is in a region of historically low seismicity. Only three or four earthquakes of MMI V or greater have been centered in Rhode Island including the 1951 South Kingstown earthquake of magnitude 4.6 on the Richter scale and a number of earthquakes centered in Narragansett Bay. Because of this low seismic level there is a general perception that the state has very little risk of sustaining any earthquake induced damage. However, areas geographically close to Rhode Island have had moderate seismic activity historically. For example the area off Cape Ann, Massachusetts has had several MMI VIII or greater events within the past 300 years. An earthquake of that location and intensity has the possibility to cause damage to structures in Rhode Island not designed to withstand seismic loadings. Currently, the Rhode Island Building Code follows the 1990 version of the BOCA code which has very elementary earthquake provisions for this area. Thus, an even moderate earthquake could cause severe damage to aged structures, unreinforced masonry buildings, etc. This was recently observed in Newcastle Australia where a moderate earthquake of magnitude 5.5 on the Richter scale in 1989 caused considerable damage in an area not very well prepared for earthquakes (Melchers,1992).

Building and Soil Types Increase Vulnerability

New England is particularly vulnerable to injury because of the building systems located in the area. Three New England states have seismic provisions in their building codes (Rhode Island, Massachusetts and Connecticut). However, these codes are only for new structures and do not take into account past structures like the" classic mill building". So, although New England is considered to have a moderate seismic risk, in general it has a high seismic vulnerability because of the built environment. The major concern of the various building systems is the unreinforced masonry buildings throughout New England. This type of structure is fine for resisting" static" vertical loads; however, when "dynamic" horizontal forces are applied (i.e. earthquake) the building collapses almost immediately.

Areas at Risk

Another important step in assessing state vulnerability to the impacts of earthquakes is the evaluation of the local site conditions. An examination of the regional geology of Rhode Island yielded the potential for amplification of ground motions in significant areas in the state. Most of the region is generally characterized by till plains. Till is generally composed of unsorted rocks of varying sizes and is considered to be a stable geological formation not susceptible to amplification. However, the area around Narragansett Bay is characterized by outwash deposits. These deposits are typically sorted sand and gravel under dynamic loading, they tend to amplify the intensity of the bedrock motion so that the surface intensity is greater than that of the bedrock. This phenomenon has been known to cause extensive damage to


Earthquake Exposure Map
Derived by multiplying earthquake hazard scores with combined exposure scores.
Earthquake Exposure
Lowest
Lower
Moderate
Higher
Highest
N
4 0 4 8 Miles
Source: Rhode Island Natural Hazard & Exposure Database
Odeh Engineers, 2001

structures as exhibited in the Mexico City earthquake of 1987. Studies indicate change of intensity by one step or even two steps for extreme cases of made land (Barosh, 1989).

It should be noted that the City of Providence located at the head of Narragansett Bay, is within the outwash region and is therefore in the zone of potential amplification. In this region of outwash deposits, the bedrock intensity will be increased by one intensity level to account for the possibility of amplification. The region identified as Charlestown and Block Island Moraine will be increased by a 0.5 intensity level.

In addition to the physical characteristics of the soil and built environment, one of the most critical factors of vulnerability is the low public awareness. In Rhode Island, there is 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 than in other regions of the country.

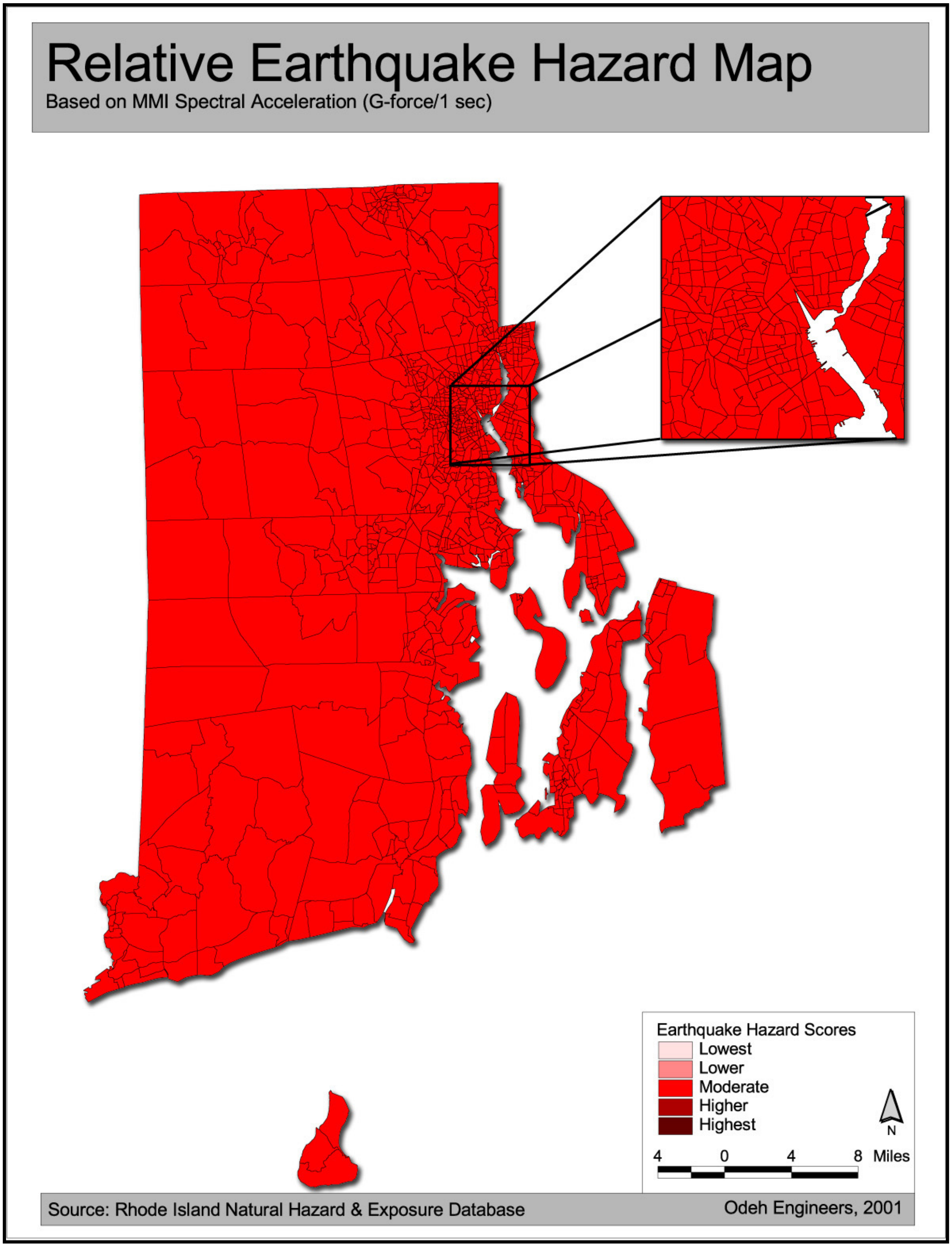
State Owned/Operated Critical Facilities: Building Type & Local Jurisdiction

Rhode Island is a state of historically low seismic activity. However, due to the proximity of several moderate active seismic areas, Rhode Island has the possibility of experiencing potentially damaging effects from an earthquake in Massachusetts, Connecticut or Narragansett Bay. Based on a deterministic procedure using scenario earthquakes it has been found that the potential exists for Modified Mercalli Intensity VII effects to be seen in Providence. Since Rhode Island's building codes did not contain seismic provisions until recently, as well as due to the large number of historic unreinforced masonry.

Loss Estimate of State Owned/Operated Facilities to Earthquakes
Table 4-36

Community	Construction Type	Count	Replaceme nt Costs	Comments
Barrington	block	2	n/a	community mental health center
Bristol	block, stone, brick	12	n/a	
Burriville	brick	19	n/a	
Charlestown	block	7	n/a	maintenance garage & storage facilities
Cranston	stone, brick	105	n/a	most of the buildings are state prison
Cumberland	block	1	n/a	offices
East Greenwich	concrete	2	n/a	armory & storage
East Providence	brick, block	8	n/a	Highschool & dewatering facility
Exeter	brick, block	30	n/a	mostly vacant buildings (Ladd Center)
Foster	block	2	n/a	RI State Police
Glocester	block, brick	2	n/a	RI State Police
Hopkinton	block	1	n/a	maintenance garage
Jamestown	concrete, block	15	n/a	Fort Wetherill & Beavertail
Johnston	brick	5	n/a	many vacant
Lincoln	block, concrete	17	n/a	3 are pump staations

Little Compton	block	1	n/a	RI State Police, CCRI, Davies Vocational
Middletown	block	1	n/a	maintenance
Narrgansett	brick, concrete	26	n/a	maintenance
Newport	brick, block, stone, concrete	20	n/a	Nuclear Reactor, beach bathrooms, URI labs
North Kingstown	brick, block, stone, concrete	10	n/a	Highschool
North Providence	block, brick, concrete	11	n/a	water plant
Pawtucket	brick, block	4	n/a	RI College
Portsmouth	brick, block	4	n/a	Maintenance garage & storage
Providence	stone, brick, block	92	n/a	Water plant, sewage treatment plant, college dorms, historic Buildings, City offices, garages
Richmond	Concrete, block, brick	5	n/a	Critical facilities: power plant, police station, water Tx plant, high school
Scituate	Brick, stone, block	11	n/a	State police, maintenance garage
Smithfield	Brick, block	3	n/a	Maintenance garage & storage
S. Kingstown	Brick, stone, block	65	n/a	URI classrooms & dorms, pump stations, train depot
Tiverton	Block	1	n/a	Maintenance garage
Warren	Brick, block	3	n/a	Maintenance garage
Warwick	Brick, stone, block	24	n/a	Plane hangars, pump stations, garage
Westerly	Brick, stone, block	11	n/a	Train depot, shelter, aircraft hangar
West Greenwich	Brick, stone, block	11	n/a	Pump stations, town admin offices
Woonsocket	Brick, stone, block	11	n/a	High School, admin offices, storage, courthouse
TOTAL		**542**		


Relative Earthquake Hazard Map
Based on MMI Spectral Acceleration (G-force/1 sec)
Earthquake Hazard Scores
Lowest
Lower
Moderate
Higher
Highest
N
4
0
4
8
Miles
Source: Rhode Island Natural Hazard & Exposure Database
Odeh Engineers, 2001

5. State Hazard Mitigation Action Strategy

5.1 Implementing Hazard Mitigation in Rhode Island

The Rhode Island Hazard Mitigation Program continues to aggressively implement a widely-recognized, comprehensive program that goes beyond that of solely reducing hazard vulnerability, but also incorporates complementary goals that can address multiple state and local needs and lead to safer, more sustainable communities.

Rather than focus on short-term solutions to inevitably long-term problems, the State Mitigation Program's work emphasizes the need to ensure communities to become better able to withstand the forces of nature while at the same time improving their residents' overall quality of life. By avoiding unnecessary exposure to known hazard risks, communities will save lives and reduce property damages and minimize the social, economic and environmental disruptions that commonly follow hazard events. Within our work and within this Plan, the Rhode Island Mitigation Program addresses the needs of current residents and also considers the needs of future generations that will one day live in Rhode Island. It is hoped that this focus on an integrated, future-oriented approach will result in communities that are less vulnerable and more sustainable. We have therefore carefully and deliberately embodied the principles and spirit of community sustainability into many sections of this Plan.

Achieving Sustainable Communities

Shortsighted development patterns, along with a misunderstanding of how the natural environment plays a significant role in protecting us from natural hazards, have contributed to the vulnerability of many Rhode Island communities to inland flooding, hurricane winds and storm surge. Implementing the precepts and practices of hazard mitigation can help ensure that such communities do not increase their vulnerability by continuing inappropriate land uses, and by encouraging the acquisition, relocation or retrofitting of existing vulnerable structures along with the protection of valuable natural resources.

Through experience, we have learned that communities will face significant challenges during post-disaster redevelopment on how to balance the driving need for rapid recovery with implementing long-term hazard mitigation. The necessity to meet basic needs and resettle displaced populations immediately following a disaster often overshadows the more abstract, longer-term sustainability considerations. Once full-scale reconstruction is initiated, it is difficult to modify projects in progress to meet sustainability objectives. This phenomenon highlights the need for pre-disaster mitigation planning that incorporates principles of sustainable development within the context of reconstruction, so that communities can more easily rebuild in a manner will make them less vulnerable to future hazard events and improve their residents' quality of life. If a disaster should strike any one of these communities, the Rhode Island Mitigation Program will guide communities to rebuild stronger than before, incorporating the tenets of hazard mitigation.

Much of the work in hazard mitigation and sustainable development must be carried out at the local level. It is at the local level where land use decisions are made, growth and development take place, and the impacts of natural hazards are most direct. The Rhode Island Emergency Management Agency has always supported local sufficiency and reliance, providing assistance to communities where it is needed, but allowing local initiative to take the lead. As noted within this Plan, a major goal of the Mitigation Program is to support local capacity and commitment to hazard mitigation practices.

Establishing a true statewide mitigation ethic will take hard work, dedicated long term commitment and quite possibly will require major paradigm shifts among many different state, federal and local entities. State agencies, local government, non-profit organizations, business and industry, and private citizens will have to become more involved and active. This Plan is meant to be the first step toward that end.

Legal Framework for Implementing Hazard Mitigation

A number of different Rhode Island state agencies and offices have incorporated hazard mitigation objectives into their organizational missions. Descriptions of each agency's hazard mitigation-related functions, including their enabling legislation, and current hazard mitigation measures can be found on the chart in Section 5.2, State Capability Assessment.

Several important pieces of legislation, including Executive Orders, in support of federal and state agencies' incorporation of hazard mitigation methods and initiatives, should be noted. For example, Federal Executive Orders 11988 and 11990, Floodplain Management and Protection of Wetlands, require that federal agencies avoid direct or indirect support of development in the floodplain and work to minimize harm to floodplains and wetlands. State agencies receiving federal grants for projects must abide by these Executive Orders.

In regard to drought issues, in 1998 the 105th Congress enacted United States Public Law 105-199, The National Drought Policy Act. This act established an advisory commission charged with recommending preparedness over crisis management, systematic versus ad hoc responses, and mitigation strategies for drought management. In Rhode Island, the Water Resources Board has the primary responsibility for the coordination of the drought management process and plan implementation as advised by the Drought Management Steering Committee. In 2002, Rhode Island completed a state drought management plan in which the primary purpose is to coordinate state, federal and local agencies with responsibilities for water resource management during a drought. The Plan establishes data gathering, communication, and response actions, in addition to a framework for coordinating the statewide response to drought with the authorities and actions of regional and local water supply systems and municipal governments.

Lead State Agencies

Rhode Island Emergency Management Agency (RIEMA)

National Flood Insurance Program (NFIP)
On the State level, in 1999, the Department of Administration (DOA) signed a Memorandum of Agreement (MOA) with RIEMA to reassign the National Flood Insurance Program (NFIP) to RIEMA from DOA as the state agency to implement floodplain management regulations.

All of Rhode Island's 39 municipalities are part of the NFIP and floodplain regulations conforming to NFIP requirements as part of their zoning ordinances. These regulations can involve regulation of development within a designated "floodway" area, restrictions on activities which involve alteration of watercourses or sand dunes, and criteria for the location of mobile homes. In addition, some communities also impose special zoning regulations governing accessory structures, storage of buoyant or hazardous materials, and set-backs for new/substantially improved and/or damaged structures within flood hazard zones.

Governor

Rhode Island Executive Order 98-13
On December 18, 1998, Governor Lincoln Almond signed an Executive Order designating Rhode Island as the first Showcase State for Natural Disaster Resistance and Resilience in the country (see Appendix for copy of the language). The Governor's Showcase State Executive Order provides a comprehensive framework for public and private stakeholder collaboration on natural disaster protection. The Rhode Island Emergency Management Agency (RIEMA), the Institute for Business & Home Safety (IBHS), the Region I Office of the Federal Emergency Management Agency (FEMA), public and private partners have all been collaborating to prevent injuries and deaths, protect public and private property and create a disaster-ready statewide economy. The goal is to make natural hazards loss reduction an integral part of everyday planning and decision-making in Rhode Island at the state and local government levels.

The first of 14 Showcase elements charges the state, under the leadership of RIEMA, to "identify state agencies and private sector entities responsible for implementing actions in each of the areas" and to develop a strategic plan. As a result, a Showcase State Steering Committee, led by RIEMA and comprised of a variety of state agencies and private sector representatives, was formed and met three times in 1999 to develop a strategic plan. Steering committee members represent agencies or organizations that have a mission, authority and accountability that encompass one or more of the 14 elements of the Showcase State Executive Order. Each Showcase element adds a critical piece to the collective, comprehensive effort - an endeavor which will create its own momentum to raise public awareness, concern and activity to make Rhode Island a safer place in which to live, work and play.

Rhode Island State Building Commission

RI Building Code: Specifications for Hazards Effects
The effective date of the original implementation of the Rhode Island State Building Code was July 1, 1977, following adoption of the concept of uniform regulations to control construction, reconstruction, repair, removal, demolition, and inspection of all buildings in the state. (GL, 23-27.3) The Rhode Island building code incorporates provisions of BOCA (Building Officials and Code Administrators International, Inc.) the basic national Building Code with changes and additions as adopted by the State of Rhode Island Building Code Standards Committee. BOCA consists of model building regulations for the protection of public health, safety and welfare. The chief executive of each city and town is required to appoint a Building Official to administer the Building code; two or more communities may join in the appointment of a building official. The Code stipulates that the building official review all permits for construction in flood hazard areas to ascertain that all required federal, state, and local permits have been obtained.

The State Building Commissioner serves as executive secretary to the State Building Code Standards Committee. He also inspects and issues various building permits for all structures and service equipment on state property. The Commissioner administers and enforces the FEMA Flood Insurance Administration Regulations pertaining to building construction and provides technical assistance to local officials and homeowners in proper construction methods in flood hazard areas.

The State Building Code specifies basic roof snow loads for buildings, as well as design requirements for withstanding wind pressures. Two geographic zones, coastal and non-coastal are established, with basic design wind speed of 110 mph for coastal communities (Zone 2) and 100 mph for the remainder of the state (Zone 1). BOCA provisions for earthquake loads are contained in the State Building Code "for reference only." The State Building Code Standards Committee reserves the right to require the earthquake design provisions for any structure. Structures which shall require earthquake design are as follows: fire stations, hospitals, police stations, high hazardous structures, and elevated structures over 6 stories or 75 feet in height.

With regard to flood control, Section 1310.0 of the Building Code states:

> "All building projects including manufactured homes shall be reviewed to determine if the location is within the special flood hazard areas as defined by the Flood Insurance Rate Maps as prepared by the Federal Emergency Management Agency and adopted by the local community under the National Flood Insurance Program, boundary maps."

Per the Rhode Island Building Code, all new construction, major repairs, or substantial improvements to existing buildings shall conform to the Corps of Engineers minimum standards referenced in Appendix B and regulation SBC-8 Construction in Flood Hazard Areas, developed in accordance with the requirements of the Federal Emergency Management Agency, as well as pertinent rules and regulations promulgated and adopted by the Department of Environmental Management, Coastal Resources Management Council and the Division of Statewide Planning.

Specific construction requirements for flood hazard areas are contained in Regulation SBC-8 of the Code, referenced above. The requirements generally conform to the standards of federal regulations implementing the National Flood Insurance Act. One departure, enacted in 1981, is in the interpretation of the term" substantial improvement" which triggers - the need to conform to flood zone regulations when modifying or rebuilding structures subject to flooding. Federal regulations interpret "substantial improvements" as "any repair, reconstruction, or improvement of a structure" the cost of which equals or exceeds 50 percent of the market value of the structure either: (a) before the improvement or repair is started; or (b) if the structure has been damaged, and is being restored, before the damage occurred "The Rhode Island Building Code definition of substantial improvement is "any repair, reconstruction, or improvement of a structure, the cost of which equals or exceeds 50 percent of the physical value of the structure," with physical value defined as the current replacement value.

Further, in determining the value the Rhode Island rule states that, "the building official shall exclude the alteration and repair cost of the following items":

1. All non-permit items such as painting, decorating, landscaping, fees and the like; and

2. All electrical, mechanical, plumbing and equipment systems. The change was made to allow greater flexibility in code application to existing buildings and to encourage rehabilitation of structures versus demolition and reconstruction.

While this reasoning is sound for most areas with regard to flood hazard areas, this provision may create an increased incentive to reconstruct buildings that have been badly damaged in storms and are likely to be damaged in the future.

Coastal Resources Management Council (CRMC)

The Rhode Island Coastal Resources Management Council (CRMC) was created in 1971 to "properly manage coastal resources." It does this in large part through regulations which apply to users of the coastal environment. CRMC permits are required for most physical alterations in tidal water or coastal lands, and construction involving such lands within a strip extending 200 feet inland from the mean high water mark of the nearest coastal feature. Coastal features are areas characterized by the presence of beaches and barrier beaches, sand dunes, shorefront cliffs, ledges, and bluffs, coastal ponds or coastal wetlands. Permits may be required inland to a distance of 200 feet from the most inland extent of these features.

A "substantive objection" to an application for activities and alterations in coastal areas subject to CRMC jurisdiction triggers full Council review and a public hearing. One criterion for a substantive objection is where "evidence is presented which demonstrates that the proposed activity or alteration has a potential for significant adverse impacts on shoreline erosion and flood hazards." In the event of a severe coastal storm in which damage and destruction has occurred, CRMC can mandate a moratorium on all coastal redevelopment activities to ensure that all construction is in accordance with state building regulations. In the event that a structure, built prior to CRMC and/or building code regulations, has had damage greater than 50% ("substantial damage") all reconstruction must be in compliance with all applicable codes and regulations (e.g. state building code, NFIP minimum criteria, RI Coastal Resources Management Plan. etc.).

CRMC Barrier Beach Polices
Also among the Council's stated goals are: preventing activities that will create an erosion or flood hazard; and protecting dunes from activities that have a potential to increase wind or wave erosion. To that end, the state's barrier beaches have been mapped and assigned by the CRMC to one of three categories as listed in the State Coastal Resources Management Plan. Construction is prohibited on undeveloped barriers except where the primary purpose of the project is restoration or improvement of the coastal feature as a conservation area or storm buffer.

On barrier beaches classified as moderately developed, existing roads, bridges, public utility lines, public recreational structures, and shoreline protection facilities may be maintained. On barriers classified as developed, construction is permitted under CRMC regulation; "the Council's goal is to ensure that the risks of storm damage and erosion for the people inhabiting these features are minimized activities that may reduce the effectiveness of the barrier as a storm buffer are avoided, and that associated wetlands and ponds are protected. Construction of new buildings is prohibited on developed barriers on which only roads, utility lines, and other forms of public infrastructure were present as of 1975.

Where residential and non-water-dependent recreational, commercial, and industrial structures on dunes are destroyed 50 percent or more by storm-induced flooding, wave or wind damage, they may not be reconstructed regardless of the insurance coverage carried. The Council reports that 65 percent (or 17.5 miles) of Rhode Island's 27.3 miles of oceanfront barrier beaches as undeveloped.

CRMC Special Area Management Planning
The Council's *Special Area Management Plan for the Salt Pond Region* includes an area encompassing much of the ocean shorefront of the towns of Westerly, Charlestown, South Kingstown, and Narragansett, found that "this region is particularly vulnerable to coastal flooding and that a considerable amount of development already exists in high hazard flood zones. Most of the approximately 3,000 existing structures in the flood zones, valued at more than $135 million, are "grandfathered" and if substantially damaged would have to be rebuilt to current NFIP criteria after a hurricane or other significant disaster event per the National Flood Reinsurance Act of 1994. CRMC is seeking federal funding to prepare a plan to guide reconstruction after the next major hurricane in a way that will mitigate future hazards from storm damage.

Department of Environmental Management (DEM)

Dam Safety Program
The division's Dam Safety Section is the nucleus within the state for inspecting and evaluating the structural stability and maintenance of all dams and dikes, both privately and publicly owned. Dam owners are notified owners of any deficiencies and must seek corrective action as necessary. During 1980-81, 137 dams were surveyed and photographed, and relevant data documented by the division.

Division of Water Resources
The division's Wetlands Section administers the state's Freshwater Wetlands Act of 1971, which seeks to protect wetlands from unnecessary drainage, excavation, and filling. Anyone proposing a project with possible adverse effects on a wetland assumes the burden of proving that the activity will not violate the law. The act is based on the alleviation of flooding and the public interest in the value of these areas for groundwater, wildlife habitat, and recreation. Freshwater wetlands include, but are not limited to, swamps, bogs, marshes, rivers and streams, and their floodplains. Regulatory authority also covers land within 50 feet of the edge of any bog, marsh, swamp or pond, and land within 200 feet of the edge of any flowing body of water at least ten feet wide or within 100 feet of any flowing body of water less than ten feet wide. Filling, draining, running a ditch or drain into, or changing the flow of water into or from a wetland are among the activities requiring a permit. Substantial penalties for violations are provided under the wetlands act.

Division of Coastal Resources
With creation of the Coastal Resources Management Council in 1971, this division was charged with the responsibility of providing staff to support its broad jurisdiction in developing and implementing coastal management plans. The division processes, reviews, and makes recommendations to the Council on applications for residential, commercial, and industrial construction in the coastal zone.

Department of Transportation (DOT)

All roads in the state except rural minor collectors and local roads and streets are eligible for federal highway aid and must adhere to federal design regulations. These include standards for the location and hydraulic design of roads and bridges that encroach on floodplains. It is the stated policy of the Federal Highway Act (FHWA) to "prevent uneconomic, hazardous or incompatible use and development" of floodplains. Rhode Island DOT conducts hydraulic analyses for all new and rebuilt roadways over water bodies, including emergency construction when feasible. While there is no set rule, it is DOT policy to build bridges to the one-hundred-year flood standard wherever appropriate from an engineering standpoint.

DOT Bridge Program
Approximately 75 percent of the state's total mileage consists of streets not on the federal-aid system. These roads would not be subject to federal design standards. The

state DOT bridge program, however, also provides construction supervision for many of the off system bridges; among the design criteria is the ability to withstand flooding, consistent with the level of risk and the level of use of the roadway.

Rhode Island Water Resources Board (WRB)

The Water Resources Board (WRB) was created in 1967 and is a state agency charged by Chapter 46-15 of the Rhode Island General Laws with the development, use and conservation of water resources. The primary function of the Board is to assure that a sufficient water supply is available to the present and future populations of the State. The Board is also charged with the sole responsibility of apportioning available water when necessary and establishing water allocations for the State.

In 2002, the WRB approved the *Rhode Island Drought Management Plan.* The plan establishes coordinated procedures for the State of Rhode Island's response to severe drought episodes. It outlines the responsibilities of state; federal and local entities involved in water resources management, and define the roles these key entities play in the state's response to a long-term drought. Duties related to data-gathering, anticipation of drought conditions, and mitigation of the effects of drought is described. Policies and recommendations are established to anticipate drought conditions, respond early and coordinate resources to effectively manage the state's water resources during a drought.

Digitizing Rhode Island's Watersheds
The General Assembly also found that "many of the rivers of Rhode Island or sections thereof and related adjacent lands possess outstanding cultural aesthetic and recreational value of present and potential benefit" The General Assembly declared that the preservation and protection of these rivers, lakes, ponds, estuaries, and their immediate environment together with their significant recreational, natural and cultural value is a public policy and it is in the public interest to:

1) Preserve open space, natural resources and features, and scenic landscapes;
2) Preserve cultural and historic landscapes and features;
3) Preserve opportunities for recreational use of rivers; and
4) Encourage the establishment of greenways, which link open spaces together.

In 1995, digital maps of Rhode Island’s eighteen watersheds were prepared utilizing the Division of Planning's Geographic Information System. The maps illustrate the rivers' classifications developed by the Rivers Council. In the fall, citizens were given the opportunity to review and comment on the maps at a public workshop, as well as at a joint meeting held with the Rhode Island Greenways Council. In 2003, the 'Basins' map was revised to include all coastal watersheds previously omitted in the 1995 map and to delineate the smallest watershed areas (subwatersheds) by the Hydrologic Unit Code-12 (HUC-12) that are covered by the Rivers Policy and Classification Plan.

Rivers Policies and Classification Plan
The Rivers Policies and Classification Plan is a product of multiple years of effort, with extensive public involvement. Throughout its work, the Rivers Council relied on numerous parties to help format the Plan These groups included:

1. local citizens and subject experts concerned about conditions in the watershed;
2. state agencies, especially DEM and the Division of Planning;
3. federal agencies, especially the Natural Resources Conservation Service (NRCS) of the Department of Agriculture (USDA); and
4. environmental organizations, including *Riverwatch*, river monitoring programs, outdoor recreation associations, and local planners. The Rivers Council has worked to synthesize existing efforts and diverse interests and perspectives of these various groups and disciplines.

5.2 State Capability Assessment – Current Programs Supporting Hazard Mitigation

The following Rhode Island State Capability Assessment is a summary of the State's hazard mitigation capability through a variety of state laws, regulations, authorities and agencies. This matrix includes current state laws, Executive Orders, regulations, policies and programs as well as related federal programs that currently support hazard mitigation throughout the State. This assessment provides descriptions of each element and includes: the elements' effect on loss/and or risk reduction and opportunities for new actions to enhance potential hazard mitigation strategies that will reduce future risks and losses due to natural hazards.

All evaluative comments on the various programs, policies and agencies are listed in the column "Effect on Loss and/or Risk Reduction." In those cases where RIEMA did not have experience with a State program, policy, agency, etc., that shortfall will be immediately addressed in the Mitigation Strategy Actions items related to better communication/collaboration with other state agencies. Also, many of these shortfalls may also be addressed through the expansion of the State Hazard Mitigation Committee. The most current information on all Rhode Island State agencies, including those listed throughout this matrix may be found on the official Rhode Island website at www.ri.gov. Except when noted with an * all programs included in the table are considered pre-disaster programs.

Public Safety & Emergency Management
Table 5-1

Type of Existing Protection	Description	Effect on Loss and/or Risk Reduction	Opportunities
Department of Administration (DOA) State Guide Plan	At the State level, the RI State Guide Plan is developed by the DOA's Statewide Planning Program as a means for centralizing and integrating long range goals, policies and plans and implementing programs prepared by each of the functional areas of the Plan. Element 211 of the Economic Development Plan's policies addresses Hazard Mitigation; Element 121, Policy G-11 prohibits fill in floodways and Policy G-13 prohibits floodway encroachment; Policy R-15 protects the natural functions of floodplains and minimizes flood hazards to property and people.	The State Guide Plan provides guidance on how State agencies must incorporate hazard mitigation measures, goals, policies and programs into all State agencies' missions. The State Guide Plan and all policies relating to hazard mitigation have proven to be very effective in helping communities implement local hazard mitigation policies, programs and projects through their local community comprehensive plans as mandated by the State Guide Plan.	By coordinating State agencies to incorporate mitigation policies and directives into their agency mission and every day activities, stronger and more consistent partnerships can be established, and there will be more opportunities for leveraging a greater number of resources and creating new partnerships.
DOA Comprehensive Planning and Land Use Act, R.I.G.L. 45-22.2	This act requires local governments to adopt and maintain local comprehensive plans. The plans can be used to direct community land use decisions and capital improvement funding strategies. Under the Act, local plans must be reviewed for consistency with the State Guide Plan and the goals and policies of State agencies.	Future updates of local comprehensive plans will be expected to address hazard mitigation in order to be consistent with this State Guide Plan Element. The State Guide Plan and all policies relating to hazard mitigation have proven to be very effective in helping communities implement local hazard mitigation policies, programs and projects through their local community comprehensive plans as mandated by the State Guide Plan.	Provides another mechanism to integrate State Hazard Mitigation Plan with local plans, and also more opportunities to enforce mitigation actions through the comprehensive local plans.
State Building Commission, Building Code R.I.G.L. 23-27.3, 1976	RI. Building Code is implemented statewide and enforced through the building official in each city and town. The Code consists of uniform regulations to control construction, reconstruction, repair, removal, demolition, and inspection of all buildings. Section 1313.0 contains most of the NFIP construction requirements.	The NFIP standards, wind and snow loads are all an integral part of the State building code ensuring that all new construction and substantial improvements meet national flood resistant standards. Communities have enacted stricter standards under their local floodplain ordinances. Seismic design standards are advisory. The Building code has been extremely effective in addressing structural issues as they relate to potential damage and safety issues in regard to natural disasters. The Building Commission has also been very proactive	Allows for the consistent statewide application of NFIP minimum criteria, snow and wind loads. New construction is captured, and substantial improvement (majority of construction in RI) is also flagged for safer building criteria.

		in minimizing the granting of variances to the NFIP criteria.	
Department of Environmental Management (DEM) – RI Dam Safety Program R.I.G.L. 46-19 1896	All dams and reservoirs are to be inspected at intervals; plans for construction or alteration of dams and reservoirs must be approved by DEM.	Regular inspection schedules are critical to assessing safety of dams and especially in the densely developed and populated areas in close proximity to the spillway. This program is extremely important to the continued safety of the citizens of Rhode Island, however is woefully under funded and understaffed. Many more resources are critically needed for this program to be truly effective.	Through a regular assessment and inspection program, an accurate inventory of unsafe/safe dams can be created. This inventory will also provide a basis for prioritizing dam repair and maintenance.
DEM – Division of Forest Environment	The Forest Management Division manages 40,000 acres of state owned rural forestland It coordinates a statewide forest fire protection plan, provides forest fire protection on state owned lands and assists rural volunteer fire departments, and develops forest fire and wildlife management plans for private landowners.	The Division promotes public education and outreach on environmental conservation, enforces DEM rules and regulations on state lands and assesses risks of fires in wild land areas, state forests, parks and rural areas. Also responsible for suppression resources and coordinating with other local,. State and federal entities to obtain needed resources. RIEMA has not worked with this DEM Division before. Have only learned of them through the development of this Plan. As indicated in the Mitigation Strategy action items strengthening communication with other sate agencies is of vital importance.	Opportunity to coordinate with and leverage state and federal resources for fire prevention, including equipment and public education and outreach activities.
RI Water Resources Board (WRB) State Guide Plan Water Management Polices (R.I.G.L.46-15)	WRB is charged with broad duties to regulate the proper development, protection, conservation and use of the water resources of the State WRB also manages an Emergency Water Systems Interconnection Program to promote emergency connections between large public water systems throughout the state for use during the time of water shortages and supply emergencies.	State Guide Plan Element 723 *R.I. Water Emergency Response Plan* (1993) provides the State with a policy guide and framework for coordinated responses in times of drought. State Guide Plan Elements 721(1997) & 722 (1991) contain polices regarding supply management, demand management, and planning and administrative management issues for water use.	Provides forum for better collaboration among State agencies, Boards and Commissions on all water-related issues (flooding and drought). Better collaboration will result in stronger, more consistent policies and may also offer opportunities to leverage more resources.

		I am not familiar with the effectiveness of this program. The potential is very good for RIEMA and WRB to work together on drought particularly if emergency conditions arise.	
United States Department of Agriculture (USDA)-National Resource Conservation Service (NRCS) Emergency Watershed Protection Program	Provides technical and financial assistance to localities to reduce vulnerability of life and property in small watersheds damaged by severe natural events.	Allows immediate action to stabilize storm damages in streams following a federal declared natural disaster. The EWP program has been extremely effective in working with several communities that have had a very serious storm water/urban flooding problem in assisting them to develop a watershed management program and also to redevelop the Hydrology and Hydraulics for the entire watershed region which will enable these communities to have a new FIRM developed.	Pocassett Watershed (Johnston, Cranston and Providence) received $500,000 to address Pocassett River flooding in which homes and businesses were repetitively damaged each year by 6 to 12-year rain events. Watershed study including detailed hydraulics and hydrology study was completed and provides more precise contour data and possibly new FIRMs for the area.
U.S. Army Corps of Engineers (USACE) flood control projects and habitat restoration program	Built by the Army Corps of Engineers, these structures (dams, groins, breakwaters, hurricane barriers and seawalls) protect many municipalities in Rhode Island from riverine and tidal flooding. USACE assists the state and local governments in conducting annual inspections.	Since completion, these structures have prevented flood damages in major Rhode Island urban areas estimated at millions of dollars. Habitat restoration helps to repair the original condition of the natural area which, in the case of a coastal wetland, restores it back to its natural and beneficial use and helps to control flooding and acts as a natural buffer prior to the onset of coastal storms. This program has been very beneficial to RI because Army Corps and the CRMC have been working together on one of the largest habitat restoration programs in the south county coastal lagoons in order to repair decades of damage to this environmentally fragile area by Army Corps flood control structures.	The negative of hard structures is that they require continual maintenance, which is a challenge to state and local governments. There may be future opportunities to work with ACE on floodplain management planning initiatives such as inundation mapping for high hazard dams.

Hazard Mitigation Grants for Plans & Projects
Table 5-2

Type of Existing Protection	Description	Effect on Loss and/or Risk Reduction	Opportunities
*** FEMA Hazard Mitigation Grant Program (HMGP)**	Established pursuant to Section 404 of the Stafford Disaster Relief and Emergency Relief Act (PL 100-707), this program provides matching grants (75% Federal, 25% non-Federal) for FEMA-approved hazard mitigation projects following a Presidential declared disaster. These grants are available to state, local and tribal governments as well as eligible non-profit organizations.	Allows for the completion of post disaster mitigation projects as identified in a FEMA-approved state and/or local hazard mitigation plan The approved hazard mitigation projects reduces and/or eliminate losses due to natural hazards. No experience with this program as RI has not had a declared disaster since 1991.	The data collected from the local plans will help the state to identify potential hazard mitigation strategies and projects before disasters occur.
FEMA Pre-Disaster Mitigation Program (PDM)	This all hazards mitigation grant program provides funding for hazard mitigation planning initiatives and projects. Originally allocated to states under a formula based on risk estimates, these matching grants (75% Federal, 25% non-Federal) for FEMA- approved hazard mitigation projects are now awarded through an annual national competition.	Provides critical funding for local plans and projects which is available now on an annual basis. This could potentially be a good program. However the application process is a nightmare and too cumbersome. M<any RI local communities pulled out of the last grant cycle because of the difficulties encountered in the application process (15 communities dropped out.)	Ongoing federal funding is needed to continue Rhode Island's Statewide Mitigation Planning Strategy for the development of an enhanced Strategy and continued funding for local plans' identification of mitigation projects.
FEMA Flood Mitigation Assistance (FMA) Planning & Project Grants	Since 1997, this program has provided annual pre-disaster funding for developing local flood mitigation plans and corresponding flood mitigation projects on a cost-shared basis (75% Federal, 25% non- Federal). Program focuses on mitigation to NFIP repetitive loss properties.	Program is often the sole source of continued funding for flood mitigation plans, planning initiatives and projects which have resulted in cost savings for communities and property owners. This program is very ineffective because the amount of money the state can receive can in no way implement anything that is effective or worthwhile.	Continued funding allows for ongoing focus on repetitive loss properties and complements current funding under the PDM and HMGP programs.

Hazard Identification & Mapping
Table 5-3

Type of Existing Protection	Description	Effect on Loss and/or Risk Reduction	Opportunities
University of Rhode Island Environmental Data Center (EDC)	Funded by RIEMA for the past 7 years, EDC provides GIS risk and vulnerability maps for all of RI's cities and towns. Locations where hazards have hit local areas in addition to the location of critical facilities are some of the information put on these local risk maps	Information educates the community of the location of the vulnerabilities in light of natural hazards and how and where to allocate and prioritize resources to minimize the damages from natural hazards. GIS hazards and risks mapping provides a critical geospatial component and is critical to improve the effectiveness of mitigation programs and more importantly, widespread understanding of RI risks and vulnerabilities	EDC has also provided similar mapping analyses for the State Hazard Mitigation Plan and will continue to work with RIEMA on other geospatial hazard risks and vulnerability assessments.
RI Map Modernization Plan	Developed by the RI NFIP, as part of FEMA's nationwide program to update the maps of flood zones in local communities. Flood Insurance Rate Maps (FIRMs) and the accompanying Flood Insurance Study (FIS) data are used in the administration of the minimum requirements of the NFIP.	Business Plan includes a strategy and 5-year implementation schedule for the update of FIRMs throughout Rhode Island, Rhode Island cities and towns are totally dependant upon the flood hazard information contained in the FIRMs and FIS for review of proposed development. The average age of RI FIRMs is 20 years. This program is proving to be ineffective because the mapping parameters that FEMA is using "digitize it all" rather than create accurate maps will lead to many more problems in the future.	May help to increase the purchase of flood insurance and increase the public's awareness of flood prone structures and potential mitigation measures. Updating FIRMs is critical because of the amount of development that has occurred in the past 20 years and therefore not been captured by existing FIRMs.
Odeh Engineers Statewide Risk and Vulnerability Assessment	Funded completely by the NOAA Coastal Services Center (CSC), RIEMA worked with Odeh to develop a methodology to complete a statewide and local risk and vulnerability assessment (RVA) for multiple natural hazards. The State RVA was completed in addition to the City of Warwick's. All of the data used in the risk assessment has been broken down by municipalities. GIS maps were developed based on the RVA data. The maps include information on where the state is	This assessment, fully completed in 2002, has been incorporated in to the State Hazard Mitigation Plan and has been shared with local communities. The development of the RVA was key to understanding RI risks and vulnerabilities. As important was the understanding through the results of this risk assessment of how various hazard impact critical facilities in addition to the impact on environmental	New data from the local hazard mitigation plans will assist in better identification of critical facilities and other structures which may be at risk to natural hazards. This data may be used by other state agencies as other plans are developed.

	most vulnerable to various natural hazards	resources, populations at risk and economic values. The DMA criteria only asked states to assess was simply how hazards affect structures and their function rather than the impact on people and their environment.	

Environmental Protection
Table 5-4

Type of Existing Protection	Description	Effect on Loss and/or Risk Reduction	Opportunities
Coastal Resources Management Program (CRMP) R.I.G.L. 46-23, 1971	Establishes the CRMC to plan and manage 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 police power to restrict the use 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. This coastal program is very good. The problem is that the Council is not implementing its own program. The staff does a very thorough job in abiding by the coastal program regulations, the Council, however overrules staff advice and obliterates the purpose and objectives of the coastal program to protect and preserve coastal resources.	
RI Water Resources Board (WRB) Water Management Policies (RIGL 46-15)	WRB is charged with broad duties to regulate the proper development, protection, conservation and use of the water resources of the State WRB also manages an Emergency Water Systems Interconnection Program to promote emergency connections between large public water systems throughout the State for use during the time of water shortages and supply emergencies.	State Guide Plan Element 723 RI Water Emergency Responses Plan (1993) provides the State with a policy guide and framework for coordinated responses in times of drought. State Guide Plan Elements 721 (1997) & 722 (1991) contain polices regarding supply management, and planning and administrative management issues for water use. The State Guide Plan and all policies relating to hazard mitigation have proven to be very effective in helping communities implement local	

		hazard mitigation policies, programs and projects through their local community comprehensive plans as mandated by the State Guide Plan.	
DEM Office of Water Resources (OWR)	Office of Water Resources (OWR) implements a variety of programs aimed at the protection of the quality of the state's surface waters, groundwater and wetlands. OWR's programs play a pivotal role in controlling wastewater discharges, promoting non-point source pollution abatement, and preventing alterations to wetlands.	This Program is also in charge of Pollution Discharge Elimination System (RIPDES) and wastewater permitting. I am not familiar with the effectiveness of this program. The potential is very good for RIEMA and WRB to work together on drought particularly if emergency conditions arise.	
Department of Administration (DOA) Statewide Planning Program, Element 152 State Comprehensive Outdoor Recreation Plan (SCORP)	Within the State guide Plan, Element 152 provides for the protection of floodplains and wetlands and open spaces for passive and active recreational use.	SCORP provides an inventory of all statewide recreation areas and open spaces. I am not familiar with the effectiveness of this program. The potential is very good for RIEMA and WRB to work together on drought particularly if emergency conditions arise.	In coordination with the SCORP, open space can be purchased and used for passive recreation as well as retaining waters from floods.
Department of Administration State Guide Plan, Land Use Policies	Within the State Guide Plan Element 121, Policy W-8 protects the natural and beneficial uses of wetlands and floodways; Goal 4 protects the coastal region by preventing the filling of coastal wetlands and waterways; and Goal 7 protects the loss of life and property by flood damages	These policies and goals protect wetlands, floodways thereby preserving the natural and beneficial uses of floodplains for storm water retention and buffers from coastal storm events. The State Guide Plan and all policies relating to hazard mitigation have proven to be very effective in helping communities implement local hazard mitigation policies, programs and projects through their local community comprehensive plans as mandated by the State Guide Plan.	Coordination approach implemented statewide to protect the natural and beneficial uses of floodplains.

Cultural & Historical Resources
Table 5-5

Type of Existing Protection	Description	Effect on Loss and/or Risk Reduction	Opportunities
*** State Historic Preservation Office/RIEMA Disaster Recovery MOU**	An MOU was created in the event of destruction and damage resulting from a natural disaster, RIEMA would defer to the State Historic Preservation Office policies when repairing historic structures and other structures	The MOU provides a mechanism whereby damaged buildings will be repaired utilizing mitigation measure while also following the guidance as set out in the State Historic Preservation regulations. This MOU has not been tested as there have been no disaster declarations.	Structures can be retrofitted utilizing mitigation measures while also preserving the historic integrity of these very unique resources.
RI Rivers Council, Cultural Heritage and Land Management Plan for the Blackstone River Valley	Element 162 of the Rivers Policy & Classification Plan, encourages the preservation of open space, natural habitat resources and features. Also provides for the preservation of cultural and historic landscapes and features. Element 131 provides the preservation of river corridors through the integration of the corridor cultural and management plans into existing state and regional planning initiatives (with Connecticut and Massachusetts)	Preservation of riverbank alterations from development. I am not familiar with the effectiveness of this program. The potential is very good for RIEMA and WRB to work together on drought particularly if emergency conditions arise.	

Technical Assistance
5-6

Type of Existing Protection	Description	Effect on Loss and/or Risk Reduction	Opportunities
University of Rhode Island Environmental Data Center (EDC)	GIS maps depicting statewide risks and areas of vulnerability	Statewide assessment of risks and vulnerabilities by local jurisdictions provides sound basis upon which to prioritize and allocate limited resources. GIS hazards and risks mapping provides a critical geospatial component and is critical to improve the effectiveness of mitigation programs and more importantly, widespread understanding of RI risks and vulnerabilities	Comprehensive assessment of risks, vulnerabilities and resource needs. Could provide a regional opportunity for sharing resources to address similar needs and vulnerabilities between communities.
Department of Transportation – GIS Division	Digital evacuation mapping of hurricane evacuation routes	First ever collaboration among cities and towns and the State to develop a comprehensive approach to statewide evacuation routes This effort was extremely effective because RIEMA gave DOT all of the local evacuation routes for hurricanes for the first time. DOT can now digitize these routes and put them up on a web.	Communities know where their evacuation routes are and they now know where abutting communities are directing evacuees. First time critical resource needs inventoried and collaborated among towns and with State Police and DOT.
National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS)	HURREVAC/SLOSH Training, evacuation planning	HURREVAC allows local EMS Directors and personnel to plan and forecast evacuations identify potential resource needs and areas at greatest risk. Training the EMA Directors on HURREVAC and SLOSH was extremely beneficial because the software is very easy to use and provides local Directors the tools they need to make critical decisions at the time of disaster – such as when and if to evacuate.	State of the art computer software programs taught to locals to provide greater capacity to forecast how hurricanes may impact their community.
United States Geological Service (USGS)	USGS researches the processes that control or trigger natural hazards and manages real-time river flood stage monitoring	Real-time flood stage monitoring is critical for the operation of flood response plans, and to	The State continues to partner with USGS and is seeking ways in which to develop a statewide system

	and warning systems USGS maintains stream- gauging stations in cooperation with the cities and towns and the National Weather Service.	provide additional lead time to down-river communities in addition to RIEMA for response purposes. The USGS gauge program is critical for RI in order to address riverine flooding which is the most frequent disaster. However the funding needed is not available.	of real-time river flood warning and monitoring systems. Also need to assist USGS and provide resources necessary to enhance the use of USGS river gauges.

5.3 Mitigation Measures and Projects

Implementing effective hazard mitigation in high risk areas in Rhode Island involves several approaches. These approaches may be categorized in two major areas: non-structural and structural hazard mitigation measures, or projects. In support of the efforts by municipalities, organizations, businesses and private citizens to reduce damages after natural disasters, Rhode Island's Hazard Mitigation Program emphasizes the use of a non-structural hazard mitigation approach before undertaking a structural approach. Rhode Island places a higher priority on funding non-structural projects. Although some non-structural hazard mitigation measures may be lower in cost (i.e. institution of a floodplain ordinance), such measures may be very time intensive in terms of staff time and take several years to implement.

Non-Structural Hazard Mitigation Measures & Projects

A non-structural hazard mitigation approach is a strategy that does not change the natural hazard, but involves preventative actions that improve infrastructure to reduce the damages, or improve coordination of resources. Rhode Island places a priority on funding non-structural projects.

Some examples of non-structural projects include:

- Enforcement of the State Building Code
- Establishing freeboard standards for all new construction and all substantial improvements
- Improvements to Existing Flood Control Structures
- Planning and Zoning; Hazard Overlay Zones
- Open Space Preservation
- Subdivision Regulations
- Storm water management plans, best management practices, ordinances
- Erosion and sediment control ordinances
- Local floodplain management ordinances
- Wetlands Protection
- Denial of Variances
- Acquisition, relocation, demolition and elevation

- Flood proofing (elevation of essential utilities, dry and wet flood proofing, barriers)
- Sewer Backup Protection Insurance
- Beach Renourishment
- Dune protection
- Vegetative buffers
- Riverine real-time tidal gauge system
- Vegetative buffers and setbacks
- Public Information dissemination (accurate flood maps, outreach projects, real estate disclosures, training for enforcers and practitioners, website updates, quarterly newsletters)

Structural Mitigation Measures

A structural approach involves measures used to prevent a natural hazard, such as floods, from reaching property. These measures are "structural" because they involve construction of man-made structures to control a hazard, such as construction of a dam or sea wall to control water flow. Most structural projects can be very expensive and have other shortcomings, such as: destruction of natural habitats by disturbing the land and natural water flow, increased erosion to adjacent unarmored shorelines or river banks; causing extensive damage when built to a certain flood protection level, but then are exceeded by a larger flood and require continuous and high cost maintenance. Examples of structural measures include dikes, drainage modifications, dams and seawalls.

While Rhode Island's Hazard Mitigation Program emphasizes the use of non-structural approaches over structural approaches, the density of at-risk development in some areas combined with the high value of existing mitigation infrastructure (e.g., seawalls, drainage systems) at times makes it more cost-effective to upgrade existing structures to provide added levels of protection. In such cases a limited structural approach (e.g., upgrading an existing seawall or culvert) may be preferable to a non-structural approach.

Hazard Mitigation, Project Eligibility and Prioritization

Eligible projects for pre-disaster and post-disaster hazard mitigation funding in Rhode Island must meet the following criteria:

1) Must be in conformance with a FEMA-approved local and/or multi-jurisdictional all hazards mitigation plan which meets the mitigation planning requirements per the Disaster Mitigation Act of2000 (this guideline become effective Nov. 1, 2004).

2) Must be in conformance with the Rhode Island State Multi- Hazard Mitigation Plan developed as a requirement of the Disaster Mitigation Act of 2000 Rhode Island places a priority on local mitigation projects that involve: nonstructural, or "low cost" solutions (i.e. updating and enforcing local flood ordinances); retrofitting high-risk structures (i.e. elevating residences in coastal flood zones) and the acquisition of

repetitive loss storm-damaged structures.

3) Must be located in, or have a beneficial impact upon, past declared disaster areas; or in a high risk area for potential impacts from one or more natural hazards, such as a floodplain, high wind area, coastal zone, etc. This high risk area should be identified in either the local, regional or state mitigation plan.

4) Must be in compliance with all existing Rhode Island Laws and Regulations for construction, land alterations, and natural resource protection, such as the Rhode Island State Building Code, the Rhode Island Coastal Resources Management Plan, and all legislation pertaining to the protection and preservation of wetlands.

5) Must be in compliance with municipal ordinances and zoning regulations

6) Must be in conformance with 44 CPR, Part 9, Floodplain Management and Protection of Wetlands, and 44 CFR, Part 10, Environmental Considerations.

7) Must provide a solution to a problem independently, or provide a significant functional portion of a solution being addressed in a combined project. If the project constitutes a significant functional portion of a solution being addressed, the status of any associated dependent or supporting projects must be given. There must be reasonable assurance that the total mitigation project will be completed. The identification or analysis of a problem does not automatically qualify for eligibility.

8) Must meet FEMA's cost-effective criteria such as the need to substantially reduce the risk of future damage, hardship or losses resulting from a major disaster. Documentation will be required that demonstrates that:

    i. The problem is repetitive and/or poses a significant risk if left unsolved. Therefore, a brief history of previous occurrences of the problem at the project location, including dates and impact of each event, and/or an analysis of projected potential damages if the project is not completed must be given.

    ii. Sufficient information to allow comparison of the cost of the project with the anticipated value of future direct damage reduction or negative impacts to the area.

    iii. Sufficient information to allow comparison of the cost of the project with the anticipated value of future direct damage reduction or negative impacts to the area.

    iv. The proposal has been determined to be the most practical, effective, and environmentally sound alternative found after consideration of all available options.

v. The project contributes to the long-term solution of the problem it addresses. Therefore, an estimate of the effective life of the project and a listing of influence factors should be included.

vi. Development of the project considers any long-range alterations to the area and the entities that it protects, has future maintenance requirements that are financially feasible and can be modified, if necessary, without changing the impact on the area.

Hazard Mitigation Project Selection

Available federal funds for pre-disaster and post-disaster hazard mitigation assistance will most likely not be sufficient to support all eligible project applications. An attempt will be made to award grants to the maximum number of eligible projects.

Recommendations for funding will be made to the FEMA Region 1 office by the State Hazard Mitigation Officer in consultation with NFIP State Coordinator, under advisement by the State Hazard Mitigation Committee. FEMA will make the final selection of grants to be awarded. The mitigation measure proposed should not be intended to replace what was damaged only, but rather should provide more protection to life and property than what existed prior to the storm.

The proposals will be evaluated and prioritized by the Rhode Island Hazard Mitigation Committee according to the following criteria:

1) Measures that best fit within an overall plan for development and/or hazard mitigation in the community, disaster area, or State, especially those described in a local and/or multi-jurisdictional mitigation Plan. Rhode Island sets priority on nonstructural solutions, storm damaged structure/property acquisition efforts, and plans that promote retrofitting flood prone structures and overall environmental protection. Equipment purchases will be a low priority unless demonstrated to be an integral part of an overall hazard mitigation plan.

2) Measures that, if not taken, will have a severe detrimental impact on the applicant, such as loss of life, loss of essential services, damage to critical facilities, or economic hardship on the community.

3) Measures that have the greatest potential impact on reducing future disaster losses. Measures must have a demonstrated ability to solve the problem. They cannot merely analyze or identify hazards and problems.

4) Projects designed to protect and/or improve the environment while reducing damage potential.

5) Projects that have maximum local support, a high level of interest and

commitment by the applicant.

6) Applicant has technical ability to successfully implement the project in a cost-effective manner.

7) Projects that enhance environmental protection; at a minimum, projects must meet all local, state, and federal environmental standards, and not require a variance to state environmental regulations.

8) Projects involving public/private partnership.

Upon completion of local and multi-jurisdictional plans, local hazard mitigation assistance will be based in part on the risk assessments, project recommendations and benefit cost analyses described in these plans.

Local Hazard Mitigation Plans

As part of Rhode Island's statewide planning strategy to meet the multiple hazard mitigation planning goal of DMA 2000, local communities will be developing specific local hazard mitigation strategies and identifying specific mitigation measures, such as non-structural measures and projects that address the highest natural hazard risks within their community. All thirty-nine municipalities - received funding from the State in 2003 through the Pre-Disaster Mitigation Program to complete local hazard mitigation plans.

As these plans are completed and submitted to the FEMA for review and approval, the local hazard mitigation measures will be incorporated into this section of the State Hazard Mitigation Plan. Additional information related to risk and vulnerability, estimated losses by jurisdiction, and identification of mitigation projects, will be incorporated into the State Mitigation Plan. These mitigation measures will be reviewed and analyzed by the State Hazard Mitigation Committee team in order to identify any trends and issues related to these proposed hazard mitigation measures. Dependent upon future funding, Rhode Island will provide the participating communities with technical assistance as needed for the implementation of cost effective hazard mitigation measures. It is expected that this section of this plan will be updated with input from the local plans. The schedule for incorporating the information from the local plans into the State Hazard Mitigation Plan by the National Flood Insurance Program Manager is listed in the Table 8 below:

5.4 Statewide Goals, Strategies & Action Steps

The overall strategy of the Rhode Island Hazard Mitigation Plan is to minimize the loss of life, property, cultural and environmental resources from natural disasters in Rhode Island in addition to developing better programs to educate the public in issues related to hazard mitigation and strengthening communication within RIEMA, and with other state agencies, local officials and any appropriate and potential partners in mitigation. In support of that primary mission are goals and mitigation strategies developed by the RIEMA Mitigation Division, the State Hazard Mitigation Committee and various stakeholders throughout the process of developing this Statewide Mitigation Plan. These goals reflect Rhode Island's commitment to enhancing the state's resilience to natural disasters by minimizing potential impact.

Rhode Island's Multi-Hazard Mitigation Goals

1. **Enhance the Rhode Island Emergency Management Agency's capacity to promote and implement projects, programs, policies and legislative action to minimize losses due to natural hazards.**

2. **Build and support local capacity and commitment to continuously become less vulnerable to natural hazards.**

3. **Improve coordination and communication with other relevant organizations, agencies and stakeholders.**

4. **Increase public understanding, support, and demand for hazard mitigation.**

The state mitigation goals listed above offer broad guidance as to what Rhode Island intends to accomplish. To elaborate on the statewide mission and goals, a number of action items, or mitigation strategies, were identified. This section of the Plan provides a list of Rhode Island's strategies and action steps, categorized by goal, needed to implement a comprehensive hazard mitigation program over the next three years. These strategies and action steps as well as the statewide mission are based on the data provided in the previous section of the plan, especially the hazard risk and vulnerability assessment and the current hazard mitigation state capability assessment matrix (Section 5.2).

The State Mitigation goals and strategies are listed in order of priority based on RIEMA present staffing level and financial resources. Following each action is an evaluation relating to cost effectiveness (High, Medium or Low); Environmental soundness (High, Medium or Low); technical feasibility (High, Medium or Low); and priority (Most important, Very Important, and Important). A timeline is also given that indicates at what point in the next three years the action item can be addressed.

GOAL #1 Enhance the Rhode Island Emergency Management Agency's capacity to promote and implement projects, programs, policies and legislative actions to minimize losses due to natural hazards.

Strategy 1.1 Maintain and implement a State Mitigation Plan that fosters innovation, advances public support, and gains long-term commitments for pre-disaster mitigation from Rhode Island State agencies and the legislature.

How the Actions Contributes to Mitigation Strategy: A FEMA-approved mitigation plan is needed to continue to implement the Statewide Mitigation Planning Strategy, and continue the availability of disaster assistance and hazard mitigation grants. These actions will help RIEMA increase its present capacity and capabilities in achieving the mitigation strategy.

Action 1.1.1 Identify and secure funding to administer and implement pre-disaster mitigation programs.
Timeline: On going
Cost effectiveness: M
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Most Important

Action 1.1.2 Research ways in which the effectiveness of mitigation measures can be determined.
Timeline: Within three years
Cost effectiveness: M
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Very Important

Action 1.1.3 Educate and assist the Rhode Island General Assembly in developing state legislation that will further hazard mitigation efforts.
Timeline: Within one year
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Most Important

Action 1.1.4 Target legislative representatives of local communities that are most vulnerable to natural hazards and provide information about the risks their community faces and how and where their community is vulnerable to natural hazards
Timeline: Within three years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Very Important

Action 1.1.5 Invite State Legislative Representatives to hazard mitigation workshops, meetings and all other relevant functions in which they

can learn more about hazard mitigation programs, polices and projects
Timeline: Within three years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Very Important

Action 1.1.6 Cooperate and coordinate with partners at all government levels in planning and use of best technology.
Timeline: Within three years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Important

Action 1.1.7 Maximize the utilization of best technology through the incorporation of a progressive geographical information system (GIS) as the primary tool for spatial data management and as a recognized essential tool in land use decision making
Timeline: Within three years
Cost effectiveness: H
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Most Important

Action 1.1.8 Encourage State agency and local government officials involved in floodplain management, community planning, building inspection, emergency services, or enforcement of land use planning to take the Federal Emergency Management Agency Independent Study Courses related to flooding, flood mitigation, and floodplain management.
Timeline: Within one year
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Important

Action 1.1.9 Ensure that hazard mitigation is recognized in any state-level programs that targets “smart-growth” or sustainable development practices.
Timeline: Within three years

Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Very Important

Action 1.1.10 Work in coordination with other state and local agencies and organizations to acquire and connect hazard-prone or environmentally sensitive lands throughout the state.
Timeline: Within three years
Cost effectiveness: N/A
Environmentally Sound: H
Technically Feasible: N/A
Priority: Very Important

Action 1.1.11 Promote and support enforcement of the latest version of the model building code as adopted by the state of Rhode Island and implemented without local variances
Timeline: Within one year
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Very Important

Strategy 1.2 Attract and retain qualified, professional and experienced Hazard Mitigation Staff.

How Actions Contribute to Mitigation Strategy: Increasing the staffing and improving the current level of expertise will only serve to improve the efficiency in which the agency will operate. Accomplishing these actions is critical to improving communication with state agencies and strengthening communication and collaboration with any future partnerships to implement the goals of hazard mitigation.

Action 1.2.1 Add a minimum of two additional full time staff to the RIEMA Mitigation and NFIP programs and seek additional resources through more state funding and additional contract services.
Timeline: Within one year
Cost effectiveness: H
Environmentally Sound: N/A
Technically Feasible: H
Priority: Most Important

Action 1.2.2 Provide high quality training to members of Mitigation and Homeland Security Divisions in order to "cross train" more staff to be used more efficiently.
Timeline: Within one year
Cost effectiveness: H
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Most Important

Action 1.2.3 Improve organization efficiency and lines of communication within RIEMA by holding regular staff meetings with all branches of the agency in order to not only support mitigation efforts, but to also identify ways in which mitigation and homeland security can commingle efforts.
Timeline: Within one year
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Most Important

Action 1.2.4 Encourage professional development and certification through outside continuing education programs (e.g. CFM certification, EMAP program accreditation).
Timeline: Within one year
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Important

Action 1.2.5 Allow staff members, and local EMA Directors and NFIP Coordinators to travel and attend relevant conferences, workshops and professional meetings
Timeline: On going
Cost effectiveness: H
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Very Important

Action 1.2.6 When appropriate, provide membership fees for professional organizations for RIEMA staff
Timeline: On going
Cost effectiveness: H

Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Very Important

Strategy 1.4 Improve the capacity and diversify the representation of the State Hazard Mitigation Committee

<u>How Actions Contribute to Mitigation Strategy</u>: A more diverse representation will help to implement the tenants of hazard mitigation more broadly throughout the state and also improve the chances for leveraging more available resources. These actions will help achieve the Mitigation goal of improving collaboration with state agencies.

Action 1.4.1 Add members to the State Hazard Mitigation Committee that will represent federal, state and local agencies and more relevant stakeholders from both non-profit and the private sector.
Timeline: Within one year
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Most Important

Action 1.4.2 Educate and provide training to new and existing State Hazard Mitigation Committee members
Timeline: Within one year
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Most Important

Action 1.4.3 Encourage opportunities for the State Hazard Mitigation Committee to collaborate with the Lieutenant Governor's Domestic Preparedness Sub Committee
Timeline: Within one year
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Important

GOAL #2 Build and support local capacity and commitment to continuously become less vulnerable to natural hazards.

Strategy 2.1 Strengthen local government commitment to hazard mitigation and ability to implement hazard mitigation programs, policies and projects

How Actions Contribute to Mitigation Strategy: Mitigation is most directly achieved when implemented at the local level. These actions will improve local capability of local officials to address and implement hazard mitigation.

Action 2.1.1 Incorporate the new local hazard mitigation data and capability assessment (hazard profiles, risk and vulnerability assessments, mitigation actions/strategies, etc.) into the State Multi-Hazard Mitigation Plan.
Timeline: Within one year
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Very Important

Action 2.1.2 Provide direct technical assistance to local public officials and help communities obtain funding for mitigation planning and project activities.
Timeline: On going
Cost effectiveness: H
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Very Important

Action 2.1.3 Increase awareness and knowledge of hazard mitigation principles and practices among local public officials and R.I. Legislators through outreach efforts and educational presentations and materials
Timeline: Within one year
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Very Important

Action 2.1.4 Conduct hazard mitigation and community outreach educational programs and training courses for local government and stakeholder groups and the general public
Timeline: Within one year
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A

Priority: Important

Action 2.1.5 When available, allocate federal grant funding to local governments (or other eligible recipients) for the purposes of implementing eligible hazard mitigation projects.
Timeline: On going
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Important

Action 2.1.6 Work in coordination with other state and local agencies and organizations to acquire and connect hazard-prone or environmentally sensitive lands throughout the state.
Timeline: Within one year
Cost effectiveness: M
Environmentally Sound: H
Technically Feasible: N/A
Priority: Important

Action 2.1.7 Encourage all relevant state, local and Federal agencies and professional associations to assist in the establishment of a Rhode Island Floodplain Management Association in coordination with the Association of State Floodplain Managers (ASFPM) and the New England Floodplain and Stormwater Manager Association (NEFSMA).
Timeline: Three years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Important

Action 2.1.8 Provide technical assistance to municipalities for development of local recovery plans from natural disasters
Timeline: Within three years
Cost effectiveness: M
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Important

Strategy 2.2 Strengthen local government capacity to effectively implement and enforce the National Flood Insurance Program within their community

How Actions Contribute to Mitigation Strategy: Better enforcement of the NFIP will result in safer construction and fewer flood losses. These actions will help to strengthen local capacity to address flood hazard issues thereby reducing damages and losses caused by floods.

Action 2.2.1 Provide floodplain management resources to local government such as: an updated Local Administrator's Handbook; quick guide for floodplain management; updates segment of Floodplain management on the EMA website; a guidebook for local public officials with recommendations for incorporating higher regulatory standards into local flood damage prevention ordinances to enhance local capability to manage floodplain development.
Timeline: Within two years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Very Important

Action 2.2.2 Improve compliance with the NFIP through better understanding by local officials of the NFIP criteria and therefore fewer variance approvals.
Timeline: Within two years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Very Important

Action 2.2.3 Increase participation with the Community Rating System (CRS) and improve the ratings of current communities.
Timeline: Within one year
Cost effectiveness: H
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Very Important

Action 2.2.4 Integrate the broad principles of sustainable development into state and local hazard mitigation practices, policies and programs by coordinating with organizations responsible for promoting and/or implementing sustainable development or "smart growth" initiatives.
Timeline: Within three years
Cost effectiveness: N/A
Environmentally Sound: N/A

Technically Feasible: N/A
Priority: Very Important

Action 2.2.5 Ensure that hazard mitigation is recognized in any community programs that target “smart-growth” or sustainable development practices.
Timeline: Within three years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Important

Action 2.2.6 Add a minimum of two additional full time staff to the RIEMA Mitigation and NFIP programs and seek additional resources through more state funding and additional contract services.
Timeline: Within one year
Cost effectiveness: H
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Most Important

Action 2.2.7 Improve efficiency in tracking and storing NFIP-related data by:

a) Developing a statewide community database, including NFIP administrator contact and ordinance information
b) Developing a NFIP Technical Assistance database to track issues and needs
c) Developing and maintaining accurate and current statewide Repetitive Loss databases
d) Maintaining current and archived FIS/FIRM files, including map changes

Timeline: Within one year
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Very Important

GOAL #3 Improve coordination and communication with other relevant organizations, agencies and stakeholders.

Strategy 3.1 Leverage resources and expertise that will further hazard mitigation efforts.

<u>How Actions Contribute to Mitigation Strategy</u>: Coordination with other state agencies to learn of all existing state and federal potential funding resources for the implementation of mitigation projects will provide a greater likelihood that more actions will be funded and implemented. Becoming knowledgeable of statewide expertise, data and policies in various areas related to hazard mitigation will allow for the hazard mitigation goals to become more widely recognized statewide and therefore enhance statewide implementation efforts. This effort to collaborate will also help to avoid the duplication of efforts and therefore streamline state agency hazard mitigation objectives and actions.

Action 3.1.1 Develop and track joint mitigation/conservation projects with CRMC, DEM, land trusts, EDC and other environmental groups.
Timeline: Three years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Important

Action 3.1.2 Develop a database of potential hazard mitigation projects and strategies that support the mission and goals of the State Hazard Mitigation Plan and the FEMA approved local hazard mitigation strategies.
Timeline: Three years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Important

Action 3.1.3 Improve coordination with the Department of Environmental Management in addressing storm water management and other riverine and floodplain management-related issues and determine the probability for urban/stormwater flooding. Obtain information to develop a statewide database of historic areas of past events of urban/stormwater flooding. Based on this information complete an assessment of communities/regions of greatest impact to urban/stormwater flooding.
Timeline: Three years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Important

Action 3.1.4 Work with the National Weather Service and local communities to develop a statewide database of how winter-related hazards impact communities throughout Rhode Island. The database should consist of historic data from past events for snow, ice and extreme cold. The database should highlight communities most impacted by winter-related events. Based on the database, GIS maps need to be completed depicting areas of impact from heavy snow, ice storms and extreme cold. As important is a database of the locations and building design (type of roof), function and use of state facilities (including critical facilities) located in areas impacted by winter-related events. Additionally, with the collected information and database, determine the probability of future occurrences of snow, ice storms and extreme cold events in the future.

Timeline: Three years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Important

Action 3.1.5 Work with the Rhode Island Water Resources Board to complete an assessment of the probability of future drought occurrences. As important is a clarification from the WRB of what communities /regions in Rhode Island are potentially affected by drought and what are the economic impacts.

Timeline: Three years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Important

Action 3.1.6 Work with the NOAA National Weather Service to complete an assessment of the probability of future occurrences of hurricanes and tornadoes in Rhode Island and the locations of greatest impact.

Timeline: Three years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Important

Action 3.1.7 Using the information collected for vulnerability regarding state owned/operated facilities, critical facilities and infrastructure to estimate losses for all identified hazards addressed in the Plan.

Timeline: Three years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Important

Strategy 3.2 Incorporate hazard mitigation into the activities of other organizations.

How Actions Contribute to Mitigation Strategy: Becoming knowledgeable of statewide expertise, data and policies in various areas related to hazard mitigation will allow for the hazard mitigation goals to become more widely recognized statewide and therefore better chances of more widespread implementation which will result in the reduction of losses and damage caused by disasters. This effort to collaborate will also help to avoid the duplication of efforts and therefore streamline state agency hazard mitigation objectives and actions.

Action 3.2.1 Educate state and local organizations on the theory and practice of hazard mitigation, and help them to identify how mitigation can become incorporated into land use decisions and other routine functions and activities.
Timeline: Within three years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Important

Action 3.2.2 Agree to address relevant hazards and the risks they pose in any state-level land use decisions, including plans for state-owned property development. The state will also encourage adoption of local land use plans that incorporate hazards into decision-making.
Timeline: Within three years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Important

Strategy 3.3 Streamline policies to eliminate conflicts and duplication of effort.

How Actions Contribute to Mitigation Strategy: By collaborating with state agencies and organizations will the duplication of efforts can be avoided and state agency hazard mitigation objectives and actions can be streamlined. These actions contribute to the overall mitigation strategy of improving communication and collaboration and education efforts with other potential mitigation partners.

Action 3.3.1 Coordinate data collection and sharing with other statewide initiatives such as the Homeland Security Grants and Planning process.
Timeline: Within three years
Cost effectiveness: H
Environmentally Sound: N/A

Technically Feasible: N/A
Priority: Very Important

Action 3.3.2 Continue to support existing statewide mitigation planning initiatives especially the Community Assistance Program – State Support Element (CAPSSE), the National Flood Insurance Program (NFIP), and the FEMA Mapping and Modernization Program.
Timeline: Within three years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Most Important

Action 3.3.3 Work with DEM Division of Dam Safety to garner additional resources/staff needed to develop dam inundation maps in areas that pose greatest threat and for those dams that have been classified as high hazard and significant hazard dams. Also obtain information from DEM Dam Safety on when and what dams have had breeches.
Timeline: Within three years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Most Important

Action 3.3.4 Work with the Coastal Resourcews Management Council to obtain resources needed to develop a statewide coastal erosion risk and vulnerability assessment. This information should be used to develop coastal erosion maps that depict areas at greatest risk throughout the state to coastal erosion and also depict erosion rates. Additionally, develop statewide database of history of coastal erosion events and locations and from that information develop an assessment of the probability of future occurrences of coastal erosion.
Timeline: Within three years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Most Important

GOAL #4 Increase public understanding, support, and demand for hazard mitigation.

Strategy 4.1 Identify and educate hazard specific issues and needs to the public.

<u>How Actions Contribute to Mitigation Strategy</u>: Educated consumers will be better

protected from natural disasters because they have reduced risks by implementing various hazard mitigation techniques, projects and actions. These actions will contribute to the overall mitigation strategy of improving public education and communication relative to hazard mitigation issues.

Action 4.1.1 Develop statewide database (inventory) of local hazard risks and vulnerabilities based on local hazard mitigation plans
Timeline: Within three years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Very Important

Action 4.1.2 Develop a statewide inventory of local hazard mitigation projects
Timeline: Within three years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Most Important

Action 4.1.3 Develop programs to increase public awareness of the importance of mitigating the damage caused by natural hazards, through a coordinated effort with multiple stakeholders.
Timeline: Within three years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Important

Action 4.1.4 Develop a web based site (on the existing RIEMA web site) for public education and outreach initiatives.
Timeline: Within one year
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Very Important

Strategy 4.3 Engage the private sector in hazard mitigation initiatives and encourage partnerships between the private sector and state/local government. These actions will contribute to the overall mitigation strategy of improving education and communication relative to hazard mitigation issues with all potential

partners.

How Actions Contribute to Mitigation Strategy: Often, private sector has access and ability to more innovative and proactive means of implementing hazard mitigation measures.

Action 4.3.1 Develop partnerships with businesses to provide a public-private link for coordinated mitigation, preparedness, response and recovery. Partnerships should include critical businesses involved in recovery from natural hazard events (e.g., utilities, communications, food suppliers, medical facilities) and those businesses that would impact the local and state economy.
Timeline: Within three years
Cost effectiveness: H
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Very Important

Action 4.3.2 Develop and conduct mitigation training for building, design, and construction professionals.
Timeline: On going
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Most Important

Action 4.3.3 Develop a set of public sector incentives to implement mitigation measures in collaboration with private sector financial incentives. Public sector incentives could include tax incentives and regulatory streamlining or acceleration of the permit process for those who implement mitigation activities.
Timeline: Within three years
Cost effectiveness: M
Environmentally Sound: N/A
Technically Feasible: N/A
Priority: Important

Action 4.3.4 Address the vulnerability of utility lines to high winds and ice storms that could result in breakage and power outages. Investigate the possibility of working with the Public Utilities Commission and private companies.
Timeline: Within three years
Cost effectiveness: N/A
Environmentally Sound: N/A
Technically Feasible: N/A

Priority: Important

5.5 Funding Resources

The availability of federal funding depends upon Congress' ongoing appropriations process. In 2003, the federal government established two comprehensive web sites that track available funding from all federal agencies at www.fedgrants.gov or www.grants.gov.

A Summary of Federal Funding Sources

The Federal Emergency Management Agency (FEMA), which is now part of the Department of Homeland Security, administers the National Flood Insurance Program (NFIP), the Community Rating System (CRS), the Flood Mitigation Assistance Program (FMA), the Hazard Mitigation Grant Program (HMGP) and the Pre-Disaster Mitigation Program (PDM). All of these programs are administered in the Rhode Island Emergency Management Agency (RIEMA).

The following is a tabular summary, followed by a more detailed description of programs that are the primary source of federal funding of hazard mitigation projects and activities in Rhode Island. All of the program listed below are current sources funding for RIEMA, with the exception of the HMGP because RI has not had any declared disasters since 1991. At this point in time, there are no state sources of funding for any hazard mitigation programs. The only availability of local funding would be if a community chooses to apply to a federal program, and if approved, the community would have to match the federal resources at a 25% rate, or otherwise indicated in the table below.

Federally Funded Mitigation Programs
Table 5-7

Program	Type of Assistance	Availability	Managing Agency	Funding Source
National Flood Insurance Program (NFIP)	Pre-Disaster Insurance	Any time (pre- and post disaster)	RIEMA	Property owner, FEMA
Community Rating System (CRS) (Part of the NFIP)	Flood Insurance Discounts	Any time (pre- and post disaster)	RI NFIP	Property Owner
Flood Mitigation Assistance Program (FMA)	Cost share grants for pre-disaster planning and projects	Annual pre-disaster grant program	RINFIP	75% FEMA/25% local government or other organization
Hazard Mitigation Grant Program	Post-disaster cost share grants	Post disaster grant program	RIEMA	75% FEMA/25% local government or other organization

(HMGP)				
Small Business Administration (SBA) Mitigation Loans	Pre- and Post-disaster loans to qualified businesses	Ongoing	RIEMA	Small Business Administration
Pre-disaster Mitigation Program	National, competitive grant program for multiple hazard mitigation projects and "all hazards" plans	Ongoing	RIEMA	75% FEMA/25% local government or other organization
Infrastructure Support Program (formerly Public Assistance)	Post-disaster aid to state and local governments	Post disaster	RIEMA	FEMA

NATIONAL FLOOD PROGRAM (NFIP)

Type of Assistance: Pre-Disaster Insurance
State Managing Agency: Rhode Island Emergency Management Agency
Funding Source: Property Owner, FEMA

The National Flood Insurance Program (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 made available to residents in exchange for community compliance with minimum floodplain management requirements. Since homeowners' insurance does not cover flooding, a community's participation in the NFIP is vital to protecting property in the floodplain as well as ensuring that federally backed mortgages and loans can be used to finance property within the floodplain.

Pursuant to the Flood Disaster Protection Act of 1973, many forms of federal financial assistance, including disaster assistance and federally regulated loans, related to structures located in the 100-year floodplain are contingent on the purchase of flood insurance. Such federal assistance includes not only direct aid from agencies, but also from federally insured institutions. In order for property owners to be eligible for purchasing flood insurance through the federal government, their respective community must be participating in good standing in the NFIP.

Communities participating in the NFIP must:

- Adopt the Flood Insurance Rate Maps as an overlay regulatory district or through another enforceable measure.
- Require that all new construction or substantial improvement to existing structures in the flood hazard area will compliant with the construction

standards of the NFIP.
- Require additional design techniques to minimize flood damage for structures being built in high hazard areas, such as floodways or velocity zones.

In Rhode Island the majority of the NFIP construction standards are contained in the Rhode Island State Building Code (Section) which is implemented at the local level by municipal building inspectors. All 39 cities and towns in Rhode Island communities are participants in the NFIP and are in good standing. The NFIP Program could be more effective if more staff and more resources were assigned. Currently, the RI NFIP is operating with the lowest staff level in the country (one person) and the least amount of financial resources. On several occasions federal grant money had to be returned to FEMA because the required match could not be met.

Community Rating System (CRS)

(Part of the Nation Flood Insurance Program)
Type of Assistance: Flood Insurance Discounts
Managing Agency: RIEMA Flood Insurance Program
Funding Source: NFIP, FEMA

A voluntary initiative of the NFIP, the Community Rating System (CRS) encourages communities to undertake activities that exceed the minimum NFIP floodplain management standards. Communities participating in CRS can reduce flood insurance premiums paid by policy holders in that community by performing such activities as: maintaining records of floodplain development, publicizing the flood hazard, improving flood data, and maintaining open space. Communities can gain additional credit under CRS by developing a flood mitigation plan.

In Rhode Island, there are four communities that participate in CRS: North Kingstown, Middletown, Pawtucket and Narragansett. Fourteen communities have expressed very strong interest in joining the CRS program. Despite the severe lack of staffing at RIEMA (natural hazards program), it is hoped that all fourteen communities will be able to become members of the CRS program by the end of 2005.

RIEMA has not had recent experience with this program and therefore, cannot fairly evaluate effectiveness.

FLOOD MITIGATION ASSISTANCE PROGRAM (FMA)

Type of Assistance: Post-disaster Cost-Share Grants
Managing Agency: RIEMA
Funding Source: FEMA

Authorized by the National Flood Insurance Reform Act of 1994, the Flood Mitigation Assistance (FMA) program makes cost-shared grants available for flood mitigation planning and projects, such as property acquisition, relocation of residents living in floodplains, and retrofitting of existing structures within a floodplain. Flood hazard mitigation plans, approved by the state and FEMA, are a pre-requisite for receiving FMA project grants. FEMA provides a federal share of up to 75% of the cost of the plan or project while communities and/or homeowners contribute a minimum of 25%. This program is not effective because the money provided to Rhode Island is a paltry sum that in no way could be used for the purchase acquisition , elevation or relocation of flood prone, of repetitive loss properties.

HAZARD MITIGATION GRANT PROGRAM (HMGP)

Type of Assistance: Post-disaster Cost-Share Grants
Managing Agency: RIEMA
Funding Source: FEMA

Established pursuant to Section 404 of the Stafford Disaster Relief and Emergency Relief Act (PL 100-707), this program provides matching grants (75% Federal, 25% non Federal) for FEMA-approved hazard mitigation projects following a Presidential declared disaster. These grants are available to state, local and tribal governments as well as some non-profit organizations. The grants are specifically directed toward reducing future hazard losses, and can be used for projects protecting property and other resources against the damaging effects of floods, hurricanes, earthquakes, high winds, and other natural hazards. The HMGP in Rhode Island encourages non-structural hazard mitigation measures, such as:

- The acquisition of damaged structures and deeding the land to a community for open space or recreational use.
- Relocating damaged or flood prone structures out of a high hazard area.
- Retrofitting properties to resist the damaging effects of natural hazards. Retrofitting can include wet or dry-flood proofing, elevation of the structure above flood level, elevation of utilities, or proper anchoring of the structure.
- Proposals for funding are submitted for review by Rhode Island's Hazard Mitigation Committee which makes recommendations to the Stat Hazard Mitigation Officer for review and approval. The committee uses a list of criteria contained in the Rhode Island Mitigation Grants Administrative Plan (see Appendix K). Review and final approval of state recommendations is made by FEMA's Region I office.

Rhode Island has not had a Presidential declared disaster since 1991. Therefore, no meaningful recent experience with this federal program.

PRE-DISASTER MITIGATION COMPETITIVE PROGRAM

Type of Assistance: National, competitive grant program for multiple hazard mitigation

projects and "all hazards" mitigation plans
Managing Agency: RIEMA
Funding Source: 75% Federal/25% State or local government

The Pre-Disaster Mitigation (PDM) Program was authorized by §203 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act), 42 US.C. Chapter 68, as amended by § 1 02 of the Disaster Mitigation Act of 2000. Funding for the program is provided through the National Pre-Disaster Mitigation Fund to assist states, local governments and Indian Tribal governments in implementing cost effective hazard mitigation activities that complement a comprehensive mitigation program. All applicants must be participating and in good standing in the National Flood Insurance Program (NFIP) if they have been identified through the NFIP as having a Special Flood Hazard Area. 44 CFR Part 201, Hazard Mitigation Planning, establishes criteria for State and local hazard mitigation planning authorized by §322 of the Stafford Act, as amended by §104 of the DMA 2000. After November 1, 2004, local governments and Indian Tribal governments applying for PDM funds through the States will have to have an approved local mitigation plan prior to the receipt of local mitigation project grants. States will also be required to have an approved Standard State mitigation plan in order to receive PDM funds for State or local mitigation projects after November 1, 2004. Therefore, the development of State and local multi-hazard mitigation plans is critical to maintaining eligibility for future PDM funding. For current information on available Pre-Disaster Mitigation Program, refer to FEMA's website at http://www.fema.gov/fima/pdm.shtm.

The application procedure is unnecessarily burdensome and has resulted in over 15 communities in FY2005 dropping out and not applying.

SMALL BUSINESS ADMINISTRATION (SBA) MITIGATION LOANS

Type of Assistance: Pre-disaster mitigation loans to qualified businesses
Managing Agency: Small Business Administration
Funding Source: Small Business Administration

The SBA's Pre-Disaster Mitigation Loan Program was developed in support of FEMA's Pre-Disaster Mitigation program. SBA's pilot loan program was authorized at a level of $15 million for each of five fiscal years from 2000 to 2004 to provide loans to small businesses for the purpose of implementing mitigation measures to protect their property from disaster related damage. Eligible small businesses may borrow up to $50,000 each fiscal year at a fixed interest rate of four percent per annum or less for mitigation measures approved in the loan request.

Businesses proposing mitigation measures to protect against flooding must be located in a Special Flood Hazard Area (SFHA). To apply for a pre-disaster mitigation loan, a business must submit a complete Pre-Disaster Mitigation Small Business Loan Application within the 30-day application period announced by the SBA. SBA will publish a Notice of Availability of Pre-disaster Mitigation Loans in the Federal Register announcing the availability of pre-disaster mitigation loans each fiscal year. The Federal

Register notice will designate a 30-day application period with a specific opening date and filing deadline, as well as the locations for obtaining and filing loan applications. In addition, SBA will coordinate with FEMA, and will issue press releases to the local media to inform potential loan applicants where to obtain loan applications.

A business' proposed mitigation measure as described in the application must conform to the priorities and goals of the mitigation plan for the community in which the business is located. For more information on this program, The Small Business Administration (SBA) published a Final Rule on their Pre-Disaster Mitigation Loan Program in the Federal Register on October 7, 2002. The Federal Register may be viewed online.

RIEMA has never worked with this program, therefore no information is available upon which to evaluate the effectiveness of this program.

INFRASTRUCTURE SUPPORT PROGRAM

Type of Assistance: Post-disaster Cost-Share Grants
State Managing Agency: RIEMA
Funding Source: FEMA

The Federal Emergency Management Agency's Infrastructure Support Program is triggered for counties declared major disaster areas by the President. Communities and public agencies in designated counties are eligible for partial reimbursement (75%) of expenses for emergency services and removal of debris, and partial funding (75%) for repair and replacement of public facilities which were damaged by the declared disaster. Rhode Island funds an additional 12.5% of these projects. Cost-effective hazard mitigation measures to protect eligible facilities from future damage can be included as part of the disaster assistance. Eligible applicants for Infrastructure Assistance include:

- State government agencies/departments
- Local governments (county, city, town, village, district, etc.) .
- Certain private non-profit organizations

For the latest updates on this FEMA program, refer to the FEMA website at: www.fema.gov. This strategy will contribute to the overall mitigation strategy of improving public education and communication relative to hazard mitigation issues.

VOLUNTEER FIRE ASSISTANCE GRANTS (VFA)

Type of Assistance: Pre-disaster Grants
State Managing Agency: State Fire Marshall's Office
Funding Source: USDA Forest Service

Volunteer Fire Assistance (VFA) is a Federal grant program that provides funds for fire equipment, training, and initial fire department organization to fire departments serving small communities under 10,000 in population. Congressionally appropriated VFA funds are provided to the State forestry agencies through the USDA Forest Service. The State forestry agencies pass this money on to needful fire departments within their states. A fire department may buy equipment, pay for training or training materials, or cover the cost of department incorporation, as long as the funds are matched. VF A funds are granted on a 50/50 matching basis. In other words, the department must match the dollars, dollar for dollar, in money, time, or equipment. Most grants are $5,000 or less. Actual amounts depend on the VF A funding allocated to the particular State, which in turn depends on Congressional action.

This strategy will contribute to the overall mitigation strategy of improving public education and communication relative to hazard mitigation issues.

ASSISTANCE TO FIREFIGHTERS GRANTS PROGRAM -FIRE PREVENTION & SAFETY GRANTS

Type of Assistance: Pre-Disaster Grants
Managing Agencies: Local or community organizations, including fire departments, state, regional and national organizations
Funding Source: Dept. of Homeland Security/Office of Domestic Preparedness

This grant program awards grants to national, regional, State, departments) that are recognized for their experience and expertise in fire prevention or safety programs and activities. Private non-profit and public organizations are eligible to apply for funding for these grants. Fire departments that have received or applied for training, equipment, vehicles, etc. under the FY 2004 Assistance to Firefighter Grant Program are eligible to apply for the fire prevention grants in this application period. However, funding to any organization is limited to a $750,000 Federal share per program year.

This strategy will contribute to the overall mitigation strategy of improving public education and communication relative to hazard mitigation issues.

6. State & Local Planning Coordination

6.1 Local Capability Assessment

As mentioned in Section 2, local municipalities have primary authority over land use and development in Rhode Island. In regard to hazard mitigation, local government has the primary role in developing policy, making all land use decisions, establishing annual capitol budgets, and implementing hazard mitigation and floodplain management activities. The following table is an overview of the local departments and/or organizations that have a responsibility in overseeing and/or implementing the local hazard mitigation projects, programs and policies within each community.

The information provided in the tables below represents the extent of knowledge that RIEMA has of local capability as it relates to Hazard Mitigation. Each community may have unique programs, policies and organizations relating to hazard mitigation, however, this agency has no current knowledge of these activities. Once the local hazard mitigation plans have been completed and receive federal approval, the plans will be forwarded to RIEMA for a more comprehensive and extensive review and evaluation.

The information presently available to RIEMA is listed below—*it is not possible at this time to evaluate information that is not available to RIEMA.* However, during the evaluation process of the local hazard mitigation plans local capability will be evaluated, documented and then reported during the process of integrating the local plans into the State Hazard Mitigation Plan (see mitigation action item 2.1.1).

Local Capability Assessment –
Current Programs Supporting Hazard Mitigation
TABLE 6-1

Function	*Description*	*Effect on Loss Reduction*	*Opportunities*
Building Officials	The Building Inspector implements and enforces the RI Building Code which incorporates the NFIP construction criteria. The RI Building Code also includes sections on wind, snow loading, structural loads and seismic retrofitting. The building official also enforces locally adopted ordinances (e.g. zoning and subdivision ordinances)	Ensures that the NFIP standards and other construction standards are consistently applied statewide.	RIEMA continues to provide training opportunities such as the FEMA 2000 Coastal Construction Manual (CCM) which calls for standards much more comprehensive and stricter than the NFIP minimum criteria. So far every local building official in coastal areas department has been trained on the CCM.
Emergency Management	Each RI community has a local Emergency	EMA Directors play a critical role in the	Need to more strongly develop the

Director	Management Director who's primary responsibility is local response and recovery.	development of the Local Emergency Operations Plan and the Hazard Mitigation Plan. Both of these plans address opportunities to minimize loss of life and property damage.	relationship between the local EMA Director, NFIP Coordinator, Building Official and Community Planner in order to leverage assets/resources to strengthen the effectiveness of hazard mitigation
Hazard Mitigation Committee	Established at the onset of the local hazard mitigation planning process. Committee has a diverse representation linking together many community departments and the public and private sectors.	This Committee has the primary responsibility of developing and updating the Local Hazard Mitigation Plan, and identifying potential mitigation projects for funding.	Depending upon the diversity of the Committee and its dedication to the implementation of the mitigation plan, hazard mitigation can be readily implemented in the consideration of all local land use decisions
Local NFIP Coordinators	Each NFIP community has an appointed local NFIP Coordinator who oversees compliance with the NFIP. Flood determinations, mapping issues construction standards within special flood hazard areas are all addressed by the NFIP Coordinator.	Implementation can occur at the local level typically by an official that has the knowledge of local land use and construction issues.	Should develop a stronger relationship between the planning, public works and building departments relative to floodplain management. Should also purse and offer outreach activities regarding good floodplain management practices (e.g. *No Adverse Impact)*
Public Works Departments	The local department of Public Works and/or Water and Sewer Departments, which are primarily responsible for municipal drainage and storm water management systems, take the lead in insuring the communities' compliance with the EPA's Phase II Storm water Regulations.	Because storm water flooding is one of the major flood hazards in Rhode Island, ongoing maintenance and upgrading of local storm water systems by local public works departments is critical to reducing flood risks.	Public works staff is key in implementing local hazard mitigation plans, especially in identifying and implementing local hazard mitigation projects.
Conservation Commissions	The Conservation Commission has primary responsibility for overseeing issues relating to natural resources areas, critical areas of concern (per local comprehensive community comprehensive plans) and other environmentally sensitive areas. Also primary implementers of soil and	Strong advocates for open space acquisition and preserving the natural and beneficial resources of wetlands and other special flood hazard areas. Protection of wetland areas and buffer zones adds additional layer of protection to	All new development and substantial improvement with potential impacts on any river, stream, ponds wetlands or coastal areas must be reviewed by local Conservation Commission who play an important role in

	erosion control ordinances.	promote flood loss protection.	enforcing regulations that minimize flood impacts.
Planning Director/Planning Boards	Per the State Enabling Act, the Planning Board, with the Town Planner, implements local subdivision regulations. The Planning Board responsibilities include recommending land use regulations to protect public health, safety and welfare. The Planning Board is the primary vehicle at the local level that ensures new development and substantial improvements incorporate	The Planner or Planning Board often coordinates with the NFIP Local Coordinator and the Local Hazard Mitigation Committee through the mitigation planning process and the implementation of the plans (particularly when land use is involved). Can provide expertise in grant development and drafting of local ordinances and bylaws.	Planning boards can often bring in more holistic perspectives (i.e. watershed context and longer term issues of a sustainable community).
Town/City Council	Rhode Island cities and towns are governed by Mayors, Town Managers and Administrators, and city/town councils. This body approves subdivision, zoning and land ordinances and bylaws. Also facilitates annual financial town meeting overseeing the local capital improvements budget and plan.	These bodies are comprised of the chief elected officials and provide leadership and approval for local hazard mitigation plans, projects, grants and programs.	Much more education needed concerning the beneficial uses of floodplains, hazard mitigation and other national policies and programs such as ASFPM's No Adverse Impact Initiative.

Compliance with the NFIP

All 39 of Rhode Island's cities and towns are in the NFIP program. The NFIP minimum building and construction criteria and floodplain ordinances are implemented through the local NFIP Coordinators. Each local planning board's responsibilities for NFIP enforcement are part of its larger duty to review and regulate the subdivision of land in the community. The NFIP criteria pertaining to subdivisions require that they be reasonably safe from flooding and that subdivision developers furnish flood data for subdivision proposals above a certain size. Under the State Building Code and local zoning ordinances, applicants who are denied permits for floodplain development can generally apply to the Local Building or Zoning Appeals Board for variances to the floodplains management criteria. The Appeals Board may grant variances on a case-by-case basis provided they comply with the variance guidelines established by the NFIP. *The National Flood Insurance Program Handbook for Rhode Island Communities,* produced by the Office of State Planning, cautions:

> *"In granting variances, however, the Appeals Boards must be aware that they*

are reducing the effectiveness of the NFIP's floodplain management requirements and likely exposing floodplain development to greater flood risks. Beyond the specific land use regulations required for participation in the NFIP, communities have broad discretion to guide development in a manner that will protect the health and safety of their residents and reduce the dangers of floods."

Local Emergency Management Programs

A local Emergency Management Agency (EMA), headed by a director, exists in each city and. town in the state. The Emergency Management Director is primarily responsible for local response and recovery, in addition to overseeing updates and implementation of the local hazard mitigation strategy. The powers and duties of these agencies within their respective jurisdictions are similar to those of the state agency. Local agencies may act jointly with other such agencies. The chief executive officer of each city and town has powers and duties with respect to disaster preparedness within their city or town similar to those of the governor on the state level, not inconsistent with other provisions of law. During a local or state disaster, the head of the local government or the director of the local EMA is to activate a local Emergency Operations Center (EOC), with direct communication link to the state center. Each Rhode Island municipality has an Evacuation Annex as part of its local Emergency Operations Plan (EOP). The Evacuation Annex includes a map of coastal areas (if any) threatened by a hurricane storm surge and wave action flooding. The map shows areas to be evacuated, routes of travel, and shelters.

Developing Local Hazard Mitigation Plans

The Rhode Island Mitigation Program of the State Emergency Management Agency has worked with local jurisdictions to encourage and support local hazard mitigation planning since the recovery efforts after Hurricane Bob in 1991. At that time, every effort was made to address future losses through the reduction of damages to property by integrating ongoing growth management, sustainability and land use management initiatives with hazard mitigation planning. Despite the fact that the state hazard mitigation resources are most likely the scarcest in the country, the RI mitigation program has nonetheless forged ahead of most of the country by mandating that communities develop local hazard mitigation plans (nearly ten years prior to the passing the federal Disaster Mitigation Act 2000) that address land use issues and can be implemented through existing local comprehensive community plans.

Technical assistance to communities has consisted of statewide planning workshops to train locals on how to develop a hazard mitigation plan (prior to DMA 2000) and providing those GIS (Geographical Information Systems) maps of the communities' risks and vulnerabilities. FEMA contractors were hired to facilitate one and two day workshops on how to develop local hazard mitigation plans and how to identify sound hazard mitigation projects. Tabletop exercises were also held with local officials in which a simulated "real time" hurricane and/or flood exercise hit a community and the participants were expected to respond and identify the proper actions to take throughout the response and recovery process. Based on that experience, participants were asked to identify mitigation actions, policies, programs and projects that they would take to lessen the impact of disasters the next time the hazard hit their community.

Other types of technical planning assistance were given to communities and involved assisting them with establishing local hazard mitigation committees to develop their local hazard mitigation plans. These committees were assisted by RIEMA staff when needed and when RIEMA was able. As of February 2005, nine communities have FEMA approved local hazard mitigation plans; the remainder of Rhode Island's 30 communities' plans is in the process of completion and approval.

It is the responsibility of the municipality to initiate the hazard mitigation planning process by sending a "Letter of Intent" to the executive director of RIEMA (see local planning process on following page). It is usually the mayor *or* the town administrator who writes this letter. Currently, RIEMA is providing technical and planning assistance to communities that have submitted a letter of intent through the distribution of PDM funds.

RIEMA requires that prior to a community receiving technical assistance for their local hazard mitigation plan a Local Hazard Mitigation Committee (LHMC) must be established. This committee usually consists of various municipal officials including the planner, emergency management director, NFIP Coordinator, fire chief, engineer, building official, town administrator and public works director, and especially anyone else who may have a role or will be responsible for implementing the strategy. The committee is responsible for identifying the hazards, incorporating public input, developing and prioritizing mitigation actions and implementing and revising the strategy.

Local Hazard Mitigation Projects and Measures

All of Rhode Island's communities are working toward completing their plans and receiving approval from FEMA (see Table 6-7 Status of Local Hazard Mitigation Plans Approved by FEMA). Because of the inopportune timing of local plans and the State plan completion at the same time, it is extremely difficult to review and capture relevant information from all of the 39 local plans and integrate where appropriate into the State plan in order to meet the same deadline as the local plans. Once the local hazard mitigation plans have been completed, they will be reviewed by the State for hazard risk and vulnerability locations, mitigation actions, local capacity assessments, programs, policies and projects. These results will be collected and then integrated into the State Hazard Mitigation Plan. Once this has been accomplished, regional workshops will be held to solicit input from the communities and stakeholders to ensure that the local interests and issues have been accurately represented in the State Hazard Mitigation Plan.

6.2 Local Funding and Technical Assistance

Since 1993, Rhode Island has been providing technical assistance to communities in the manner of assisting in local hazard mitigation planning, training and statewide workshops on hazard mitigation planning for local cities and towns. The first efforts to develop local hazard mitigation plans commenced in 1993 when RIEMA formed a partnership with Rhode Island Sea Grant to develop two prototype hazard mitigation strategies: a coastal community plan and a riverine community plan. Guidance was developed so that other communities could write their local plans and become involved and ultimately integrated into neighboring communities' hazard mitigation process planning efforts and initiatives. Pre-disaster funding from FEMA to local communities for hazard mitigation was not available until Project Impact in 1998. Listed in Table 6-3 below is a breakdown of the Flood Mitigation Assistance Program Grant Funds awarded to Rhode Island communities and the breakdown of funds awarded to communities for the Pre-Disaster Mitigation (PDM) Program grants.

1997-2003 Rhode Island Flood Mitigation Assistance (FMA) Funding of Local Flood Mitigation Projects & Planning Initiatives
Table 6-3

Year of Award	FMA Project Funding	Funded Projects	Funded Plans*
1997	$108,810.00	Charlestown – survey of repetitive losses, hazard mitigation web page, public education to NFIP property owners	Completed Local Hazard Mitigation Strategy for the Town of Charlestown
1997	$12,090.00	N/A	URI EDC – GIS mapping o flood risks and vulnerabilities
1997	$12,200.00	N/A	Assisted Narragansett, Pawtucket in developing Local Hazard Mitigation Plan
TOTAL	**$132,900.00**	**1 project**	
1998	$110,700.00	Pawtucket – flood proofed City Hall which is located on Blackstone River in FEMA A-zone	N/A
1998	$12,200.00	N/A	Printed Local Hazard Mitigation Plans for three communities
1998	$12,300.00	N/A	URI EDC – GIS mapping of flood risks/vulnerabilities
TOTAL	**$135,200.00**	**1 project**	
1999	$113,670.00	Narragansett – storm surge/erosion control in FEMA V-zone for Ocean Road and South	N/A

		Pier Road drainage system	
1999	$12,100.00	N/A	Printed Local Hazard Mitigation Plans for Three communities
1999	$12,300.00	N/A	URI EDC – GIS mapping o flood risks/vulnerabilities
TOTAL	**$138,070.00**	**1 project**	
2000	$12,200.00	N/A	Printed Local Hazard Mitigation Plans for three communities
2000	$12,430.00	N/A	URI EDC – GIS mapping o flood risks/vulnerabilities
2000	No money awarded	No project	N/A
TOTAL	**$24,430.00**	**0 projects**	
2001	$11,940.00	N/A	URI EDC – GIS mapping o flood risks/vulnerabilities
2001	$12,000.00	N/A	Printed Local Hazard Mitigation Plans for three communities
2001	$111,690.00	Westerly – designs for building elevations in FEMA V-zone	N/A
TOTAL	**$135,530.00**		
2002	$11,940.00	N/A	URI EDC – GIS mapping o flood risks/vulnerabilities
2002	$12,000.00	N/A	Printed Local Hazard Mitigation Plans for three communities
2002	$111,690.00	Westerly – Building elevation & dune renourishment in FEMA V zone	N/A
TOTAL	**$135,630.00**	**1 project**	
2003	$11,000.00	Education & training for all communities for CRS & NFIP 101 course	N/A
2003	$11,000.00	N/A	URI EDC – GIS mapping o flood risks/vulnerabilities
2003	$70,580.00	Westerly – Demolish town owned buildings in FEMA V-zone to convert beach to open space	N/A
TOTAL	**$92,580.00**	**1 project**	

(Source: RI State Hazard Mitigation Officer and the RIEMA Fiscal Office)

* FMA Planning grants were awarded to the University of Rhode Island Environmental Data Center (URIEDC) to produce Geographical Information System (GIS) flood risks and vulnerability maps for all of Rhode Island’s cities and towns.

Table 6-4 is a breakdown for fiscal years 2002 and 2003 listing recipients of pre-disaster mitigation grant funding, a brief description of the project, the amount of the federal grant award and local cost match.

2002-2003 Annual Pre-Disaster Mitigation (PDM) Programs Funding for Mitigation Projects & Plans
Table 6-4

Year	Recipient/Description	Federal Funds	Local/ Other Match (25%)	Total
2002	Johnston – Designs and engineering permits	$ 111,690.00	$27,922.50	$139,612.00
2002	Narragansett – retrofitting of wastewater facilities in FEMA A & Z flood zones	$113,000.00	$28,250.00	$141,250.00
2002	URI EDC- GIS risk/vulnerability mapping for 322 Plan	$42,683.00	$10,670.75	$53,353.75
TOTAL		**$274,799.99**	**$68,700**	**$343,498.25**
2003	RIEMA - utilizing HAZUS to complete statewide loss estimation for natural hazards	$33,875.00	$8,468.75	$42,343.75
2003	Funds awarded to all RI communities to complete DMA 2000 local mitigation plan requirements	$5,000 to towns $6,000 to cities Total award $203,000.00	$50,750.00	$253,750.00
2003	RIEMA - public education/training "How to Develop local hazard mitigation plans per DMA 322 planning criteria	$11,500.00	$2,875.00	$14,375.00
TOTAL		**$248,375.00**	**$62,093.75**	**$310,468.75**

(Source: RJ State Hazard Mitigation Officer)

Table 6-5 is a listing of the New England States Emergency Consortium (NESEC) grant awards for the Hurricane Protection Grant Program from 1995 through 1998. During that time, 100% grants (no state or local match required) were given to communities that applied to fund a project that would reduce potential damages and better prepare a community in the event of a hurricane (such as high winds, coastal erosion and storm surge).

1995 -1998 HURRICANE PROTECTION GRANTS AWARDED BY THE NEW ENGLAND STATES EMERGENCY CONSORTIUM (NESEC)
Table 6-5

Recipient/Description of Project	Award Amount (100%)	Date Awarded
Bristol - Hurricane Preparedness Plan	$850.00	3/2/98
Smithfield - Removal of Trees in High Wind Vulnerable Area	$4,150.00	3/2/95
Providence - Repair to interior walls of Fox Point Hurricane Barrier Pump	$5,000.00	3/2/95
Pawtucket - Tree inventory & trimming, vegetation improvements for protection against soil erosion	$5,000.00	3/2/95
North Smithfield - Trailer mounted 10 KW generators		
Barrington - Latham Park Shoreline rebuild	$5,000.00	3/14/96
Cranston - Phase I Soil Erosion Inhibitor	$5,000.00	4/10/97
Charlestown - Road replaced due to Beach Erosion	$10,000.00	9/16/97
Warwick/Cranston -funding for flood warning system for tidal river gauge	$5,000.00	7/16/98
Providence - Fox Point Hurricane Barrier maintenance and repair of shaft line, couplings, bearing and worn gear for river gates	$5,000.00	8/6/98
TOTAL	**$45,000.00**	

Table 6-6 is a listing of the mitigation projects funded from the Hazard Mitigation Grant Program (HMGP)funds Rhode Island received as a result of the Presidential declared disaster Hurricane Bob in 1991. After the HMGP funds were awarded to Rhode Island, 15% of that amount, or $400,000, was used for mitigation purposes. There was a variety of mitigation measures ranging from maintenance and repair of the Fox Point Hurricane Barrier pumps to the purchase of EOC generators and the establishment of public outreach and mitigation programs.

HMGP PROJECTS & PLANNING INITIATIVES FUNDED UNDER HURRICANE BOB
Table 6-6

Project Titles	Amount Awarded	Date
Fox Point Hurricane Barrier – repair & maintenance of Pump 5	$275,000	1993
RI DEM - State Police microwave generator	$15,908	1994
Narragansett Bay Commission -	$24,000	1992

Reservoir Avenue Pump Station Improvements		
Narragansett Bay Commission - Washington Park Pump Station Improvements	$44,000	1993
URI Coastal Resources Center - Integrated hazards mitigation planning initiative	$73,068	1993
URI Coastal Resources Center - Integrated hazards mitigation planning initiative	$35,322	1995
URI Coastal Resources Center - Integrated hazards mitigation planning initiative	$4,500	1997
Woonsocket Water Dam Control	$18,000	1997
Narragansett - Great Island Bridge hydrant installation	$7,500	1997
Barrington - Latham Park Shoreline Erosion Abatement	$12,600	1997
RIEMA Mitigation Planning	$4,072	1999
Smithfield - Installation of weather station equipment at the EOC	$4,718	1998

(Source: R.I. State Hazard Mitigation Officer)

Despite Rhode Island's early efforts to advocate for and provide, when financially possible, technical assistance to communities to implement hazard mitigation, RIEMA was, and still remains, the lowest funded and staffed mitigation program in the country. Since the hazard mitigation efforts began in 1991, RIEMA has had only 1.5 full time staff to implement and provide technical assistance and training, public outreach and workshops and grant administration for not only the mitigation program, but the entire state National Flood Insurance Program (NFIP), in addition to responding to natural and manmade (e.g. Y2K, 911, and Tall Ships) events.

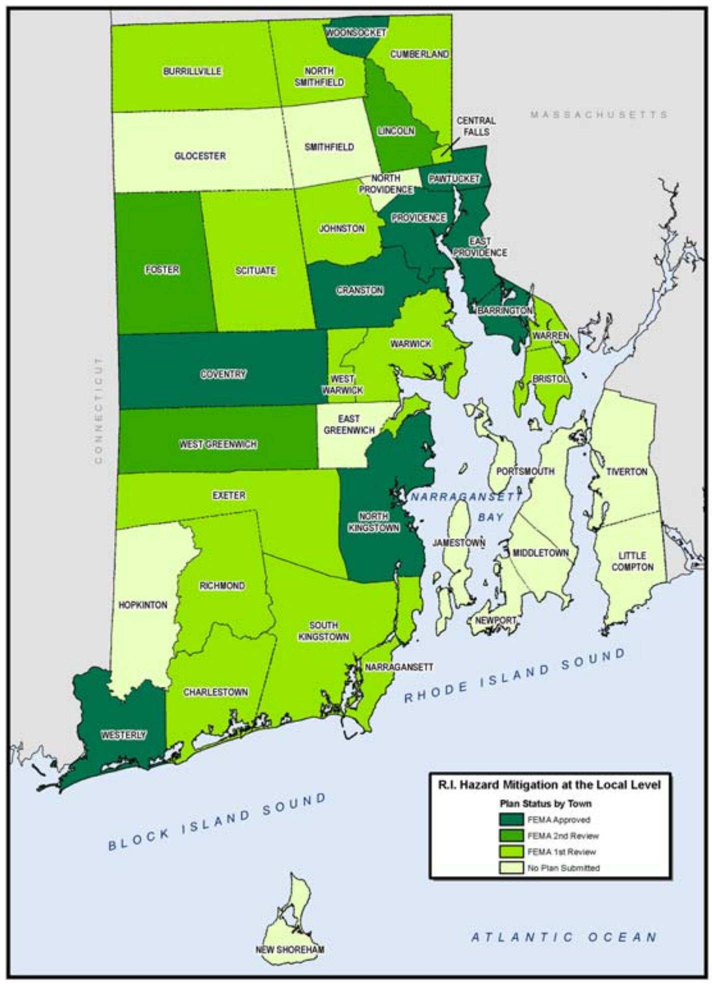
6.3 Local Plan Integration

Process & Timeframe to Coordinate and Integrate Local Hazard Mitigation Plans into the State Hazard Mitigation Plan

The Mitigation Division of the RI Emergency Management Agency (RIEMA) is an on-going effort to foster the development of the State and local hazard mitigation plans. The development of these plans will ensure that hazard mitigation principles become incorporated into the routine activities and day-to-day decision-making of local governments, ultimately decreasing the current and future vulnerability of our communities to all hazards. The initial phase of this initiative began following Hurricane Bob in 1991 with the award of HMGP funds. Under a partnership with the University of Rhode Island's Coastal Resources Center (CRC), a multi-hazard mitigation program was conceived in addition to an outreach program to Rhode Island's communities with the objective of reducing losses from natural disasters. The Coastal Resources Center provided technical assistance that included:

- The identification and analysis of all hazards which threaten the community;
- An assessment of vulnerable properties and populations through the completion of GIS maps;
- An assessment of local capabilities to implement various mitigation programs and policies; and
- The identification and prioritization of feasible mitigation opportunities

RIEMA believes that much of the work in hazard mitigation and sustainable development must be carried out at the local level. It is at the local level where land use decisions are made, growth and development take place, and where the impacts of natural hazards are most direct. The Mitigation Division has always supported local self-sufficiency and reliance, providing assistance to communities where it is needed, but allowing local initiative to take the lead. As noted within this Plan, a major goal of the Mitigation Section is to build and support such local capacity and commitment.



Status of Local Plans Completion
Table 6-6

Community	Status
FEMA Approved Plan	
Barrington	FEMA Approved
Coventry	FEMA Approved
Cranston	FEMA Approved
East Providence	FEMA Approved
North Kingstown	FEMA Approved
Pawtucket	FEMA Approved
Providence	FEMA Approved
Westerly	FEMA Approved
Woonsocket	FEMA Approved
FEMA 2nd Review	
Foster	Need final approval by Town Council
Lincoln	Need final approval by Town Council
West Greeenwich	Need final approval by Town Council
FEMA 1st Review	
Bristol	Incorporating FEMA comments
Burriville	Incorporating FEMA comments
Central Falls	Sent 1st Draft to FEMA Feb. 2005
Charlestown*	Incorporating FEMA comments
Cumberland	Incorporating FEMA comments
Exeter	Incorporating FEMA comments
Johnston	Incorporating FEMA comments
Narragansett*	Incorporating FEMA comments
North Smithfield	Under FEMA review
Richmond	Under FEMA review
Scituate	Under FEMA review
South Kingstown*	Under FEMA review
Warren	Under FEMA review
Warwick	Incorporating FEMA comments
West Warwick	Incorporating FEMA comments
Plan not sent to FEMA yet	
East Greenwich	still working on 1st draft
Glocester	still working on 1st draft
Hopkinton	still working on 1st draft
Jamestown	still working on 1st draft

Little Compton	still working on 1st draft
Middletown	still working on 1st draft
Newport	will send plan to FEMA by Feb. 14, 2005
New Shoreham	still working on 1st draft
North Providence	still working on 1st draft
Portsmouth	still working on 1st draft
Smithfield	still working on 1st draft
Tiverton	still working on 1st draft

* Denotes that the community had completed a local hazard mitigation strategy prior to the 2000 Disaster Mitigation Act, and are updating their plan to incorporate DMA planning criteria for final FEMA approval.

The State Hazard Mitigation Committee will review risk assessments and mitigation strategies of approved local plans when preparing the next edition of the state plan. For the second edition of the State Hazard Mitigation Plan (c. 2007), all 39 local hazard mitigation plans (in particular the risk and vulnerability assessments and the mitigation projects) will be completed and approved. The incorporation of this data will provide more than sufficient information to provide an accurate representation of both the Risk Assessment and the Mitigation Strategy of the State Plan.

Once the local comprehensive plans have been completed, they will be reviewed by the State for areas of hazards risks and vulnerability, mitigation actions, programs, policies and projects. These results will be collected and then integrated into the State Hazard Mitigation Plan. Once this has been accomplished, regional workshops will be held to solicit input from the communities and stakeholders to ensure that the local interests and issues have been accurately represented in the State Hazard Mitigation Plan.

6.4 Prioritizing Local Assistance

The process used by the state of Rhode Island to review, evaluate and select projects for the various mitigation grant programs is based on years of public participation and supports the state’s home-rule form of government. Home rule provides that government at the lowest-possible level is the one best prepared to make decisions that affect it the most - including hazard mitigation projects.

Rhode Island’s concept is to support all local mitigation efforts. Typically, hazard mitigation funds following a disaster are available to all eligible agencies and organizations statewide for projects that reduce the risk of future damage, regardless of the hazard being addressed (i.e., funds available following an hurricane disaster can address problems presented by other hazards).

Occasionally, when mitigation funds are limited, grants can be restricted to specific areas of the state or address specific hazards. This has occurred as a result of FEMA’s national initiative to award flood mitigation money to repetitive loss properties. Through this initiative, project funds from the Flood Mitigation Assistance Program must be awarded to repetitive loss properties. The state's Flood Mitigation Assistance Program (FMAP) uses a competitive system to evaluate and recommend for funding only the most environmentally sound and cost-effective projects. Projects recommended for funding are those that best document their ability to reduce future impacts of natural disasters as well as demonstrate cost-effectiveness through a benefit-cost review.

Potential projects are evaluated using a scoring process emphasizing protection of life and property, reduction of risk, and cost-effectiveness. Two cost-benefit workshops have been held and it is expected that they will continue to be held on an annual basis prior to each grant funding cycle. Staff from the Mitigation Division work with each potential grant applicant to ensure that proposed projects provide as great a public benefit as possible.

Criteria for the Prioritization of Mitigation Grants

In evaluating hazard mitigation applications for grant funding, the State Hazard Mitigation Committee uses a scoring system to prioritize projects according to both federal eligibility criteria and the state eligibility criteria as published in the grant application guidance. For each round of grant funding, the committee reviews the applications.

When prioritizing grant applications, the seriousness of risk is emphasized when considering an applicant's response to the following federal and state eligibility criteria. Among the criteria receiving greatest weight in scoring are those dealing with reduction of risk posed by hazards, prevention of repetitive losses, and protection of critical areas including frequently flooded areas and geologically hazardous areas. The state criteria used for prioritizing local eligible projects for pre-disaster and post-disaster hazard mitigation funding in Rhode Island requires that the project:

1) Must be in conformance with a FEMA-approved local hazard mitigation strategy which meets the DMA 2000 planning criteria

2) Must be in conformance with the Rhode Island State Hazard Mitigation Plan developed as a requirement of the Disaster Mitigation Act of 2000. Rhode Island places a priority on local mitigation projects that involve: non-structural solutions; retrofitting high risk structures, and the acquisition of repetitive loss flood-damaged properties.

3) Must be located in, or have beneficial impact upon, past declared disaster areas or in a high risk area for potential impacts from one or more natural hazards, such as flood-plain, high wind area or coastal zone, etc. This high risk area should be identified in either the local or state mitigation plan.

4) Must be in compliance with all existing Rhode Island laws and regulations for construction, land alterations, and natural resource protection such as the Rhode

Island State Building Code, the Coastal Resources Management Plan and the Wetlands Protection Act.

5) Must be in compliance with municipal ordinances and zoning regulations.

6) Must be in conformance with 44 CFR, Part 9, Floodplain Management and Protection of Wetlands, and 44 CFR, Part 10, Environmental Considerations.

7) Must provide a solution to a problem independently, or provide a significant functional portion of a solution being addressed in a combined project. If a project constitutes a significant functional portion of a solution being addressed, the status of any associated dependent or supporting projects must be given. There must be a reasonable assurance that the total mitigation project will be completed within the allowable performance period per the grant guidance. The identification or analysis of a problem does not automatically qualify for eligibility.

8) Must meet FEMA's cost-effective criteria such as the need to substantially reduce the risk of future damage, hardship, or losses resulting from a major disaster. Documentation will be required that demonstrates:

a. The problem is repetitive and/or poses a significant risk if left unsolved. Therefore, a brief history of previous occurrences of the problem at the project location, including dates and impact of each event, and/or analysis of projected potential damages if the project is not completed must be given.

b. Sufficient information to allow comparison of the cost of the project with the anticipated value of future direct damage reduction or negative impacts to the area.

c. Documentation comparing the proposed project to alternatives considered, including non-structural approaches.

d. The proposal has been determined to be the most practical, effective, and environmentally sound alternative found after consideration of all available options.

e. The project contributes to the long-term solution of the problem it addresses. Therefore, an estimate of the effective life of the project and a listing of influence factors should be included.

f. Development of the project considers any long-range alternatives to the area and the entities that it protects, has future maintenance requirements that are financially feasible and can be modified, if necessary, without changing the impact on the area.

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7. Plan Maintenance Process

7.1 Monitoring, Evaluating and Updating this Plan

The Rhode Island State Hazard Mitigation Plan is a living document which will be reviewed, updated and adopted by state officials and submitted to FEMA for approval every three years. Per the Rhode Island State Hazard Mitigation Strategy outlined in this plan, the plan will be revised more frequently as local plans are completed and if conditions under which the plan was developed change, such as a major disaster or a new or revised state policy.

This section describes the process through which this plan will be updated. Federal hazard mitigation planning regulations (44 CFR 201.4) require the state plan to be reviewed, revised and submitted for approval to the Regional Director of FEMA every three years. The regulations require a plan maintenance process that includes an established method and schedule for monitoring, evaluating and updating the plan; a system for monitoring implementation of mitigation measures and project closeouts; and a system for reviewing progress on achieving goals as well as activities and projects identified in the Mitigation Strategy.

Plan Maintenance Process

The State Hazard Mitigation Committee is responsible for developing and maintaining the Rhode Island State Hazard Mitigation Plan. The team's State Hazard Mitigation Officer is the individual responsible for overseeing this work. Additional participants in the plan maintenance process include the following:

- Representatives of local jurisdictions whose hazard mitigation plans were used in the development of the multi-jurisdictional plans, or who developed a "stand alone" local plan

- Representatives from the Water Resources Board, who have developed a State Drought Management Plan

- Representatives from the Department of Environmental Management who have developed a State Wildfire Plan

The state plan review will take place in three ways:

- Annually for progress made on mitigation actions and projects identified in the Mitigation Strategy of the state plan in Sections 5.3 and 5.4.

- After each major disaster in Rhode Island declared by the president, to look for areas where the state plan should be refocused due to the impact of the disaster.

- Every three years, before submission to FEMA for approval per federal regulations.

7.2 Monitoring Progress of Mitigation Activities

Annual Progress Evaluation

The purpose of the annual evaluation is to gauge the progress of mitigation activities as well as to evaluate any changed conditions that may affect hazard mitigation planning and implementation in Rhode Island. The state plan will be reviewed annually to reflect significant policy changes that took place during the preceding year and to report on the progress made on funded hazard mitigation projects statewide. Based on FEMA approving the Rhode Island State Hazard Mitigation Plan in May 2005, this annual review will take place at the end of the calendar year. Review on the progress implementing the actions and measures identified in the state plan will occur at this time.

Once a year, the State Hazard Mitigation Committee and other participants will:

- Evaluate, revise and update the state plan's Risk and Vulnerability Assessment as necessary to incorporate any changes and/or updates. This will include a review and update of hazard profiles and data on vulnerable state facilities.
- Examine progress on mitigation actins and projects in the State Mitigation Strategy, especially progress on the multi-jurisdictional and local plans.
- Identify any implementation problems (financial, technical, political and legal)
- Recommend how to solve such problems and to increase involvement of state agencies, local jurisdictions and the private sector in hazard mitigation planning
- Monitor, revise and update the State Capability Assessment and the Mitigation Strategy in Section 5 to reflect major changes in Statewide policies, priorities, programs and funding.
- Will monitor the progress toward achieving identified hazard mitigation goals

Post Disaster Review

After each Presidential disaster declaration and in coordination with FEMA, the State Hazard Mitigation Committee will assist in documenting the effects of the disaster and convene a meeting of all the state planning participants in Section 7.1. The purpose of this meeting is to share observations and data related to the disaster and to review specific hazard mitigation needs of the disaster affected area. This will allow for the development of hazard mitigation recommendations to FEMA during the disaster operation as well as to update the State Hazard Mitigation Strategy as needed. This post-disaster review may replace an annual review in any year a major disaster occurs, depending on the disaster event's severity and time of year.

Three-Year Plan Review and Revision

The State Hazard Mitigation Team will facilitate the review and revision of the Rhode Island State Hazard Mitigation Plan every three years. The review and revision will begin approximately 9 to 12 months before FEMA approval is required. Review and revision will involve the State Hazard Mitigation Committee and the other planning participants, especially the local communities that have completed local hazard mitigation plans. This process will incorporate all of the revisions made during the annual plan review, especially new data obtained from the local hazard mitigation plans. As these plans are completed per the timeline chart in Section 6.3, the new information relative to hazard identification and risk assessment will be incorporated into the three year update.

The State Hazard Mitigation Committee and other planning partners will:

- Monitor and revise the Hazard Identification and Risk Assessment section, in order to remain current, comprehensive and accurate. New data from the completed local plans will be vital to updating these sections of the state plan.

- Monitor the progress on and determine the effectiveness of the mitigation strategies and actions outlined in the State Mitigation Plan and in the local plans, and determine how the performance of such recommendations will influence the State Mitigation Plan. It is anticipated that local governments, pending available funding, will review and revise their plans and annexes using the processes that they have identified and described in the in plans and annexes.

- Monitor the effectiveness of funded, local mitigation projects (see following section on monitoring plans and projects) and determine how the performance of those projects should influence the State Mitigation Plan.

- Monitor the overall implementation of the state plan, identify problems (financial, technical, political and legal), and develop recommendations to overcome them.

- Recommend ways to increase participation by state agencies and local jurisdictions in the hazard mitigation planning process.

- Recommend any necessary revisions to the Risk Assessment and to the State Mitigation Plan to reflect changes in federal and state policies, priorities, programs and funding, and incorporating new information following major disaster events.

- Following review and revision of the state plan, participants will analyze the plan maintenance process and the project monitoring process, and make appropriate changes to improve these processes.

7.3 Monitoring Plans & Projects Implementation and Closeouts

RIEMA has an outdated Grant Administration Plan that was located as an annex in the back of an old outdated Emergency Operations Plan. A critical mitigation action will be included for RIEMA to develop a system of monitoring hazard mitigation implementation activities and measures, in addition to project closeouts and a system for monitoring progress on achieving goals as well as activities and projects as identified in the State Mitigation Strategy (see Mitigation Action Item 1.1.12).

In addition to the monitoring activities of the State Hazard Mitigation Committee, the State Hazard Mitigation Team will monitor the progress of local hazard mitigation plans and projects through the following activities:

- Bi-annual reports
- Site visits/Community Assistance Visits (CAVs)
- Phone calls/Community Assistance Contacts (CACs)
- Meetings/Workshops
- Questionnaire
- Mitigation Project Tracking System and Database
- Quarterly Reports
- State Grants Administrative Plan

Monitoring Program for Mitigation Projects
Table 7-1

Mitigation Projects Monitoring Activity	Who	Responsibility	Timeframe
Site Visits	RIEMA, RI NFIP, members of the State Hazard Mitigation Committee	To evaluate the potential project, to monitor progress, and to ensure that the contracted work has been done	Before a grant is awarded, during construction, and upon completion of a project
Questionnaire	RIEMA, RI NFIP, grant recipients	Send out a questionnaire to participating communities to determine and document progress on the mitigation planning progress as well as the mitigation project and gather information to evaluate successes/area of needed improvement	Annually beginning in 2005 following completion and approval of several local hazard mitigation plans.
Quarterly Reports	RIEMA Fiscal/grants office	Each recipient of a mitigation grant must file quarterly reports with the State	Quarterly
Mitigation Project Tracking System &	RIEMA fiscal grants office, RI NFIP, State Hazard	Review current mitigation grant and project guidelines and make updates as	Immediate upon Plan approval by FEMA

Database	Mitigation Officer	appropriate, especially as federal regulations are updated	
State Grant Administration Plan	RIEMA fiscal/grants office, RI NFIP, State Hazard Mitigation Officer	Review current mitigation grant and project guidelines and make updates as appropriate, especially as federal regulations are updated	Must be updated after every disaster declaration or every three years

Comments and More Information

Any comments, questions, corrections or suggestions concerning any part of this Plan should be addressed to:

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