

2014 UPDATE

City of Cranston, RI



MULTI-HAZARD MITIGATION STRATEGY



CDR MAGUIRE

Acknowledgements

The City of Cranston commends the efforts of its Hazard Mitigation Committee in completing this important plan. The effort is sure to result in the protection of life and property and special thanks are extended to Committee members:

Peter Lapolla – Planning Director, Cranston Department of Planning and National Flood Insurance Program Coordinator; Hazard Mitigation Committee Chair

Mario Aceto- Cranston Councilman

Stephen Boyle- Cranston Chamber of Commerce

Lawrence DiBoni - Director, Cranston Department of Economic Development

Ed Greene- Sage Business Solutions

Hy Goldman- Greylawn Food Corporation

Kenneth Mason- Director, Cranston Public Works

William McKenna- Chief, Cranston Fire Department and Emergency Management Agency

Marco Palumbo- Cranston Police

Jason Pezzulo- Cranston Planning

Stanley Pikul – Director of Building Inspections, Cranston

In addition the City also recognizes the contribution of the Cranston Tax Assessors Office, Planning Department, School Department, Recreation Department, Historic District Commission, Engineering Division, Harbormaster and Housing Authority; the United States Department of Agriculture Natural Resource Conservation Service; the American Red Cross; Narragansett Electric; Veolia Water; the Providence Water Supply Board; Cox Communications; and Verizon Telecommunications for assisting with the compilation of facilities inventories and in reviewing proposed mitigation actions.

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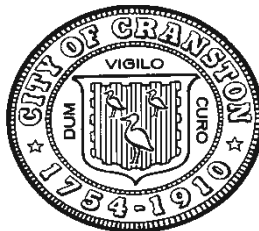
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Executive Summary

This Hazard Mitigation Plan (HMP) is a product of the Cranston Hazard Mitigation Committee (CHMC). It has been approved by the Cranston City Council, the Rhode Island Emergency Management Agency, and the Federal Emergency Management Agency in accordance with the Disaster Mitigation Act of 2000.

Its overview of past natural hazard occurrences verifies that the area is vulnerable to diverse events including blizzards, floods and even tornados. The discussion puts the likelihood of these events into historical perspective and recognizes that although the probability of thunderstorm, high wind and lightning events may be higher; the intensity and potential impacts from less likely events such as hurricanes and earthquakes can be far greater.

The risk assessment portion of the plan confirms that the City has much to lose from these events. Total vulnerabilities are conservatively estimated at \$1,044,441,740 in property damages with potential risks to each of the City's 80,529 residents. More specifically, the four highest ranking risks identified include flood prone drainage systems (\$ 599,862,240 estimated property damage with an at-risk population of 7,727, potential dam failures, and damage to adult care and sewerage treatment facilities. Those classified as medium risks include the, high density residential developments, electrical substations and critical municipal response facilities. Those facilities classified as lower risks include the State concerns at the Pastore Center, Western Cranston Water District, Tennessee Gas Pipeline, recreational facilities, schools, marinas and private mooring facilities and historical resources.

To address these risks the 2014 HMP put forth a clear mission, a distinct set of goals and 25 specific mitigation actions. As part of this update, the CHMC reviewed each mitigation action with regards to activities completed to date and with regards to if the mitigation actions identified in the 2010 HMP should be carried forward into the 2014 HMP. The City's hazard mitigation mission is to protect and enhance the quality of life, property and resources by identifying areas at risk and implementing appropriate mitigation actions. The specific goals include upgrading infrastructure, protecting property, integrating planning and management approaches, strengthening regulatory control, improving response effectiveness and raising awareness of hazard mitigation benefits and procedures. Each of the subsequent mitigation actions for achieving these goals summarizes specific problems and possible solutions, details the primary tasks to be undertaken, identifies an appropriate lead and anticipates funding concerns.

In reviewing the 2010 HMP, the CHMC found that

- 4 of the 17 mitigation actions have been completed: Pump Station Flood Proofing, Flood Proofing of Peters School, Bridge Retrofitting and Repair, and CHMP Evaluation and Update.
- 10 of the 17 mitigation actions have been partially completed or are underway: Pocasset River Flood Improvements, WCWD Service Loop, Sewage Infiltration and Inflow Analysis, Tree-Trimming Program, Acquisition/Mitigation Program, Debris Management Plan, NFIP Community Rating System, and Small Business Outreach Program.
- Two mitigation actions are no longer necessary and will be removed in the next plan update: Long Term Disaster Mitigation Plan and ARC Shelter Capacity
- Two mitigation actions: Meshanticut Brook Flooding Improvement and Repetitive Loss Strategy have not been started yet.
- One mitigation action, Hazard Mitigation Coordinator was marked as completed in 2010 but circumstances have changed and the 2014 CHMC has decided that this action does not need to be carried forward.

Table of Contents

CHAPTER 1: INTRODUCTION	1
1.1 PLAN PURPOSE.....	1
1.2 HAZARD MITIGATION AND ITS BENEFITS	1
1.3 CRANSTON HAZARD MITIGATION COMMITTEE.....	2
1.4 THE PLANNING PROCESS	2
1.5 BACKGROUND	3
CHAPTER 2: NATURAL HAZARDS.....	5
2.1 HAZARDS OF CONCERN	5
2.1.1 Flood Related Hazards	5
2.1.2 Winter Related Hazards	10
2.1.3 Hurricanes.....	13
2.1.4 Wind, Lightning and Hail Storms.....	15
2.1.5 Tornadoes	18
2.1.6 Geologic Related Hazards: Earthquakes	19
2.1.7 Coastal Erosion.....	20
2.1.8 Wildfire and Drought	20
2.2 LIKELIHOOD OF FUTURE EVENTS.....	21
CHAPTER 3: RISK ASSESSMENT	22
3.1 FACILITIES INVENTORY	22
3.2 HAZARD MITIGATION MAPPING	22
3.3 FISCAL IMPACT ANALYSIS.....	22
3.4 POPULATION IMPACT ANALYSIS	25
3.5 LEVEL OF RISK DETERMINATION	26
3.6 VULNERABILITY OF FUTURE STRUCTURES	27
3.7 RISK ASSESSMENT MATRIX	28
CHAPTER 4: PROGRAMMATIC CAPABILITY ASSESSMENT.....	30
4.1 PURPOSE.....	30
4.2 PRIMARY PROGRAMS.....	30
4.2.1 Cranston Comprehensive Plan	30
4.2.2 Cranston Waterfront Storm Preparedness Plan.....	30
4.2.3 Subdivision and Land Development Regulations	30
4.2.4 Cranston Flood Hazard District	30
4.2.5 Rhode Island State Building Code.....	31
4.2.6 Cranston Emergency Operations Plan (EOP).....	31
4.2.7 Cranston Public Education Program	31
4.2.8 Rhode Island State Dam Safety Program	31
4.2.9 National Flood Insurance Program (NFIP): Community Rating System (CRS)	31
4.2.10 The Pocasset River Flood Plain Study and Management Plan	32
4.2.11 The Meshanticut Brook Flood Plain Management Study: Cranston and Warwick, RI	32
4.3 OTHER RESOURCES.....	32
CHAPTER 5: IDENTIFICATION OF MITIGATION ACTIONS	35
5.1 MISSION STATEMENT.....	35
5.2 MITIGATION GOALS.....	35
5.3 IDENTIFIED ACTIONS AND OBJECTIVES	35
5.3.1 Infrastructure Improvement and Property Protection	35

5.3.2. Planning and Management	45
5.3.3. Preparedness to Reduce Losses.....	49
5.3.4. Education and Training.....	50
CHAPTER 6: IMPLEMENTATION ELEMENT.....	53
6.1 PRIORITIZATION OF MITIGATION ACTIONS.....	53
6.2 EVALUATION AND REVISION	54
6.2.1. Monitoring, Evaluating and Updating the Plan	54
6.2.2. Continued Public Involvement	54
CHAPTER 7: PUBLIC INPUT AND ADOPTION PROCESSES	55
7.1 SUMMARY	55
 Appendices	
A. Critical Municipal Facilities.....	56
B. School Inventory.....	57
C. Bridge and Culvert Inventory.....	58
D. Historic Properties Inventory.....	61
E. Child Day Care Facilities Inventory.....	62
F. Dam Inventory	63
G. Technical and Financial Assistance for Mitigation.....	64
H. Existing Protection Systems.....	67
I. Financing Options.....	69
J. Public Adoption Documentation.....	73
 Endnotes.....	 74

[Carissa to add list of figures]

Chapter 1: Introduction

1.1 Plan Purpose

The purpose of the City of Cranston Hazard Mitigation Plan (Plan) is to create a comprehensive review of Cranston's existing capabilities, vulnerabilities, risks, and mitigation actions, before a disaster occurs. This plan was constructed using input from a variety of municipal and private stakeholders and the general public involved in the planning process. This plan serves as guidance to help the City reduce their losses and vulnerabilities relating to floods, winter storms, hurricanes, wind, lightning, and hail, tornadoes, earthquakes, coastal erosion, wildfire, and drought.

1.2 Hazard Mitigation and its Benefits

Hazard mitigation planning is advance action taken to identify specific areas that are vulnerable to natural and man-made hazards within a city, and seeks to permanently reduce or eliminate the long-term risk to human life and property. It coordinates available resources and identifies community policies, actions, and tools for implementation that will reduce risk and the potential for future losses citywide. The process of natural hazard mitigation planning sets clear goals, identifies appropriate actions, and produces an effective mitigation strategy that can be updated and revised to keep the plan current.

States and communities across the country are slowly, but increasingly, realizing that simply responding to natural disasters, without addressing ways to minimize their potential effect, is no longer an adequate role for government. Striving to prevent unnecessary damage from natural disasters through proactive planning that characterizes the hazard, assesses the community's vulnerability, and designs appropriate land-use policies and building code requirements is a more effective and fiscally sound approach to achieving public safety goals related to natural hazards.¹

In the past, federal legislation has provided funding for disaster relief, recovery, and some hazard mitigation planning. The Disaster Mitigation Act of 2000 (DMA 2000) is the latest federal legislation to improve this planning process. It reinforces the importance of natural hazard mitigation planning and establishes a pre-disaster hazard mitigation program and new requirements for the national post-disaster Hazard Mitigation Grant Program (HMGP). Section 322 of the Act specifically addresses mitigation planning at the state and municipal levels of government. It identifies new requirements that allow HMGP funds to be used for planning activities. As a result of this Act, states and communities must now have an approved natural hazard mitigation plan in place prior to receiving post-disaster HMGP funds.² In the event of a natural disaster; municipalities that do not have an approved natural hazard mitigation plan will not be eligible to receive post-disaster HMGP funding.

The City of Cranston also recognizes the important benefits associated with hazard mitigation, its interaction with municipal land use and infrastructure planning, and the need for a comprehensive planning approach, which accommodates these interdependencies. The City's current comprehensive plan addresses land use, housing, economic development, natural resources, services and facilities, open space and recreation. While the entire hazard mitigation plan will not be formally incorporated into the Comprehensive Plan, certain, applicable mitigation actions will be incorporated. The City recognizes coordination between the HMP and the Comprehensive Plan to be of benefit because it will ensure a unified planning approach into the future and ensure that risk reduction remains a critical element of municipal planning.

A second benefit of hazard mitigation allows for a careful selection of risk reduction actions through an enhanced collaborative network of stakeholders whose interests might be affected by hazard losses. Working side by side with this broad range of stakeholders can forge partnerships that pool skills, expertise, and experience to achieve a common goal. Proceeding in this manner will help the City ensure that the most appropriate and equitable mitigation projects are undertaken.³

A third benefit of hazard mitigation would be endorsing a proactive planning approach focused on sustainability, whereby the City of Cranston could minimize the social and economic hardships that have resulted from the occurrence of previous natural disasters. These social and economic hardships include: the loss of life, destruction of property, interruption of jobs, damage to businesses, and the loss of

historically significant structures and facilities. This proactive planning approach would look for ways to combine policies, programs, and design solutions to bring about multiple objectives and seek to address and integrate social and environmental concerns. Linking sustainability and loss reduction to other goals can provide a framework within the state and local governments that will bring the comprehensive planning process full circle.⁴

Lastly, the participation in a hazard mitigation planning process will establish funding priorities. The formal adoption and implementation of this plan will allow the City of Cranston and its residents to become more involved in several programs offered by the Federal Emergency Management Agency (FEMA) including: the Community Rating System Program (CRS); the Pre-Disaster Flood Mitigation Assistance Program (FMA); and the Hazard Mitigation Grant Program (HMGP). Money spent today on preventative measures can significantly reduce the cost of post-disaster cleanup tomorrow.

1.3 Cranston Hazard Mitigation Committee

This Hazard Mitigation Plan (HMP) is a product of the Cranston Hazard Mitigation Committee (CHMC). Committee members included:

Peter Lapolla – Planning Director, Cranston Department of Planning and National Flood Insurance Program Coordinator; Hazard Mitigation Committee Chair

Mario Aceto- Cranston Councilman

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In addition, the CHMC benefited from previous contributions of the Cranston Tax Assessors Office, Planning Department, School Department, Recreation Department, Historic District Commission, Engineering Division, Harbormaster and Housing Authority; the United States Department of Agriculture Natural Resource Conservation Service; the American Red Cross; Narragansett Electric; Veolia Water; the Providence Water Supply Board; Cox Communications; and Verizon as well as from the Rhode Island Emergency Management Agency and the Federal Emergency Management Agency. These entities were not only instrumental in inventorying pertinent facilities and in identifying risks but also in reviewing proposed mitigation actions and implementation plans.

1.4 The Planning Process

This update of the 2014 HMP is the result of a seven step process. It was initiated on September 16, 2013 with the establishment of the CHMC by the City Mayor and the dedication of technical support staff from the City's Planning Department. Step two started the plan update process and included the first meeting of the CHMC on November 22, 2013 which focused on re-ranking hazards and discussing the process for updating the plan. The resulting process is summarized below for convenience and detailed procedural methodologies are presented within the plan's respective chapters. (See Chapter 7 for a more detailed description of both the planning and the public participation process by which the 2014 update of the HMP was completed.)

Step three began with the CHMC reviewing the hazards of concerns identified in the 2010 HMP on December 18, 2013 documenting their historical occurrences and reassessing the likelihood of future events as set forth in the plan. Follow-up meetings of the CHMC were held to finalize its review which is presented in Chapter Two.

Step four involved the review of the assessment of risk identified in the 2010 HMP and which was undertaken through two meetings of the CHMC designed to identify those elements of concern within the City. On December 18, 2013 and January 29, 2014 the CHMC reviewed and updated detailed facility

inventories, mapped the concerns, generated fiscal and population impact analyses, determined the level of risk and produced a draft risk assessment matrix.

Step five entailed the CHMC reviewing and adjusting the 2010 HMP hazard mitigation mission statement, specific mitigation goals and individual mitigation actions. As above, a CHMC brainstorming session was used to provide a starting point for the CHMC's efforts. Follow-up meetings of the CHMC were then held to review the drafts and finalize the content of Chapters Four and Five.

Step six focused on the prioritization of the mitigation actions and the development of the implementation, evaluation and revision schedule. This prioritization was completed through individual review of the draft actions and updating the 2014 HMP.

Step seven furthered the public input and review process with the submittal of complete first drafts to the Rhode Island and Federal Emergency Management Agencies and presentation to the City Planning Commission and the general public for review and comment. The CHMC then held their last meeting, finalized the plan and completed the municipal adoption process as documented in Chapter seven.

1.5 Background

The City of Cranston is located on the western shore of the Providence River, just north of the head of Narragansett Bay. The City is directly south of the Capital City of Providence and north of the City of Warwick (see map 1). In 2010 U.S. Census American Community Survey set the city's population at 80,387 a figure which ranks it as the third largest in the state behind the Cities of Warwick and Providence respectively. The City's 39 square miles of area are primarily drained by the Pocasset River and the Pawtuxet River.

The development pattern of the City is distinctive in that it is densely developed in an urban fashion in the east and gradually transitions to a suburban nature and ultimately to a rural state as one heads west. Land use within the city is approximately 34% residential, 8% industrial, 4% commercial, 6% agricultural, 4 % recreational, 11 % transportation, 20% forested or vacant, with the remaining 13% classified as other uses. Between 1990 and 2008, the City's residential development grew at an average rate of 0.36% per year. Between 1990 and 2008, a total of 1960 new housing units were constructed for an average rate of 109 units per year.

Map 1: State of Rhode Island Map



Chapter 2: Natural Hazards

This history of natural hazard events verifies that the area is vulnerable to diverse events including blizzards, floods and even tornadoes. The discussion puts the likelihood of these events into historical perspective and recognizes that although the probability of wildfires, thunderstorm, high wind and lightning events may be higher; the intensity and potential impacts from less likely events such as hurricanes and earthquakes can be far greater.

The primary sources of data researched to identify occurrences of natural hazard events in Cranston were the United States Geological Survey (USGS) Earthquake Hazards Program (<http://neic.usgs.gov>), the National Climatic Data Center within the National Oceanic Atmospheric Administration (NCDC-NOAA) (<http://www.ncdc.noaa.gov/stormevents/> the 1998 Journal-Bulletin: Rhode Island Almanac, and the Taunton, MA, National Weather Service Forecast Office. The parameters and description of particular events are limited to the availability of information contained in the aforementioned sources.

2.1 Hazards of Concern

2.1.1 Flood Related Hazards

As recent history has shown, the biggest natural threat to Cranston is flooding. For the purpose of this plan, flooding related hazards include riverine flooding, flash floods, urban flooding, coastal flooding, flooding related to climate change and sea level rise, coastal erosion, and dam breaches. Flooding occurs in Cranston because of high storm surges along the coast and excessive runoff from the Pawtuxet River Watershed, which covers an area of 80.9 sq. miles. The excessive runoff is a result of heavy rainfall or in combination with snowmelt. Two flood control structures that lie outside of the City of Cranston are the Flat River Reservoir in Coventry, and the Scituate Reservoir and Pawtuxet River Dam in Scituate. In addition, according to the Rhode Island Department of Environmental Management Dam Safety Program, there are a total of 23 dams within the City, 5 of which are high hazard dams. The high hazard dams in Cranston are: the Cranston Print Works Pond, Clarke's Pond Upper, Curran Lower Reservoir, Curran Upper Reservoir, and Stone Pond. All dams are shown in Appendix F.

The flood during week of March 28, 2010, is considered the flood of record for the main channel of the Pawtuxet River since the construction of the Scituate Reservoir. The flooding that occurred originated from a series of rain events that culminated with 6 to 9 inches of rainfall over the Pawtuxet River Basin on March 29, 2010. Peak discharge within Pawtuxet was approximately 10,400 cubic feet per second (cfs) and flood evaluations reached 11.79 feet above the 9 foot flood stage (20.79 feet in total). While stream gauge data are not currently available for the Pocasset River and Meshanticut Brook, the March, the 2010 flooding event was also the record flood event for both bodies. The March, 2010 flooding affected properties along Meshanticut Brook, along the Pocasset River (especially at Fordson Avenue and south of Reservoir Avenue in the flood plain near Blackmore Pond) and along the Pawtuxet River main stem (especially in the Perkins Avenue neighborhood). During this flood event, the Natick Avenue, Elmwood Avenue and Warwick Avenue bridges were all impacted resulting in their closure.

Flood prone areas on Furnace Hill Brook include the area between the State Route 37 (westbound exit ramp) to Interstate Route 295 and Natick Avenue, and the area immediately downstream of the Phenix Avenue Bridge and downstream of the Pippin Orchard Road Bridge.⁶

Lastly, the City does participate in the NFIP, as do all the communities in Rhode Island. Currently there are 593 NFIP policies in Cranston (both residential and commercial). 391 of which are for structures in the high velocity V-Zone and 8 of which are in the less hazardous A-Zone. The total annual premiums on the 593 properties are \$884,222, providing a total of \$145,090,700 in flood insurance coverage. Since Cranston adopted its flood maps in 1978, there have been a total of 491 claims totaling \$15,057,995. Of the 563 policies held by Cranston property owners, 79 of these properties are classified as repetitive loss with 57 properties located within an A-Zone, 1 within a V-Zone and 21 within B, C or X Zones. A repetitive

loss property is defined as a property that has experienced two or more insurance claims of at least \$1,000 due to natural hazards over a period of ten years.⁷ To date, there are 79 Repetitive Loss properties in the City of Cranston. 18 of the properties have been mitigated through voluntary acquisition and demolition. Lastly, it is important to note that the City of Cranston has 73 Letters of Map Amendments (LOMA) on file. The breakdown of the flood sources for these amendments are the following: Meshanticut Brook (41), Pocasset River (12), Randall Pond (17), Pawtuxet River (1) Furnace Brook (1) and Providence River (1) Pond (1). Table 2 highlights the most recent flooding events that have affected the City of Cranston.

The CHMC has reviewed this section and has determined that the hazards identified in the 2010 HMP Plan still pose a significant threat to the both the residents and property in Cranston and that the 2014 HMP update needs to document flood events that occurred since 2010. The CHMC further finds that hazards from flooding may increase over time as global warming will contribute to an increase in both the intensity and frequency of storm events.

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Table 1: Recent Flooding Events in Cranston

Date	Type	Comments
04/01/93	Flash Flood	Pawtuxet River was reported flooding onto Woodbury Road, Marine and Wellington Avenues.
04/02/93	Flash Flood	The Pawtuxet River flooded again along Woodbury Road.
11/17/96	Flood	A 5.5' Providence Water Supply Board main ruptured on Oaklawn Avenue. Water from the ruptured main carved a 15' hole in Oakland Avenue, caused a utility outages and the evacuation of a nearby apartment complex and an assisted living facility.
01/24/98	Flood	In Cranston, the Pocasset River overflowed its banks, flooding a local road with 2' of water between 7:00 am and 9:00 am.
03/10/98	Flood	In Cranston, 3.60" of rain fell. Urban street flooding was quite serious. Many roads had to be closed due to flooding for periods varying from a few hours up to 12 to 24 hrs.
06/14/98	Flood	After 6" to 8" of rainfall, the Pawtuxet River was above flood stage from June 12th to the 14th.
07/01/98	Flood	In Cranston, the Pawtuxet River did not reach flood stage until 10:15 am on July 1st, crested at 9'40" at 8 pm on the 1st, and then fell below flood stage at 10 am on July 2nd.
09/16/99	Flood	Torrential rainfall from Tropical Storm Floyd caused the Pawtuxet River to rise out of its banks in Warwick and Cranston. The Pawtuxet went into flood at 11:32 pm on the 16th, and crested at 9'4" at 5:15 am on the 17th, just over its 9' flood stage. It returned to its banks at 2:45 pm on the 17th. Winds were recorded at 57.6mph.
04/22/00	Flood	Widespread urban flooding occurred in Cranston and West Warwick after 2" to 3" of rainfall. It was reported that some roadways were covered by 10" to 12" of water. The Pawtuxet River in Cranston experienced a minor flood, with a crest of 9'4" at 4:15 pm (flood stage is 9').
03/22/01	Flood	In Cranston the Pawtuxet River crested at 11'36" at 6:15 pm on the 22nd (flood stage is 9'). Property damage for Providence County was estimated at \$3,000,000.
03/30/01	Flood	After 3" to 4" of rainfall, the Pawtuxet River crested at 11'86" at 7:15 pm on the 31st (flood stage is 9'). Flooding was limited to several roads in low-lying areas near the river on April 1st.
09/15/05	Flash Flood	An approaching cold front interacted with a very humid air mass producing locally heavy downpours that caused flash flooding across Rhode Island during the late morning and early afternoon hours. Two to five inches of rain fell from this flood event; and most of the rain fell within a three hour period. Most of the flooding occurred across Providence and Kent counties. More specifically, 3' of water was reported on Pontiac Avenue in Cranston, which stranded cars on this flooded roadway. Also, 3' of water was reported on Killingly Street in Providence; and cars parked in the Coventry High School parking lot had water up to their doors. No known injuries directly resulted from this flash flood event.
0/10/06	Flood	Pawtuxet River A late season coastal storm brought heavy rain to Rhode Island, which resulted in widespread flooding in Providence County as well as near Narragansett Bay. Storm total rainfall averaged 2 to 4 inches. In the city of Providence, flooding closed Valley Street at Atwells Avenue. The Pawtuxet River at Cranston went into moderate flood, and crested at 12.57 feet at 4:15 pm EDT on June 8. (Flood stage is 9 feet.)
10/28/06	Flood	Widespread urban flooding was reported in greater Providence. The Pawtuxet River at Cranston went into minor flood, cresting at 9.5 feet which was just over its flood stage of 9 feet. Low pressure intensified as it tracked from the mid- Atlantic states to New England. This system brought damaging winds to much of central and southern Rhode Island, where trained spotters and amateur radio operators reported many downed trees and power lines. About 10,200 customers were left without power throughout the state, as reported by the media. Rainfall totals of 2 to 4 inches produced significant urban flooding from greater Providence to South Kingstown. Several roads were closed. In Providence, the rain collapsed the third-floor ceiling of an apartment building displacing 14 people. The heavy rainfall also resulted in minor flooding on the Pawtuxet River. At Cranston, the river crested at 9.5 feet, which was just over its flood stage of 9 feet. Significant coastal flooding also occurred as a result of the storm.
11/24/06	Flood	Minor flooding occurred along the Pawtuxet River at Cranston, after nearly 4 inches of rain in an 18-hour period. The river crested just below 10 feet during the morning of the 24th. Flood stage is 9 feet. No flood damage was reported. ODE Low pressure tracking well southeast of Nantucket brought strong northeast winds to portions of Rhode Island as well as heavy rain to much of the state. Sustained winds around 30 mph brought down a telephone pole in Warwick, at the corner of Ocean Street and Shore Avenue. Rainfall averaged between 2 and 4 inches which resulted in localized urban and poor drainage flooding. Minor flooding occurred along the Pawtuxet River in Cranston. The river crested just below 10 feet, which was just over its flood stage of 9 feet. No damage was reported.
04/15/07	Flood	Moderate flooding occurred along the Pawtuxet River. At Cranston, the river crested at 12.4 feet at 1 pm on the 17th (flood stage is 9 feet). Flooding was reported in several neighborhoods near the river in Cranston. An unusually strong and slow moving coastal storm for mid- April tracked to western Long Island Sound on April 16th before weakening

		slowly and drifting offshore. This storm brought a variety of impacts, including damaging winds in excess of 60 mph, widespread river and stream flooding, and significant coastal flooding through several high tide cycles. East to northeast winds gusted as high as 60 mph. The highest gusts reported were 62 mph in
04/15/07 Cont.	Flood	Middletown, 61 mph at T.F. Green Airport in Warwick, and 60 mph in downtown Providence. There were widespread reports of downed trees, large branches, and power lines, especially in southern Rhode Island and as far inland as Providence. Rainfall totals of 3 to 5 inches, combined with wet antecedent conditions, resulted in widespread river and stream flooding, as well as significant flooding of urban areas. Minor to moderate flooding affected the Blackstone and Pawtuxet Rivers. The highest rainfall total reported was 5.00 inches in Little Compton. Many small streams throughout Rhode Island also rose out of their banks and flooded nearby areas, including roadways. Minor to moderate coastal flooding occurred along the coastline of Rhode Island through several high tide cycles, due to the combination of strong onshore winds, high seas, and astronomically high tides. Along the South Coast, the worst coastal flooding occurred with the morning high tide on the 16th, where flood waters and debris closed several shore roads. Large boulders that washed ashore had to be removed with snow plows, according to media reports.
02/13/08	Flood	Route 114 near Greenville Road was flooded in Cranston. Also, Natick and Wilbur Avenues and Fletcher Streets were impassable due to flooding and the Meshanicut Valley construction site was washed out. The Natick Avenue bridge was closed to all traffic because of severe erosion caused by the heavy rain. In addition, Route 116 near the reservoir was flooded with 18 inches of water flowing over the road. In Johnston, severe erosion on the sides of the Plainfield Pike was reported with 12 inches of water flooding portions of the road. A low pressure system developed off the Mid-Atlantic coast and moved up the east coast southeast of Nantucket producing snow, rain, and ice across Southern New England. Widespread two to four inch rainfall amounts resulted in small stream and poor drainage flooding as well as some minor river flooding. In addition, there was some minor wind damage from strong northeast winds, especially along the coast.
2/12/08	Flood	Route 10 and Wellington Road in Cranston were flooded. The Woonasquatucket River at Centerdale overflowed its banks flooding Atwells Avenue in Providence. Benjamin Road in North Providence was closed due to flooding. While a major ice storm affected Massachusetts and Southern New Hampshire, three to five inches of rain fell in Rhode Island resulting in small stream and some street flooding.
08/95/09	Flood	Several streets in Cranston were flooded with water halfway up car tires (about 6 inches). A cold front moved across Southern New England into an unstable atmosphere, resulting in showers and thunderstorms forming along the front. Some of these storms became severe producing strong, damaging winds and frequent lightning strikes. A group of nine people sought shelter under a tree at a sports field. Lightning struck the ground or a fence nearby and the nine felt a shock from the strike. Only minor injuries were sustained.
03/29/10	Flood	Six to nine inches of rain fell across Providence County, resulting in rises on both the Blackstone River at Woonsocket and the Pawtuxet River at Cranston. The Blackstone rose to moderate flood and the Pawtuxet rose to nearly 21 feet, surpassing the previous flood of record set only two weeks prior of nearly 15 feet. Numerous streets and basements were flooded across all of Providence County, including Cranston, North Smithfield, Johnston, Scituate, East Providence, North Providence, Providence, Pawtucket, and Cumberland. Roughly 120 homes were evacuated in the Valley View neighborhood in Cranston. A four building condo complex on Fordson Avenue was also evacuated. About 300 people total were evacuated from their homes in Cranston. Tenants from lower level units of an apartment building on Exchange Court in Pawtuxet were asked to evacuate due to flooding. A car on Valley Street in Providence was stuck in flood waters, leaving the driver stranded. Two homes on Tuxedo Street in Providence were looted while their owners were kept away for safety reasons. The Cranston wastewater treatment plant failed during the flooding, untreated sewage into the Pocasset River at a rate of 8 million gallons per day. In Johnston, the Pocasset Bridge on Route 14 (Plainfield Street) that spans the Pocasset River was closed after it started to show four large cracks. Several items that had floated down the river were caught under the bridge, blocking the water flow. City Hall experienced some flooding as well, prompting employees to shut down the computer system. A low pressure system sat just south of Long Island for two days, bringing heavy rain to much of Southern New England during that time. A persistent southerly low level jet brought very moist air into the area, which resulted in high rainfall rates. A coastal front along the I-95 corridor enhanced rainfall in that area. This event followed a heavy rainfall and record flooding event in mid-March as well as a second lesser rain event about a week prior. Rivers across much of Massachusetts and Rhode Island were still high from those events and warm temperatures in northern Vermont and New Hampshire resulted in a period of snowmelt that resulted in rises on both the main stem Connecticut and Merrimack Rivers. All of these factors led to a second record rainfall and flooding event. Two day rainfall totals across Southern New England ranged from an inch to ten inches. Though concentrated

		in Rhode Island and southeastern Massachusetts, all of Southern New England was affected by the flooding. In hardest hit Rhode Island, two day rainfall totals ranged from five to ten inches. Providence, set record monthly precipitation totals during the month of March. Providence also set the record for the wettest month ever in the period of record. Both the Pawtuxet River in Rhode Island set flood of record. River and areal flooding resulted in millions of dollars of damage across Rhode Island, with numerous homes, businesses, and people affected. A portion of Interstate 95, the main highway through Rhode Island, was closed for two days after the Pawtuxet River inundated the highway with
03/29/10 Cont.	Flood	up to three feet of water. Amtrak service through the state was suspended for several days because portions of the tracks were under up to two feet of water in several locations across the state. Passengers were rerouted through Springfield, Massachusetts. Though all 39 cities and towns in Rhode Island were affected, the most damage was seen in Warwick, West Warwick, Coventry, and Cranston, where the Pawtuxet and Pocasset Rivers flow through. Four dams in Rhode Island were breached and many others were overtopped and close to breaching, which resulted in the inspection of 42 dams throughout the state. Officials estimated that more than 500 people were evacuated from their homes because of rising water or the threat of rising water. More than 500 Rhode Island National Guardsmen were activated during the flooding, filling sandbags, directing traffic, and aiding in evacuations. Six National Grid substations were flooded and four were close to flooded, disrupting electrical service in Westerly and Warwick. Half a dozen sewage treatment plants through the state were overwhelmed or compromised by the flooding, leading to raw sewage being discharged into area rivers and bays. The Governor's office estimated that tens of thousands of properties were impacted by the flooding and about 4,000 workers were affected when the businesses they worked in were closed during and after the flooding. Numerous schools and many businesses, as well as the state government were closed for at least a day because of the flooding. President Obama issued a federal disaster declaration for the entire state of Rhode Island and residents received an automatic extension for filing their state and federal income taxes. The disaster declaration encompassed both the mid-March storm and this storm
9/8/2011	Flash Flood	A slow moving cold front moved across Southern New England and stalled just south of the area. This front was instrumental in bringing tropical moisture from the remnants of Tropical Storm Lee into New England. A series of shortwaves moved through the northeast during this time period bringing several periods of showers and steady rainfall to parts of Southern New England. Rainfall totals throughout the region over the four days totaled anywhere from two to eight inches, with most areas receiving four to six inches. This resulted in flooding both on the rivers and small streams and in urban areas. The bulk of the flooding in urban areas occurred on Sept. 8 as a band of very heavy rain moved through, dumping up to two inches of rain in an hour to hour and a half in some locations. Cars were stranded on Oaklawn and Wilbur Avenues in Cranston with water nearly to the cars roofs. In Providence, the northbound portion of Route 10 from Union Avenue to Westminster Street was closed due to flooding from 0903am EST to 0924am EST. The southbound portion of Route 10 at Reservoir Avenue were closed as well and reopened at 1030am EST. Numerous cars were stranded in floodwaters in Cranston.
6/7/2013	Flood	The remnants of Tropical Storm Andrea tracked across southeastern Massachusetts bringing heavy rain (3-5 inches) to much of southern New England. This resulted in significant urban flooding, particularly across eastern Massachusetts and Rhode Island, as well as river and small stream flooding. It also contributed to record high rainfall across the area for the month of June. Three to five inches of rain fell across the Providence metro area. In Cranston, Park and Reservoir Avenues were flooded and impassable.
7/11/2013	Flood	A very warm, moist airmass remained in place across Southern New England with precipitable water values over 2 inches. Showers and thunderstorms that developed with an upper level disturbance ahead of a cold front resulted in very heavy rainfall with reports of near 2 inches in 30 minutes in some locations. This resulted in flooding particularly in southeastern Massachusetts and Rhode Island. Atwood Avenue and Pontiac Avenue in Cranston were flooded. A car was stuck in the flood waters on Pontiac Avenue.
9/2/2013	Flash Flood	A nearly stationary warm front draped across southern New England, coupled with a very moist atmosphere, resulted in showers and thunderstorms across the area for the third day in a row. Heavy rain fell within these showers and storms and flash flooding occurred, particularly over portions of Rhode Island. 60 people evacuated from Dean Estate apartment buildings. Flooding at Park and Reservoir Avenues. Flooding in some areas more than 3 feet deep

Source: <http://www.ndbc.noaa.gov/stormevents>

2.1.2 Winter Related Hazards

For the purpose of this plan, winter related hazards include heavy amounts of snow, ice, and extreme cold. All of which may occur independently or at the same time. Historically, severe winter storms for Rhode Island have resulted in the closing of schools/businesses, power outages, fallen trees/wires, disruption of transportation systems, and damage to commercial and residential property. The winter of 1978 is considered one of the worst winters on record for the State. On January 13, 1978 an ice storm hit the State. Heavy ice cover was most severe in Cranston and Warwick. Statewide the storm destroyed thousands of trees and left nearly 120,000 people without power and heat in some circumstances. A little more than three weeks later, on February 6, 1978, the State was pounded by what became known as the "Blizzard of 78". In Warwick, the official measure of snowfall at T.F. Green Airport was 28.6". Snow accumulations ranged from 10" on Block Island to 56" in northern areas. Because the heavy snowfall arrived during rush hour, nearly 30,000 vehicles were left stranded. The State was immobilized for almost a week and the President declared Rhode Island a disaster area. During that week 400 Army and Navy personnel aided local crews to clear streets and highways. The statewide estimated losses from the blizzard were near \$110 million and there were 21 storm-related deaths.¹⁹ Table 6 highlights severe winter storm events that have affected Rhode Island.

Since then, numerous winter storms events dumping 2 feet or more of snow have occurred: January 7, 1996 (12-24 inches across the state), January 22, 2005 (15-25 inches across the state), February 8, 2013 (24 inches-30 inches across the state), and March 22, 2013 (12-24 inches reported). The severe winter storm that swept through Rhode Island on March 22, 2013 was declared a major disaster (DR-4107) by the Federal Emergency Management Agency. This large storm which stretched from New Jersey into Canada brought more than two feet of snow to Rhode Island in less than 24 hours. National Grid estimated more than 180,000 customers in Rhode Island lost power.

The CHMC has reviewed this section and has determined that the hazards identified in the 2010 HMP have not changed and that the 2014 HMP update needs to document winter storms that occurred since 2010.

Table 2: Recent Winter Related Storm Events

Date	Precipitation	Damage	Comments
01/07/94	Heavy snow and ice	\$555,000	Storm ended on 01/08/94. Snow accumulation ranged from 6" to 10".
01/07/96	Heavy snow "Blizzard of 96"	N/A	Storm ended on 01/08/96. Snow accumulation ranged from 12" to 24". The heavy snowfall disrupted transportation systems, closed schools, stores and businesses. In addition, several roof collapses were reported throughout the State.
03/31/97	Heavy wet snow "Blizzard of 97"	\$700,000	Storm ended on 04/01/97. Wind gusts recorded across the State ranged from 30mph to 71mph. Snow accumulation recorded in Cranston was 24". Damages were mostly due to snow removal and power restoration. Highway travel was near impossible with over 1,000 tree limbs down, and left 55,000 customers left without power.
03/05/01	Heavy snow	\$10 Million	Storm ended on 03/07/01. Snow accumulation ranged from 6" to 16" and wind gusts were reported to be 47mph to 53mph. Tens of thousands of electric customers left powerless, schools and businesses closed for 3 days in some areas.
03/09/01	Heavy snow	\$500,000	Storm ended on 03/10/01. Snow accumulation ranged from 6" to 8" accumulation.
12/25/02	Heavy snow	\$10,000	Storm ended on 12/26/02. Snow accumulations ranged from 4" to 7" and 40mph wind gusts were recorded at T.F. Green Airport.
2/17/03	Winter Storm	N/A	A major winter storm impacted southern New England with heavy snow and strong winds as it tracked southeast of Nantucket. Snowfall totals of 1' to 2' were widely observed throughout Rhode Island. No significant damage was reported due to the storm, since the snow was fluffy and light with temperatures in the teens and 20s. Impact on travel was minimal, since the storm affected the region on Presidents Day and most schools were closed that week. There were numerous reports of minor accidents as a result of slippery roads. No injuries were reported. The storm total at T.F. Green State Airport in Warwick was 15.0 inches. Of that total, 14.7 inches fell on February 17th, which set a record for the date. The previous record snowfall was 4.1 inches set in 1974. Other snowfall totals, as reported by trained spotters, included 21 inches in Cranston and 17 inches in Warwick, Johnston, and downtown Providence.
03/06/03	Heavy snow	\$290,000	Accumulation recorded in Cranston was 8". Dozens of minor accidents reported.

12/05/03	Winter Storm	N/A	<p>A major winter storm brought heavy snow and strong winds to southern New England, dumping 1' to 2' of snow over a large area as it tracked slowly off the coast. In Rhode Island, snowfall amounts averaged between 10 and 20 inches, and had a major disruption on transportation due to the combination of poor visibility and snow covered roads. Dozens of minor accidents were reported. Two deaths were indirectly attributed to the storm. One man was killed when the inner tube he was riding in, towed behind a truck, hit a utility pole. Another man was killed when he was hit by a train while crossing the tracks on a snowmobile in Exeter. Officially, the snowfall total at T.F. Green State Airport in Warwick was 17.0 inches. Other snowfall totals, as reported by trained spotters, included 21 inches in North Foster; 19 inches in Johnston; 18 inches in downtown Providence and West Warwick; 16 inches in Cranston and North Kingstown; 15 inches in South Kingstown and Barrington; 14 inches in Woonsocket; 12 inches in Exeter and Westerly; and 8 inches in Hope Valley.</p>
12/26/04	Winter Storm	N/A	<p>A powerful winter storm brought heavy snow and strong winds to Rhode Island. Snowfall totals of 6 to 10 inches were widely observed throughout the state, along with winds gusting as high as 50 mph along the south coast. There were dozens of reports of accidents due to the combination of slick roads and poor visibility. Officially, the snowfall total at T.F. Green State Airport in Warwick was 7.0 inches. Other snowfall totals, as reported by trained spotters, included Cranston, downtown Providence, and Woonsocket.</p>
1/22/05	Winter Storm	N/A	<p>A major winter storm brought heavy snow, high winds, and coastal flooding to southern New England. In Rhode Island, snowfall totals of 15 to 25 inches were widely observed. Winds gusting as high as 60 mph at times (mainly around greater Providence) created near blizzard conditions at times, making travel impossible during the height of the storm. Officially, the snowfall total at T.F. Green State Airport in Warwick was 23.4 inches, which was the second greatest snowstorm for the Providence area since records began in 1905. The snowfall total of 16.4 inches on the 23rd set a daily snowfall record, breaking the previous record of 8 inches set in 1965.</p>
2/12/06	Blizzard	\$10,000	<p>Low pressure centered off the Virginia coast intensified into a strong Nor'easter as it tracked about 75 miles southeast of Nantucket Sunday afternoon, 12 February 2006. This strong Nor'easter produced heavy snow and windy conditions across Rhode Island. Blizzard criteria was met at the T.F. Green Airport in Warwick between 1051 AM and 3 PM. 9.4 inches of snow accumulated at T.F. Green airport, which breaks the previous record snowfall maximum for the date. The accumulating snow began around 6 AM and tapered off around 6 PM. Snowfall amounts generally ranged between 9 and 14 inches, with some locations reporting up to 16 inches of snow. No known injuries directly resulted from this winter storm.</p>
2/19/08	Heavy Snow	N/A	<p>Eleven to twelve inches of snow fell across western Kent County. An intensifying coastal low spread heavy snow across southern New England. Snow began in the early afternoon across Connecticut and southwestern Massachusetts, spreading quickly across Massachusetts, Rhode Island, and southern New Hampshire. Eight to twelve inches of snow fell across much of southern New England.</p>
12/19/09	Heavy Snow	N/A	<p>Low pressure off the mid-Atlantic coast intensified dramatically resulting in widespread snowfall along the northeast corridor of the U.S. While the mid-Atlantic received much of the snow and wind from this storm, snow spread across much of Southern New England and blizzard conditions occurred in Newport, Rhode Island. Snowfall totals ranged to 18 to 20 inches across Rhode Island and southeastern Massachusetts. This resulted in numerous flight cancellations out of T.F. Green Airport in Providence and Logan Airport in Boston, school closings, and a struggle by plows to keep the roads clear.</p>
12/26/10	Winter Storm	\$15,000	<p>A strengthening winter storm passed southeast of Nantucket and brought heavy snow and strong winds to much of Rhode Island, resulting in near blizzard conditions at times. More than 2000 flights were cancelled along the east coast due to the storm and Amtrak service between New York and Boston was suspended during the storm. Despite numerous flight cancellations, T.F. Green Airport in Warwick remained open. Snowfall totals ranged from 6 to 8 inches along the south coast to as much as 8 to 15 inches elsewhere. Snowfall totals of 8 to 12 inches were observed in southeast Providence County, including 11 inches in downtown Providence. High winds brought down wires on Pawtucket Avenue in Providence.</p>
1/12/11	Heavy Snow	0	<p>A developing nor'easter coastal storm dumped nearly two feet of snow across portions of Rhode Island in a 24 hour period.</p> <p>This was the second major storm of an above average winter of snowfall. The first occurred December 26 and 27, with several other relatively minor snowfalls in the month of January, and a third major storm February 1 and 2. With only a brief thaw</p>

			in between the December storm and the January storm, snow piled up across southern New England resulting in numerous roof collapses, towns seeking permission to dump excess snow in area rivers and bays, and numerous disruptions to transportation. Eight to fourteen inches of snow fell across southeastern Providence County.
1/26/11	Heavy Snow	0	A strong low pressure system moved up the coast and southeast of Nantucket producing up to a foot of snow across Rhode Island. Nine to eleven inches of snow fell across southeast Providence County.
2/1/11	Winter Storm	0	A series of low pressure centers impacted the Southern New England Region with a combination of heavy snows and ice. The first area of low pressure on February 1st lifted northeastward offshore of the Southeastern New England shoreline ushering heavy snows across the interior portions of New England, especially north and west. A second area of low pressure deepened through the Ohio River Valley, redeveloping over the Southeastern New England shoreline bringing a combination of heavy snows, sleet and freezing rain over much of the region February 2nd, before changing back to all snow into the end of the event. A total of 6 inches of snow fell across Southeast Providence County over the two day period, with upwards of a tenth of an inch of ice accumulation for isolated locations falling during the morning period on the 2nd.
10/29/11	Heavy Snow Halloween Nor'easter		The Nor'easter brought strong winds across the region, but nothing too strong inland. Nantucket, Massachusetts recorded a 69-mile-per-hour wind gust, which is nearly hurricane strength (74 mph). Fallen trees with wet, heavy leaves still on caused wide spread power outages (over 3 million across New England). About 6 inches of snow fell in Rhode Island.
1/19/12	Winter Weather	0	A cold front moved across Southern New England, resulting in a period of light snow overnight into the morning of the 20th. Two to five inches of snow fell across Southern New England, with the highest amounts focused across southeastern Massachusetts and Rhode Island. Amateur Radio operators reported 3 to 5 inches of snow on the ground.
1/21/12	Winter Weather	0	A weak low pressure system moved southeast of southern New England, bringing snow to much of southern New England. While most of the area received at least an inch of snow, a mesoscale band set up along the south coast of Massachusetts and Rhode Island resulting in incredible snowfall rates. Eight to twelve inches of snow fell along the coast with five to eight inches falling on Martha's Vineyard and Nantucket. Amateur Radio operator reported 3 to 5 inches of snow on the ground.
2/29/12	Winter Weather	0	Several waves of low pressure moved south of southern New England bringing a prolonged period of snow to the region. Anywhere from 1 to 12 inches of snow fell across the area. Three to four inches of snow fell across southeast Providence County.
11/7/12	Winter Weather	0	Low pressure moved up the east coast spreading snow, rain, and wind across southern New England. Cloudy skies coupled with evaporational cooling to keep temperatures cooler than expected which resulted in snow spread across all but the south coasts of RI and MA as well as portions of southeastern MA. This in turn resulted in higher snow accumulations across much of southern New England. In Rhode Island, accumulations ranged from less than an inch to five inches.
12/29/12	Heavy Snow	0	A rapidly intensifying low moved out of the mid-Atlantic, passing southeast of Southern New England. This spread heavy snow across much of Southern New England, resulting in six to twelve inches of snow across the area. Snowfall totals between eight and ten inches were reported in southeast Providence County.
2/8/13	Blizzard "Blizzard of 2013/Winter storm Nemo"	0	<p>An historic winter storm deposited tremendous amounts of snow over all of southern New England, mainly from the mid-afternoon on Friday, February 8 and lasting into the daylight hours of Saturday, February 9. What made this an amazing storm was the widespread coverage of heavy snowfall. Most locations received 2 to 2.5 feet of snow! Isolated thunderstorms were common across the entire region during the height of the storm.</p> <p>A low pressure system advancing from the Great Lakes region combined forces with a very moist low pressure system moving northeast from the Gulf Coast states. Explosive deepening took place Friday evening, February 8, as a low center moved from the North Carolina coast to south of Nantucket. Strong high pressure to the north of New England helped ensure that cold air remained in place over the area. Snowfall gained intensity during the afternoon, but during the night, 2 to 3 inch per hour amounts were common throughout the region. Snow ended in the morning in western and central MA, southwest NH, most of CT and RI, and in the early afternoon across eastern MA.</p> <p>The Blizzard of 2013 also produced a prolonged period of very strong winds Friday night along the MA and RI coasts. Gusts exceeded hurricane force (74 mph) at a few locations. Gale force gusts (to 50 mph) continued on the MA coast through</p>

			<p>Saturday afternoon. The strong winds, combined with a wet snow, led to extensive power outages from downed trees and wires in southeast coastal MA and in southern RI. Elsewhere, farther inland, the snow became drier and did not cling to trees like it did along the south and southeast coast of New England. Some wind gusts included: 76 mph at Logan Intl. Airport (Boston, MA), 75 mph at Bedford, MA, 77 mph at Hyannis, MA and 68 mph in Jamestown, RI. Damaging gusts to 60 mph were recorded as far west as Worcester County, MA. Wind gusts of 35 to 50 mph were common elsewhere in southern New England.</p> <p>Minor tidal flooding occurred along the south coasts of Connecticut, Massachusetts, and Rhode Island during times of high tide Friday night and Saturday morning.</p> <p>The Providence Journal reported that almost 170 people sought treatment for storm-related heart attacks, falls, and other injuries related to the storm at Lifespan network hospitals (which includes 4 major Rhode Island hospitals). In addition 10 people were hospitalized with carbon monoxide poisoning. No further information was available.</p> <p>Seventeen to twenty-one inches of snow fell across southeastern Providence County. A Rhode Island man died from a heart attack while shoveling snow from the blizzard. No further details were available, including what city or town the man was from.</p>
2/17/13	Winter Weather	0	A strengthening ocean storm spread advisory level snow across much of southern New England. Two to four inches of snow fell across southeastern Providence County.
3/7/13	Winter Weather	0	This storm brought heavy snow and significant coastal flooding to the forecast area. This was an unusual synoptic set-up, with low pressure lingering off the coast of southern New England for several days. Snowfall was difficult to forecast due to concerns about precipitation type and boundary layer temperature. In the end, precipitation type turned out to be all snow for much of the area, with most locations receiving 1 to 2 feet of snow. In addition, the Massachusetts east coast was hit by widespread moderate and pockets of major coastal flooding for two high tide cycles and beach erosion for at least 5 high tide cycles. Five to six inches of snow fell across southeastern Providence County.

<http://www.cdcnraap.com/ver15> NCEM only report hazard from 01/01/1950 to 09/30/2013

2.1.3 Hurricanes

Hurricanes that strike the Eastern United States originate in the tropical and subtropical North Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico. The Atlantic hurricane season spans a six-month period (June 1st through November 30th). A hurricane is a tropical cyclone with winds that exceed 74 mph. The center of the hurricane spiral marks the "eye" of the storm. The weather conditions within the eye are characterized as generally cloud, precipitation, and wind free and the barometric pressure is the lowest at the very center of the eye. Immediately surrounding the eye are the strongest winds of the storm. The greatest potential for loss of life during a hurricane is from the storm surge, which is the elevated water pushed toward the coast by the force of the winds spiraling around the storm.

Hurricanes are categorized according to the strength of their winds using the Saffir-Simpson Hurricane Scale. A Category 1 storm has the lowest wind speeds, while a Category 5 hurricane has the strongest. Relatively speaking, a lower category storms can sometimes inflict greater damage than higher category storms based on where they strike and the particular hazards they create.⁸ Hurricanes are considered the greatest natural hazard threat within Rhode Island. RIEMA annually asks the State's 39 communities to rank natural hazards indicating the level of seriousness of each natural hazard to their municipality. Hurricanes consistently rank the highest within the State.⁹

The two hurricanes that resulted in the largest loss of life in the State were "The Great New England Hurricane of 1938" and "Hurricane Carol". "The Great New England Hurricane" occurred on September 21st, 1938, and is considered the worst disaster in Rhode Island history. It resulted in the deaths of 262 persons and caused damage estimated at \$100,000,000. The eye of this hurricane tracked to the west of Rhode Island and hit at high tide. During the storm, two storm surges almost 30' high destroyed most of the beach homes along the South Shore. In downtown Providence, the surge flooded the area to a depth of more than 13'9" above the mean high-water mark. As a result, persons drowned trying to escape automobiles submerged in the streets and from buildings where the first floors were flooded to the ceiling.¹⁰ In Cranston, an abnormally high tide of 15'7" in the Providence River near the mouth of the Pawtuxet

River; this tide was 10'2" above the crest of the Pawtuxet and as a result of dam topping, extensive flooding occurred in the lower portions of the Pawtuxet River Watershed.¹¹

Throughout Rhode Island, the American Red Cross (ARC) spent \$433,485 for the rehabilitation of 3,074 families. A total of 19,695 families suffered property loss; 797 permanent homes were destroyed; 1,169 summer homes were washed away; 899 boats destroyed and 888 damaged, 177 barns and 1,800 other buildings of various types were destroyed.¹²

On August 31, 1954, "Hurricane Carol" hit Rhode Island, in the same manner as "The Great New England Hurricane of 1938". As a result, downtown Providence was flooded when the water reached 13' above mean high-water level.¹³ In Cranston, Hurricane Carol created an abnormally high tide of 14'7" in the Providence River, near the mouth of the Pawtuxet River. The overtopping of the Pawtuxet Dam resulted in flooding 12'5", upstream of the dam.¹⁴ Damage to yacht clubs, marinas and pleasure craft was in the millions with the stretch of shoreline from Fields Point to Pawtuxet Neck the hardest hit. Of the 150 craft moored in this area, 75 were sunk and 26 were damaged.¹⁵

The most recent significant weather event to affect the state was a downgraded hurricane. On October 29th 2012, Hurricane Sandy which had been sweeping up the Mid-Atlantic Coast had been downgraded by the time it had reached Rhode Island. Super Storm Sandy hit Rhode Island with strong winds, and storm surge, causing significant coastal erosion. Along the south coast, the storm surge was 4 to 6 feet and seas from 30 to a little over 35 feet were observed in the outer coastal waters. The very large waves on top of the storm surge caused destructive coastal flooding along stretches of the Rhode Island exposed south coast. Washington and Newport Counties suffered the most damage and received FEMA disaster declarations. More than \$39 million has been paid in federal support. Sadly, at least 182 people nationwide lost their lives in what turned out to be the nation's second most costly weather disaster. Fortunately there were no disaster-related deaths in Rhode Island. Cranston's mostly armored shoreline suffered little erosion. The City did experience power outages, fallen tree limbs, and minor flooding in low-lying coastal areas.

In Cranston, Ocean Avenue and Narragansett Boulevard, in the vicinity of Stillhouse Cove, serve as an arterial evacuation route. In the event of a natural hazard, this evacuation route faces a serious threat to coastal erosion. However, there are two primary threatened neighborhood areas along the coastal flood plain that depend upon this arterial evacuation route. The first area threatened comprises the Edgewood neighborhood. In this area, the roadways east of Narragansett Boulevard are at risk. Specifically these roadways include: Norwood Avenue, Arnold Avenue, Shaw Avenue, Marion Avenue, and Bluff Avenue. The second area threatened comprises the properties in and around Pawtuxet Village. The primary concern here is the threat that Pawtuxet Neck could become separated from the mainland due to the potential flooding of Ocean Avenue and Sheldon Street. Also noteworthy are several smaller roadways on which development extends to the edge of Pawtuxet Cove such as George Street, Aborn Street, Bridge Street, and Springwood Street. Table 4 highlights the most destructive hurricane events that have affected Rhode Island.

The CHMC has reviewed this section and has determined that the hazards identified in the 2010 HMP Plan still pose a significant threat to the both the residents and property in Cranston and that there has been no change in data since 2010. The CHMC further finds that hazards from flooding may increase over time as global warming will contribute to sea level rise and an increase in both the intensity and frequency of storm events.

Table 3: Hurricane Events in Rhode Island

Date	Name	CAT	Tracking of Eye	Sustained Winds (mph)	Wind Gust (mph)	Property Damage (\$ million)	Deaths
09/21/38	N/A	3	New Haven, CT	100	125	100	262
09/14/44	N/A	3	Narragansett & Warwick, RI	82	100	2	0
8/31/54	Carol	3	Old Saybrook, CT	90	105-115	90	19
09/11/54	Edna	3	Cape Cod, MA	75-95	110	0.1	0
08/19/55	Diane	Tropical Storm	South of Block Island, RI	45	N/A	170	1
09/12/60	Donna	2	New Haven, CT	58	81	2.4	0
09/27/85	Gloria	1	New Haven, CT	81	120	19.8	1
10/19/91	Bob	2	Newport, RI	75-100	100	115	0
8/28/11	Irene	Tropical Storm	Bridgeport, CT	44 (on land)	N/A	127.3	1
10/29/12	Sandy	Super Storm	New Jersey	60-80	90	0.02	0

Source: Providence Journal-Bulletin, 1998; Journal-Bulletin Rhode Island Almanac 112th ed. (Providence, RI: Providence Journal Company, 1998); 25-26; David R. Vitek and Michael R. Don, Southern New England Tropical Storms and Hurricanes: A Ninety-seven Year Summary 1900-1996 including several Early American Hurricanes. (Taunton, MA: National Weather Service Forecast Office, 1996).

2.1.4 Wind, Lightning and Hail Storms

The CHMC decided that thunder, wind, lightning, and hail events tend to occur concurrently so they were grouped together. A thunderstorm is formed from a combination of moisture, rapidly rising warm air and a force capable of lifting air, such as the meeting of a warm and cold front, a sea breeze, or a mountain. Most thunderstorms contain lightning. Thunderstorms can occur singly, in clusters, or in lines. Therefore, it is possible for several thunderstorms to affect one location in the course of a few hours. Thunderstorms usually bring heavy rains (which can cause flash floods), strong winds, hail, lightning, and tornadoes.²⁰ Lightning is caused by the attraction between positive and negative charges in the atmosphere, resulting in the buildup and discharge of electrical energy. Most thunderstorms produce lightning and are dangerous. Lightning is one of the most underrated severe weather hazards, yet ranks as the second-leading weather killer in the United States. Lightning often strikes as far as 10 miles away from any rainfall. One of the less life-threatening yet very damaging natural hazard events is hail. Large hail can dent automobiles, break windows, and destroy roofs. Table 8 highlights recent wind, lightning, and hail storms that have affected Cranston and other parts of Rhode Island.

The CHMC has reviewed this section and has determined that the hazards identified in the 2010 Plan have not changed and that the 2014 HMP update included thunderstorm and high wind events that occurred after 2010.

Table 4: Recent Wind, Lightning and Hail Storms in Rhode Island

Date	Event	Magnitude	Comments
5/1/94	Lightning	\$5,000 in damage, 0 injuries	A bolt of lightning struck and heavily damaged a single-family house. Lightning struck the side of the house, traveled through the attic, and blew a hole in the peak of the roof. The electrical system was knocked out and pieces of vinyl siding were blown off and embedded in a neighbor's house.
8/5/94	Lightning	\$5,000 in damage, 0 injuries	Lightning started a fire in a single family house and destroyed a barn.
01/07/95	Wind	58 mph	No damage was reported.
06/20/95	Hail	1.75"	No damage was reported.
07/13/96	Wind	74 mph	Tropical Storm Bertha brought a period of high winds, heavy rain, and minor coastal flooding to Rhode Island. Almost 32,000 electric customers were without power because of falling trees and tree limbs. Approximately 2" to 5.5"

			of rain fell across the State, resulting in urban street flooding in Coventry, Warwick, and Cranston. At 2:30 pm winds were recorded at 70mph in Cranston.
6/22/97	Hail	0.75"	The hail was produced from a line of severe thunderstorms that moved southeastward across Rhode Island at 3:45 pm. Approximately, 18,000 Narragansett Electric customers statewide reported power outages. In Cranston, the Deputy Fire Chief, "rushed from fire to fire like never before." Winds were recorded at 65mph.
03/09/98	Wind	40 to 55 mph	Statewide, damage was reported at \$50,000. Urban street flooding was serious in many parts of the State. Cranston reported 3.60" of rainfall.
5/31/98	Hail	0.75"	The hail produced was from a severe thunderstorm that moved across Northern Rhode Island at 10:03 pm. Winds were recorded at 57.6mph. No damage was reported.
01/03/99	Wind	51 to 73 mph	In a period of less than 12 hours, Cranston recorded 2.56" of rainfall.
01/15/99	Wind	55 mph	More than 2" of rainfall, combined with rapid snowmelt, resulted in considerable urban street flooding. In Cranston, Oaklawn Avenue flooded and several cars were submerged.
01/18/99	Wind	55 to 60 mph	Strong winds downed power lines in Cranston resulting in scattered power outages.
02/03/99	Wind	47 to 65 mph	Cranston reported 2.56" of rainfall.
03/22/99	Wind	49 to 64 mph	Almost 7,000 electric customers in East Providence, Providence, and Cranston reported scattered power outages because strong winds downed tree limbs and power lines.
10/14/99	Wind	50 mph	Approximately 7,300 electric customers, primarily located in Cranston and Johnston, lost power when a tree fell on a main line leading from a substation.
04/3/02	Lightning	\$0 in damage, 1 injury	Lightning from an isolated thunderstorm moving across Rhode Island struck a woman as she waited at a bus stop.
07/23/02	Wind	50 mph	Severe thunderstorms downed trees in Coventry, Providence, and Scituate. Dime sized hail was produced in Cranston at 3:50 pm. Winds were recorded at 57.6mph. There was a total of approximately \$5,000 in damage. Dime sized hail in Cranston.
08/02/02	Lightning	\$8,000 in damages, 0 injured	Lightning from the same storms struck a communications tower and several utility poles.
07/19/05	Wind	52 mph	Scattered strong to severe thunderstorms moved across Rhode Island during the early evening hours of 19 July. The hardest hit areas were in Providence and Newport counties. The police station in Smithfield measured a wind gust of 52 mph during the height of the thunderstorms. Trees were knocked down from these winds. A bolt of lightning set a transformer on fire. Another bolt of lightning hit a house, starting an attic fire, which caused structural damage to the house. In Jamestown, a bolt of lightning knocked out the main power supply to the town. No injuries directly resulted from these thunderstorms.
07/18/06	Wind	50 mph	Severe thunderstorms moved through Rhode Island at night, in advance of a cold front pushing through southern New England. Thunderstorm winds brought down trees and large limbs in Scituate, Johnston, Cranston, Warwick, Barrington, Middletown, North Kingstown, and Portsmouth. Damage was more widespread in greater Providence, where nearly two dozen large trees were downed around Roger Williams Park and about one hundred others were either split or splintered by strong winds. In Cranston, a large maple tree fell onto a car and another large tree destroyed a garage. An amateur radio operator in Johnston also reported golf ball sized hail as the storms moved through. Lightning from the storms caused considerable damage in the city of Providence. Lightning struck the State House, causing some marble tiles to fall from the roof. A major fire was ignited on a tanker at the port of Providence on Narragansett Bay, when it was struck by lightning. No one was injured in either case. An estimated 37,000 customers lost power during the storms.
06/28/07	Wind	56 mph	Very strong thunderstorms wind gusts. Very hot and humid conditions prevailed across Southern New England on the 28th of June. This in combination with an approaching cold front aided in the development of thunderstorms during the late afternoon and early evening hours. Many of the storms produced wind damage and hail across Rhode Island.
08/13/07	Wind	50 mph	Large tree branches down on Laurehurst Road. Isolated severe thunderstorms developed in association with a weakly unstable air mass on the 13th.
7/23/08	Hail/ Tornado	10.75"/ EF1	Ping pong to golf ball size hail fell in Cranston. A frontal system moved through southern New England with the warm front moving through first and increasing low level moisture. Then the cold front moved through providing a lifting mechanism for showers and thunderstorms to develop. High levels of moisture

			<p>contributed to heavy downpours that resulted in flash flooding in Rhode Island and portions of Massachusetts. All of this coupled with strong wind shear (turning of the winds with height) over southeast Massachusetts and Rhode Island provided the perfect environment for a tornado to form. This particular tornado began as a waterspout over Narragansett Bay and traveled east-northeast reaching land over the southern portion of Warren, Rhode Island. The tornado continued for 4.2 miles into Swansea, Massachusetts over a mostly continuous track. Most of the damage sustained was to trees which fell on power lines and houses. This tornado was rated by a National Weather Service damage survey team as an EF1 on the Enhanced Fujita Scale.</p>
6/28/10	Wind	57 mph	<p>A cold front moved across Southern New England producing showers and thunderstorms. An amateur radio operator recorded a wind gust of 58 mph on their home weather station. No damage was reported.</p>
1/25/10	Wind	51 mph	<p>Unseasonably warm temperatures moved into southern New England ahead of a cold front which allowed for excellent atmospheric mixing. This resulted in strong to damaging winds across much of eastern Massachusetts and Rhode Island. A weather station at a spotter's home in Cranston recorded a wind gust of 51 mph. A tree in East Providence was downed. In Cranston, a telephone pole was downed. A 30 foot tall pine tree in Providence was downed.</p>
6/9/11	Wind	57 mph	<p>A Mesoscale Convective System moved out of the Great Lakes and across New York state providing a focus for convection across southern New England. One overnight thunderstorm produced a severe microburst in Providence, RI that downed numerous trees throughout town. Numerous trees, large branches, and wires were downed, including trees on Route 10 South and Maplewood Avenue in Cranston.</p>
4/29/12	Wind	50 mph	<p>Low pressure over the Canadian Maritimes produced winds gusts of 40 to 50 mph throughout southern New England, resulting in scattered wind damage. Strong winds brought down wires on Pawtucket Avenue near Taunton Avenue in East Providence.</p>
9/18/12	Wind	NA	<p>A strong cold front moved through southern New England, resulting in a line of thunderstorms that produced strong to severe winds. In addition, a strong low level jet produced gusty strong to high winds with the front. A branch and wires were downed on Sunset Drive in North Providence.</p>
10/29/12	Wind	60-80 mph	<p>Superstorm Sandy, a hybrid storm with both tropical and extra-tropical characteristics, brought high winds and coastal flooding to southern New England. Easterly winds gusted to 50 to 60 mph for interior southern New England; 55 to 65 mph along the eastern Massachusetts coast and along the I-95 corridor in southeast Massachusetts and Rhode Island; and 70 to 80 mph along the southeast Massachusetts and Rhode Island coasts. A few higher gusts occurred along the Rhode Island coast. A severe thunderstorm embedded in an outer band associated with Sandy produced wind gusts to 90 mph and concentrated damage in Wareham early Tuesday evening, a day after the center of Sandy had moved into New Jersey. In general, moderate coastal flooding occurred along the Massachusetts coastline, and major coastal flooding impacted the Rhode Island coastline. The storm surge was generally 2.5 to 4.5 feet along the east coast of Massachusetts, but peaked late Monday afternoon in between high tide cycles. Seas built to between 20 and 25 feet Monday afternoon and evening just off the Massachusetts east coast. Along the south coast, the storm surge was 4 to 6 feet and seas from 30 to a little over 35 feet were observed in the outer coastal waters. The very large waves on top of the storm surge caused destructive coastal flooding along stretches of the Rhode Island exposed south coast.</p> <p>Sandy grew into a hurricane over the southwest Caribbean and then headed north across Jamaica, Cuba, and the Bahamas. As Sandy headed north of the Bahamas, the storm interacted with a vigorous weather system moving west to east across the United States and began to take on a hybrid structure. Strong high pressure over southeast Canada helped with the expansion of the strong winds well north of the center of Sandy. In essence, Sandy retained the structure of a hurricane near its center (until shortly before landfall) while taking on more of an extra-tropical cyclone configuration well away from the center. Sandy's track was unusual. The storm headed northeast and then north across the western Atlantic and then sharply turned to the west to make landfall near Atlantic City, NJ during Monday evening. Sandy subsequently weakened and moved west across southern Pennsylvania on Tuesday before turning north and heading across western New York state into Quebec during Tuesday night and Wednesday.</p> <p>In Southern New England, Rhode Island was hardest hit. A peak wind gust of 86 mph occurred in Westerly, and nearly the entire Rhode Island shoreline</p>

			<p>experienced moderate to major coastal flooding. Numerous power outages occurred with winds gusting to 60 mph over the interior and to 80+ mph along the south coast. Major coastal flooding struck the Rhode Island ocean exposed south coast during the Monday evening high tide. This storm tide, especially destructive across shorelines in Westerly, Charlestown, South Kingston, Narragansett, and Block Island, rivaled the impact from Hurricane Bob in 1991. Along the Rhode Island south coast, the damaging coastal flooding was fueled by a storm surge around 5 feet and waves of 30+ feet that propagated on a long fetch into Block Island and Rhode Island Sounds. A survey of impact along Misquamicut Beach revealed an inundation extent consistent with the upper boundary of a category 1 Hurricane and very severe erosion. It should also be noted that the previous high tide during Monday morning produced minor to moderate impacts along the Rhode Island coast and likely weakened dunes and other coastal structures in advance of the more destructive Monday evening high tide.</p> <p>A tree was downed onto a car on Veterans Memorial Parkway in East Providence. Those in the car were transported to the hospital. The roof of the U.S. Postal Service building on Newman Avenue in East Providence was partially collapsed after being damaged by high winds. Wind gusts in southeast Providence County were reported by spotters in North Providence and in the Rumford section of East Providence to be between 46 and 52 mph.</p>
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Source: <http://www.ncdc.noaa.gov/stormevents>

Note: NCDC only reports hail data from 01/01/1950 to 09/30/2003.

2.1.5 Tornadoes

A tornado is a violent windstorm with a twisting, funnel-shaped cloud. They are often spawned by thunderstorms or hurricanes. Tornadoes are produced when cool air overrides a layer of warm air, forcing the warm air to rise rapidly. The damage from a tornado is a result of the high wind velocity and wind-blown debris. Tornado season is generally March through August, although tornadoes can occur at any time of year. Over 80 percent of all tornadoes strike between noon and midnight.¹⁸ During an average year, about 1,000 tornadoes are reported across the United States, resulting in 80 deaths and over 1,500 injuries. The most violent tornadoes are capable of tremendous destruction with wind speeds of 250 mph or more. Damage paths can be in excess of one mile wide and 50 miles long.¹⁹

Tornadoes are categorized according to the damage they produce using the Fujita Scale (F-scale). An F0 tornado causes the least amount of damage, while an F5 tornado causes the most amount of damage. Relatively speaking, the size of a tornado is not necessarily an indication of its intensity. On August, 7th, 1986, a rare outbreak of seven tornadoes occurred in New England. One such tornado, rated F2 on the Fujita Scale, carved its way through Cranston, RI, and Providence, RI, causing twenty injuries and \$2,500,000 in damages. Table 7 highlights tornado events that have affected, Rhode Island.

All people are equally vulnerable to tornadoes in Cranston. Transportation and road closures could isolate some neighborhoods and services may be compromised. However, due to the unpredictability destructive capacity of tornadoes, it is costly to mitigate in a City that has infrequent tornado activity. The City does however have plans for post-disaster debris handling.

The CHMC has reviewed this section and has determined that the hazards identified in the 2010HMP have not changed and that the 2014 HMP update includes tornado events (if any) that occurred since 20010.

Table 5: Recent Tornado Events in Providence County, Rhode Island

Date	Type	Magnitude	Injuries	Damage	Location
08/26/85	Tornado	F1	0	\$0	Providence County
08/07/86	Tornado	F1	0	\$250,000	Providence County
08/07/86	Tornado	F2	20	\$2,500,000	Cranston
08/08/86	Tornado	F1	0	\$250,000	Providence County
09/23/89	Tornado	F0	3	\$250,000	Providence County

Source: <http://www.ncdc.noaa.gov/stormevents/>

2.1.6 Geologic Related Hazards: Earthquakes

The USGS estimates that there is a 40 to 60 percent chance of experiencing an earthquake of magnitude 6.0 or greater on the Richter Scale in the central or eastern United States within the next 30 years. Buildings that are most at risk from earthquakes are the old masonry buildings and large structures such as those along Elmwood Avenue, the Atlantic Tubing Factory, and Cranston Stebbins Stadium.

Although earthquakes are not considered to be a major problem in the Northeast United States, they are more prevalent than one might expect. Table 6 presents historical seismic activity for Rhode Island. It highlights the earthquake epicenter, the Richter magnitude at the epicenter, and the Mercalli Intensity Level. Richter magnitudes are technical quantitatively based calculations that measure the amplitude of the largest seismic wave recorded. Richter magnitudes are based on a logarithmic scale and are commonly scaled from 1 to 8. The higher the magnitude on the Richter Scale, the more severe the earthquake. Mercalli intensity levels are based on qualitative criteria that use the observations of the people who have experienced the earthquake to estimate the intensity level. The Mercalli scale ranges from I to XII. The higher the intensity level on the scale, the closer the person is to the epicenter.⁵

The CHMC has reviewed this section and has determined that the hazards identified in the 2005 HMP have not changed and that the 2010 HMP update needs to document seismic events that have occurred since 2005.

Table 6: Seismic Activity in Rhode Island

Date	Epicenter	Epicenter Magnitude	Mercalli Intensity Level
02/28/25	St. Lawrence River Region	7	Intensity level V shock effects were felt on Block Island. Intensity level IV effects were felt in Charlestown. The total area affected by this earthquake was over 5,000,000 sq. km.
11/01/35	Quebec, Canada	6.25	Intensity level IV shock effects were felt on Block Island and at Providence and Woonsocket. The total area affected by this earthquake was about 2,500,000 sq. km.
10/16/63	Massachusetts Coast	4.5	Intensity level V shock effects felt at Chepachet. Other places in the Northern Rhode Island felt shock effects with less intensity.
06/14/73	Western Maine	5.2	Intensity level IV shock effects were felt at Charlestown. Intensity level I - III shock effects were felt at Bristol, East Providence, Harmony, and Providence. This earthquake was felt over an area of 250,000 sq. km.
03/11/76	Near Newport, RI	3.5	Intensity level VI shock effects felt throughout Southern New England. This earthquake has the distinction of being the largest earthquake to originate in Rhode Island.
04/20/02	Plattsburgh, NY	5.2	Intensity level II to III shock effects felt throughout Rhode Island.
03/11/08	Central Connecticut	2.9	No data reported for Rhode Island
6/23/10	Ontario-Quebec	5.0	Felt throughout Rhode Island.
2011	Rhode Island	0.9	Felt locally
2012	Rhode Island	1	Felt locally
2013	Kingston, RI	Unknown	Felt locally

Source: http://neis.usgs.gov/neis/states/rhode_island/rhode_island_history.html

2.1.7 Coastal Erosion

Coastal erosion refers to the wearing away of upland areas as a result of water action. It can be a slow process that occurs over time or a dramatic event fueled by high winds or elevated sea levels. The city of Cranston is relatively protected from this hazard by its location in the low energy environment of the upper bay and due to the fact that 90% of its shoreline has been hardened; but it is not immune. Stillhouse Cove on the eastern shore of Cranston is the largest coastal area without shoreline armoring. Its shoreline is about 0.3 miles long. Residential structures are located landward of Narragansett Boulevard which runs adjacent to Stillhouse Cove. Unfortunately historic rates of coastal erosion are unavailable for the city. An inventory of other events that might have contributed to this process could include however those documented in tables 4 (hurricanes), 6 (severe winter storms) and 8 (thunderstorms/high wind events) above.

Most properties in Cranston are protected from mild coastal erosion because they are behind a hardened shoreline structure. Those that aren't located landward of a road are thusly protected from seasonal erosion. Therefore, due to the low vulnerability, the City has not created specific mitigation actions for coastal erosion. However, as climate change continues to impact the area and sea level rises, the City will have to address increased flooding in these low lying areas.

The CHMC has reviewed this section and has determined that the hazards identified in the 2010 Plan have not changed. However, the CHMC further finds that hazards from coastal erosion may increase over time as global warming with contribute to sea level rise.

2.1.8 Wildfire and Drought

A wildfire is a natural or human caused uncontrolled burning of vegetative fuel such as grasslands, trees, or woodland. There are many causes of wildfire, from naturally-caused lightning fires to human-caused fires linked to activities such as smoking, campfires, equipment use, and arson. The three major factors that sustain wildfires and predict a given area's potential to burn are fuel, topography and weather. High temperatures, low humidity, high winds, lightning, and drought can all increase the wildfire potential.

Once a wildfire has been detected and the area assessed, the wildfire is assigned one of the following categories from lowest to highest: category 1 (incipient- initial), category 2 (growing and threatening), category 3 (major aggressive fires), category 4 (major aggressive fire of at least 5,000 acres expanding at 400 acres per hour), or category 5 (major very aggressive fire of at least 16,000 acres expanding at 1000 acres per hour or more). These categories may change as the wildfire continues to burn.

As noted earlier the City of Cranston is approximately 20% forested or vacant and as such it is possible that wildfires could present a risk. Although the Cranston Fire Department does respond to a small number of brush fires on an annual basis, the Department confirmed that significant wildfires have not occurred in recent memory due to the adequacy of fire response and protection in the less developed portions of the City.

Drought is a gradual phenomenon that occurs slowly, over a multi-year period. Most natural disasters, such as floods or forest fires, occur relatively rapidly and afford little time for preparing for disaster response. Due to its coastal location in a temperate climate, Rhode Island rarely experiences extended periods of drought.. However, seasonal droughts have occurred when precipitation levels are low. Drought conditions can impact crops, water available for fire suppression, and reservoir levels. In Rhode Island, drought conditions can trigger fire hazard warnings.

Past drought events in Rhode Island have affected the entire state. It is generally not an issue that is handled at the local level although the City can enforce particular water bans as dictated by the State. Due to the broad nature of droughts, the City of Cranston does not have specific mitigation actions. For specific statewide mitigation efforts, refer to the current Rhode Island State Hazard Mitigation Plan located online <http://www.riema.ri.gov/prevention/mitigation/index.php>.

Table 7: Drought Activity in Rhode Island

Date	Type	Location	Injuries	Comments
4/12/12	D2	Regional	0	<p>The U.S. Drought Monitor declared a severe drought across Rhode Island, the eastern half of Massachusetts, and most of northern Connecticut. A moderate drought was declared over western Massachusetts and southwestern New Hampshire. This was declared as the result of a meteorological drought determined by precipitation that had been approximately one half of normal from January 2012 through April 2012. Rivers and streams were most affected as most ran at record low levels during the spring run-off season. No southern New England state issued drought declarations as reservoirs were at normal levels, thanks largely to above normal precipitation falling between August 2011 and November 2011.</p> <p>The main impact of the meteorological drought was periods of very high fire danger. In addition, small pond levels were reduced. While soil moisture was well below normal, this drought occurred prior to the beginning of the growing season. Thus, no agricultural impacts were realized.</p> <p>From January 1 through April 15, precipitation levels were 6 to 8 inches below normal across northeast Connecticut, Rhode Island, and southeast Massachusetts. Across the remainder of southern New England, precipitation levels were 5 to 7 inches below normal. This translates to around or less than 50 percent of normal precipitation for much of southern New England.</p> <p>The U.S. Drought Monitor declared severe drought (D2) over southeastern Providence County from April 12 through April 24. This was deemed a meteorological drought due to precipitation levels approximately one half of normal</p>

The CHMC has reviewed this section and has determined that the hazards identified in the 2010 Plan have not changed. Drought data since 2010 has been added to the 2014 HMP.

2.2 Likelihood of Future Events

In developing a mitigation plan it is also important to gauge the future likelihood and potential impact of natural hazard occurrences. To do this each member of the CHMC ranked the events based upon the probability of the event occurring and its impacts. The CHMC decided that thunder, wind, lightning, and hail are rarely mutually exclusive so they combined them into one category. The scores were then averaged and represented below. The resulting events were then classified as having high medium or low probabilities of occurring in Cranston (see Table 8).

Table 8: Likelihood of Future Events

Hazard	Risk Value	Probability
Flooding	1	High
Winter Storm	3	High
Hurricane	3	Medium
Thunder, Wind, Lightning, & Hail	6	Medium/Low
Tornadoes	7	Low
Coastal Erosion	8	Low
Earthquake	8	Low
Wildfire	9	Low

Chapter 3: Risk Assessment

This chapter presents the natural hazard risk assessment performed for the City by the CHMC. The purpose of the assessment is to identify those facilities and population at risk from natural hazards, to overview the particular concerns, to gauge the potential level of impact on people and property, and to assess the level of risk posed within the City.

The Assessment has six primary components that culminate in the Risk Assessment Matrix (3.7). The primary components include a: Facilities Inventory (section 3.1), Hazard Mitigation Mapping (section 3.2), Fiscal Impact Analysis (section 3.3), Population Impact Analysis (section 3.4), Level of Risk Determination (section 3.5) and Vulnerability of Future Structures (section 3.6).

3.1 Facilities Inventory

The first step in the assessment process was to review and update the inventory of facilities of special concern to the City created for the 2010 HMP. The initial inventorying process ultimately addressed at least twenty-four separate topical areas and involved almost all departments of city government as well as staff from contributing entities such as the Providence Water Supply Board (PWSB) and American Red Cross (ARC).

Individual inventories were created for the fire stations, police station, city hall, emergency response headquarters, public works garage, American Red Cross Shelters, RIEMA evacuation routes, FEMA flood zones, city schools, bridges, culverts, high density residential buildings, care facilities and hospitals, child day care facilities, dams, public drinking water facilities, sewage treatment facilities, natural gas distribution facilities, electrical substations, marinas and mooring facilities, state response and correctional facilities, historic resources, repetitive loss properties and recreational facilities. These inventories can either be found depicted on the map presented in section 3.2, in the Risk Assessment Matrix presented in section 3.7 or in the Plan's appendices.

3.2 Hazard Mitigation Mapping

The facility inventory from the 2010 plan was reviewed and determined to be largely unchanged. The City's GIS data base, including parcel data, orthophotography and FEMA flood zone information, were utilized to complete this task. The use of this system not only allowed the CHMC to estimate potential fiscal and population impacts for individual parcels (see sections 3.3. and 3.4. for results) but also allowed them to analyze spatial relations between variables.

The final output of this exercise is the City of Cranston Risk Assessment Maps (Utilities and Community Resources) below. As the titles imply the focus of the maps is not to duplicate all of the spatial information generated through the inventorying process but rather to present the location of the identified risks as they relate to the City's response facilities. The mapped elements include parcels within flood zones, parcels with repetitive flood insurance claim, high density residential properties, adult and child care facilities, marinas, dams, electrical substations, bridges, city schools, state concerns, the gas metering station, water main extension location as well as ARC shelters, evacuation routes, fire stations, police station, city hall and the public works garage.

3.3 Fiscal Impact Analysis

The City of Cranston Tax Assessor's Database and GIS, and FEMA's 100-year flood plain data were utilized to generate estimates of potential fiscal impacts from natural hazard events. This differed from the 2010 assessment which looked at estimates based on the 500 year flood event. The information utilized from the tax assessor's database and GIS included the improvement values, land usage, and unit counts. The analysis showed that Cranston is comprised of 18,507 acres of land, with 1,110 acres of land (6%) in the regulatory flood plain. These 1,110 acres of land are spread throughout eight geographic areas of the

City. Six of these geographic areas include properties along and within the following six flood plains: Pocasset River, Pawtuxet River Main Stem, Meshanticut Brook, Furnace Hill Brook, Spectacle Pond, and Spring Lakes. The final two geographic areas are the two neighborhoods of Pawtuxet Village and Edgewood, which are within the coastal flood zone.

Table 9 displays potential damage estimates of property values of parcels that are located wholly or partially within the City's 100 year flood plain. The only limitation noted, using the best available data, is that the tax assessor database does not reflect the current market value of real estate. The table categorizes the improvement values into: residential, commercial/industrial, governmental and mixed use. The table also provides the percentage contribution of the area to the City's total flood plain parcels. This percentage was calculated in order to assist with identifying which areas are at greater risk. According to Table 10, the citywide total potential improvement damages for these flood plain areas are \$444,579,500. As reflected in the table, the areas with the largest percentage of parcels in flood plains are the Pocasset River (43%), the Pawtuxet River Main Stem (18%), and Furnace Hill and Meshanticut Brooks (26.3%). Coincidentally, these three areas have the highest potential dollar damages for total citywide improvements in flood plains. The table indicates that the Pawtuxet River Main Stem Flood Plain accounts for \$92,644,300 (20.8%) of the total improvements in flood plains; and the Pocasset River Flood Plain accounts for \$157,496,400 (35.4%) of the total improvements in flood plains. The sum of these two figures for total citywide improvements in floodplains is approximately triple the potential dollar damages in total improvements for the Furnace Hill and Meshanticut Brooks Flood Plain, which accounts for \$116,021,600 (20.9%) of the total citywide improvements in flood plains.

Further analysis of the City Tax Assessor's property improvement values, indicated the following facilities to be the most costly to replace in order of expense: state concerns, care facilities, sewerage treatment facilities, high-density residential properties within flood plains, historic resources, critical municipal hazard response facilities, schools within flood plains, Tennessee Gas Metering Station impacted properties, recreational facilities, marinas and private mooring facilities, and electrical facilities.

The state concerns within the City of Cranston relate primarily to the Pastore Center, which houses the State Correctional Complex, Medical Center, and the Rhode Island National Guard and RIEMA Headquarters. These concerns are susceptible to heavy rain, high winds, ice damage, and earthquakes. In the event RIEMA becomes non-operational, the State's public response system to hazard events would be hindered. The total potential improvement damages for these facilities are \$560,685,400

Currently, there are 6 public/assisted senior housing facilities, 7 private housing facilities, and 3 private nursing home facilities within the City. The special populations occupying these structures are particularly at-risk to natural hazard events such as high winds, excessive heat, and earthquakes, given the multistory nature of many of these structures. The total potential improvement damages for care facilities are \$72,043,500. Only Knightsville Manor and Randall Manor (public/assisted senior housing) are located on parcels that are in the 100-year flood plain.

Of the 23 sewerage treatment facilities in Cranston, 14 pumping stations are located on parcels within the 100-year flood plain (see Appendix A – Critical Municipal Facilities). Flooding at these facilities exposes the potential for sewer backups due to large amounts of water infiltrating the piping system and overwhelming the capacity of the pumping stations. These 14 sewerage treatment facilities account for \$5,542,200 in total potential property improvement damages. Since the 2010 plan update, the City has flood-proofed the sewerage treatment facilities at risk for flooding. The potential property improvement damages for the Pettaconsett Sewage Treatment Facility (not in the 100-year floodplain) is \$61,768,500.

Within Cranston, 16 high-density residential properties serve as alternative housing facilities that contribute to the City's residential housing stock and account for \$87,344,100 in total potential property improvement damages. Twelve of the high-density residential properties fall within the 100-year flood plain. Not in a flood plain, yet still a concern, is Springfield Apartments because part of the foundation is situated on a rock wall revetment. In the event of an earthquake, this rock wall revetment could become a serious hazard. Springfield Apartments accounts for \$13,919,100 of the aforementioned total potential property improvement damages.

The City has three National Historic Districts and a number of structures on the National Register of Historic Places that could be impacted by natural hazard events (see Appendix D – Inventory of Historic Properties). The total potential improvement damages are \$86,236,800. The Pawtuxet Village National

Historic District is the largest historic district within the City and contains 315 contributing parcels, 55 of which have structures in the SFHA. The estimated potential improvement damages for the entire Pawtuxet Village National Historic District are \$51,773,200. The Furnace Hill Brook National Historical and Archeological District is another historic district within the City and has 158 parcels, none of which have historic structures in the SFHA. The estimated potential improvement damages for the Furnace Hill Brook National Historic District are \$29,340,700. These damage estimates are based on improvement values for all parcels in the historic districts based on 2013 tax data, not just for structures in the Special Flood Hazard Area. The Oak Lawn Village National and Local Historic District is the third largest historic district within the City and contains 41 parcels, two non-historic structures are in the SFHA. The estimated potential improvement damages for the Oak Lawn Village National and Local Historic District are \$5,122,900.

Currently, the City has 12 critical municipal hazard response facilities. These facilities include city hall, the fire department/emergency management headquarters, five additional fire stations, the police department, the public works garage, the Hamilton Building, three ARC approved shelters, and the RIEMA evacuation routes (see Appendix A – Critical Municipal Facilities). However, due to their unique response capacity, only seven of these facilities and the Ocean Avenue – Narragansett Boulevard Evacuation Route had their total potential improvement damage value calculated. The total potential improvement damages were estimated to be \$36,042,100.

Of the 26 public education facilities in Cranston, only two facilities have property, not structures, within the 100-year flood plain (Oak Lawn Elementary and Cranston West Vocational Facility). See Appendix B – School Inventory. The total potential improvement damages are \$19,951,700.

The Tennessee Gas Pipeline Gatehouse Metering Station poses an additional concern to the City. The Gatehouse is located at 65 Laten Knight Road and is an above ground processing facility for a major gas transmittal line servicing New England. In the event of an earthquake, because of the presence of natural gas, it is extremely important to keep this facility isolated due to the potential for explosion and threat to life. To estimate the potential dollar damages in the event of a blast originating from the Gatehouse, GIS was utilized to create a 1,000' impact zone. Within this zone there would be approximately 31 parcels damaged and the total potential improvement damages could climb as high as \$3,950,400.

Within Cranston, 4 recreational facilities were highlighted as resources of concern and include the CLCF, Budlong Pool, Cranston Stebbins Stadium, and the Cranston Veterans Ice Rink. Currently, the CLCF and Budlong Pool fall entirely within the 100-year flood plain. Cranston Stebbins Stadium and the Cranston Veterans Ice Rink were highlighted because of the possibility of high wind, ice damage, or even an earthquake. The total potential improvement damages to these four structures are \$2,933,600.

The coastline of Cranston, close to three miles in length, is the home of five marinas containing 405 slips. In addition, there are 137 moorings within the City. Excluding vessels, the total potential improvement damages are \$2,334,400.

The area bounded by Plainfield Pike to the north, Town of West Warwick to the south, Interstate 295 to the east, and Seven Mile Road to the west, is commonly referred to as the "Western Cranston Water District" or the WCWD. This district is currently provided with water through one singular distribution main at South Comstock Road running between Fox Ridge and Tomahawk Trail. If that main were to rupture due to an earthquake, approximately one-third of the City would be without water. The total potential improvement damages are \$375,000. This figure was derived from the cost to provide a secondary source for water service by connecting a 1900' gap in service mains.

Lastly, National Grid has a substantial number of general transmission lines running throughout the City and six electrical substations. Although National Grid services these general transmission lines and substations, the total potential improvement damages for the six electrical substations are \$ 71,400. In reviewing this section, the CHMC would note that the \$71,400 identified as the potential for damages represents only the structures on site. The CHMC recognizes that there is substantial value associated with the equipment on site. However, cost estimates are not readily available and will be added into the HMP as they are obtained.

If a natural hazard event were to occur, the improvement damages and the fiscal impacts to the City could be crippling. Approximately 75 percent of the City's revenue is generated from property tax (76 percent from residential and 24 percent from commercial). Should any of the tax base be destroyed by a natural disaster, remaining property owners would carry an increased financial burden with regards to property taxes. Therefore, it is in the best interests of the City of Cranston to take the appropriate provisions necessary to protect both persons and property from natural disasters. In addition, as Cranston's population continues to grow, so does the burden of protecting people and property.²¹

Table 9: Assessment of Property Improvement Values within Flood Plains

Pawtuxet Watershed												
			Residential		Commercial		Other		Governmental		Total	
<i>Floodplain</i>	Parcel s	%	Improvement s	%	Improvement s	%	Improvement s	%	Improvement s	%	Improvement s	%
Pocasset	1,072	43	\$72,662,700	40.7	\$21,106,500	37.6	\$42,760,500	44	\$20,966,700	18.3	\$157,496,400	35.4
Pawtuxet	449	18	\$10,521,000	5.9	\$6,181,300	11	\$12,845,800	13.5	\$63,096,200	55	\$92,644,300	20.8
Spectacle Pond	72	3	\$921,400	0.5	\$24,203,400	43.1	\$154,900	0.2	\$38,400	0.03	\$25,318,100	5.7
Spring Lake	5	0.2	\$238,000	0.1	\$0.00	0	\$0.00	0	\$250,000	0.2	\$488,000	0.1
Furnace Hill Meshanticut Brooks	654	26.3	\$227,000	0.1	\$3,266,700	5.8	\$15,277,500	16	\$25,023,800	22	\$43,795,000	9.8
Turner Pond	42	1.7	\$53,146,700	29.8	\$0.00	0	\$3,429,100	3.6	\$0.00	0	\$56,575,800	12.7
Subtotal	2,294	92	\$137,716,800	77	\$54,757,900	97.7	\$74,467,800	78.2	\$109,375,100	95.3	\$376,317,600	84.6
Coastal Areas												
			Residential		Commercial		Other		Governmental		Total	
<i>Floodplain</i>	Parcel s	%	Improvement s	%	Improvement s	%	Improvement s	%	Improvement s	%	Improvement s	%
Subtotal	198	8	\$40,814,700	23	\$1,310,000	2.3	\$20,718,500	21.8	\$5,418,700	4.7	\$68,261,900	15.4
Total	2,492	100	\$178,531,500	100	\$56,067,900	100	\$95,186,300	100	\$114,793,800	100	\$444,579,500	100

Source: City of Cranston IT Department and Tax Assessor's Database. 2014.

Note: The values contained in the tax assessor database do not reflect the current market value of real estate.

3.4 Population Impact Analysis

In order to estimate the number of City residents impacted by natural hazard events, the number of occupied dwelling units was multiplied by the average household size per occupied dwelling unit (2.54).²² This approach was utilized throughout this population analysis.

According to Table 11, using the Tax Assessor's Database and the City's GIS, there are total of 585 residential structures within City's 100-year flood zone. This includes a mix of single family, multi-family and larger condo/apartment structures.

In addition, according to Table 10, an estimated 6,070 (87.7%) residents live within the Pawtuxet River flood plain and 1,447 (19%) residents located in the Furnace Hill and Meshanticut Brooks flood plain. The Pawtuxet flood plain included both the Pawtuxet River and the Pocasset River with 3,789 (49.7%) residents located in the Pocasset River flood plain, and 1,447 (19.0%) residents located in the Pawtuxet River flood plain.

Furthermore, based on Table 10, an estimated 1,020 (12.3%) residents live in the City's coastal flood zone flood plain area.

The Providence Water Supply Board holds 2,089 residential accounts in western Cranston that are served by the singular distribution main at South Comstock Road. The at-risk population was estimated to be 5,307 which are slightly more than 10% of the entire Cranston population.

The occurrence of a natural hazard event creates a higher potential for the special populations at the Pastore Center to be rendered vulnerable due to higher security and health concerns. The population at this state institution center was reported at 3,674 in the 2009 US Census.²⁵

Currently, there are 1,435 occupied dwelling units within the sixteen high-density residential properties, including the Johnson & Wales dormitories, located in the City. The high-density residential properties at-risk population was estimated to be 3,611. Excluding Springfield Apartments (which is not within a flood plain) the population estimated to be at-risk is 3,096.

The fifteen care facilities in the City have a total capacity of 1,545 residential units. Assuming a one person-per unit occupancy rate, the population at these facilities has been estimated at 1,545.

The three public schools that are within the City flood plain areas are George J. Peters, Oak Lawn, and the Cranston West Vocational Facility. In the event of a natural hazard as many as 2,270 students could be displaced from these schools. [Note the Cranston School Department does not count Cranston West and Cranston West Vocational enrollments separately. Students share classes at both campuses.]

Approximately 31 parcels are located the 1,000' impact zone of the Tennessee Gas Pipeline Gatehouse Metering Station with an estimated 79 residents to be considered at-risk.

The final two facilities of concern for which at-risk population estimates were developed for included the sewerage treatment facilities, and the general transmission lines and six electrical substations. These estimates project worst-case scenarios. Therefore, considering that the sewerage treatment facilities serve 22,870 residential units, the appropriate calculation yields 58,090 at-risk residents. With regard to the general transmission lines and the six electrical substation facilities that serve the City of Cranston, the entire 81,686 city population is classified as at-risk.

Lastly, at-risk population estimates could not be developed for historic resources, critical municipal hazard response facilities, recreational facilities, and marinas and private mooring fields. Therefore, the analysis classifies the at-risk population as not available.

Table 10: Population Living within Flood Plains

Pawtuxet River			
Flood Plain Area	Occupied Units	Population	%
Pocasset River	1492	3789	49.7
Pawtuxet River	570	1447	19
Furnace Hill Brook & Meshanticut Brooks	570	1447	10
Spectacle Pond	8	20	0.6
Spring Lake	1	3	0.1
Subtotal	2640	6707	87.7
Pawtuxet Village	183	545	6.1
Edgewood	187	475	6.2
Subtotal	370	1020	12.3
City Wide Total	3010	7726	100

Source: City of Cranston GIS and Tax Assessor's Database. 2010.

3.5 Level of Risk Determination

Determining the City's level of risk from natural hazards was completed through a combined ranking, of the fiscal and population impacts for each of the 14 resources of concern (see Table 12). These rankings were then divided into high, medium, and low categories using a quantile approach.

The statistical rankings were then analyzed to determine if additional non-numerical factors should be adjusted for. In the end, the classifications for the state concerns, the WCWD, schools, critical municipal response facilities, and historic resources were adjusted.

The state facilities were designated as a medium, because the administration and management of the Pastore Center falls under the control of the State. The WCWD concern was designated as a low, because the historical analysis of earthquake occurrences proved it to have a low probability. School facilities designated as a low because schools are likely to be closed during a major storm event. Historic facilities were designated as a low because the low probability that all historic resources would be affect by any one event. Critical municipal hazard response facilities were designated as a medium, because they are key for coordinating a strong governmental response to a natural hazard event. Since 2010, all pump stations in the 100-year floodplain have been floodproofed, reducing potential improvement damages but the facilities still remain a high concern for the City.

The level of risk determination as presented in 2010 was reviewed by the CHMC. While the fiscal impacts have changed since then, the level and ranking of risks remains unchanged.

Table 11: Level of Risk Determination

Risk	Fiscal Impacts		Est. Population Impacts		Combined Ranking	Classification	
	Damages	Ranking	Population	Ranking		Initial	Final
Flood Prone Drainage Systems	\$599,862,240	12.5	7,726	10.5	23.0	High	High
Dams	N/A	12.5	N/A	10.5	23.0	High	High
Sewage Treatment Facilities	\$5,542,200	9	58,090	13	22.0	High	High
State Concerns	\$560,685,400	14	4,051	9	23.0	High	Medium
Care Facilities	\$72,043,500	11	1,545	6	18.0	High	High
High Density Residential	\$87,344,100	7	3,096	8	15.0	Medium	Medium
Electrical Facilities	\$71,400	1	81,686	16	17.0	Medium	Medium
Western Cranston Water District	\$375,000	2	5,307	12	14.0	Medium	Low
Schools	\$3,152,500	6	2,270	7	13.0	Medium	Low
Historic Resources	\$86,236,800	10	N/A	2.5	12.5	Medium	Low
Tennessee Gas Pipeline	\$3,950,400	5	79	5	10.0	Low	Low
Critical Municipal Response Facilities	\$560,685,400	8	N/A	2.5	10.5	Low	Medium
Recreational Facilities	\$2,933,600	4	N/A	2.5	6.5	Low	Low
Marinas & Private Mooring Facilities	\$2,334,400	3	N/A	2.5	5.5	Low	Low
Mean				15	High Quartile Range= 23 to 17.2		
Cut Points				5.8	Medium Quartile Range= 17.1 to 11.3		
					Low Quartile Range= 11.2 to 5.4		

3.6 Vulnerability of Future Structures

A preliminary buildout analysis produced by the Cranston Planning Department projects that the potential exists for an additional 2,760 residential, 231 commercial, and 84 industrial units to be constructed within the city over the years to come. Whereas all of these may be at risk to hazards such as earthquakes, hail, hurricanes, lightning, tornados, severe winter storms, high wind events and thunderstorms; the possibility does exist for 551 residential, 21 commercial, and 9 industrial units to be developed specifically within flood zones. The CHMC has reviewed the build out analysis and has determined that, given the significant downturn in the economy since 2010, the assumption and conclusions of the buildout analysis remain unchanged.

3.7 Risk Assessment Matrix

The matrix (Table 12: Risk Assessment and Identification of Priority Problems in Cranston) represents the culmination of the risk assessment process and is the final product. Its purpose is to gather all the pertinent results in one place for ease of presentation and to serve as a starting point for discussion of specific mitigation actions. It not only lists the specific concerns, but provides detailed location information, summarizes the applicable hazard, problem, mitigation benefits, and the perceived level of risk.

Table 12 Risk Assessment Matrix

Table 12 Critical Infrastructure

Cranston Hazard Mitigation Plan 2014

RISK	LOCATION	HAZARD	PROBLEM	BENEFITS	LEVEL OF RISK:
I. Flood Prone Drainage Systems	<p>A. <u>Pocasset River Flood Plain</u></p> <p>1. Fletcher Avenue Industrial Park Area - Regularly floods from Plainfield Pike (State Highway), southerly along Fletcher Avenue (State Highway) to approximately Tabor Street including bridge number 8101 (A.P. - 12/1 and 12/2).</p> <p>2. Lower Eden Park Neighborhood - Area of concern lies between Reservoir Avenue and Pontiac Avenue northeast of the Pocasset River including Davis Court, Autumn Street, and Fordson Avenue (A.P. 9/1).</p> <p>3. Garden City Neighborhood - Area of concern lies primarily along Lawnacre Drive between Reservoir Avenue (State Highway) and Pontiac Avenue (State Highway) on the southerly section of the Pocasset River including bridge numbers 2301, 20101, and 75801 (A.P. - 9/1, 9/2, and 10/2).</p> <p>4. Garden City Center- Specifically Midway Road behind Garden City Center, Hillside Road which runs through the northern portion of the mall area, and the retail area between Route 2 (Reservoir Ave.) and Midway Road which sits lower than Route 2, experience flooding from street runoff.</p> <p>5. Upper Eden Park Neighborhood - Area of concern lies between Reservoir Avenue (State Highway) and Pontiac Avenue (State Highway), northeast of the Pocasset River including Aqueduct Road, Delway Road, Interavale Road, and Longway Road (A.P. 9/2).</p> <p>6. Park Avenue Area - Floods in the vicinity of Old Park Avenue including bridge numbers 48001 and 49401 (A.P. - 11/1).</p> <p>7. Cranston Print Works Area - Area of concern is bounded by the Pocasset Cemetery to the north, Dyer Avenue to the east, the Dyer Avenue Industrial Park to the south and Southern Street to the west including bridge number 99501 (A.P. - 8/1, 8/2, 8/3, 8/4, and 8/5).</p> <p>8. Pontiac Avenue Area – The apartment complex located at 825 Pontiac Avenue (A.P. 9 Lot 149).</p> <p>9. Pontiac Avenue Area – The City’s sewer pump station located at 900 Pontiac Avenue (A.P. 5 Lot 1). This pump station process over 75% of the City’s sewerage flows.</p> <p>10. Zinnia Drive Area – In 500 year flood plain. Drainage system suffers flash floods and includes the Greylawn trucking depot downstream. Ties into State system on Pontiac Avenue before discharge into the Pocasset River. Poplar Circle and Dellwood Drive which are upstream of Zinnia Drive also suffer from flash flooding. This entire area, located to the east of the mall is part of the Garden City shopping center watershed.</p> <p>B. <u>Meshanticut Brook Flood Plain</u></p> <p>1. Meshanticut Area - Primary area of concern is the flooding that occurs on Wilbur Avenue including Burdick Drive, Redfern Drive, Amanda Court, Rodel Street, Clay Street, Warren Avenue, Ellison Street, and Benjamin Avenue, including bridge numbers 42401 and 2401, and culvert number 81901(A.P. – 18/2, 18/3, and 18/4).</p> <p>2. Meshanticut Brook Culvert System - This is the largest culvert system in the City of Cranston and is located beneath Interstate 295 and Route 37, and includes culvert numbers 81221, 81401, 81421, 81501, 81601 and 81701 (A.P. - 18/1, 18/2, 18/4, 19/1, and 19/3).</p> <p>3. Lodge and Abbot street show signs of significant flash flooding due to possible undersized pipes as part of the drainage network that discharges into Meshanticut Pond.</p> <p>4. Wedge Street – In 100 year flood plain. Drainage system suffers from flash flooding. Connected to Oaklawn Avenue, Dean Parkway watershed area. Oaklawn Avenue and Dean Parkway are State drainage systems.</p> <p>C. <u>Furnace Hill Brook Flood Plain</u> - Natick Avenue floods in the vicinity of Furnace Hill Brook including bridge number 42401, a bridge on Phenix Avenue and a bridge on Hope Hill Terrace, and culvert number 81801 (A.P. - 19/1, 21/2, and 25/3).</p> <p>D. <u>Pawtuxet River Flood Plain (Main Stem)</u></p> <p>1. Elmwood Area - Floods occur on Wellington Avenue including bridge number 101, specifically in the vicinity where the Amtrak main line bridge crosses over the Pawtuxet River and intersects with Elmwood Avenue (State Highway) (A.P. - 4/2 and 5/3).</p> <p>2. Parkview Area - Floods occur at Perkins Avenue including bridge numbers 15001 and 19001, a private footbridge and private abandoned bridge on Mill Street (A.P. - 1, 4/3 and 4/5).</p> <p>3. Pontiac Av enue Area – Floods occur at the City’s sewer treatment facility located of off Pontoace Avenue at 140 Pettaconsett Avenue (A.P. 10 Lot 27).</p> <p>E. <u>Pawtuxet Coastal Flood Zone</u> - Floods occur at Ocean Avenue after the intersection with Commercial Street, and on Narragansett Boulevard in the vicinity of Stillhouse Cove (A.P. - 1 and 2/2).</p> <p>F. <u>Spectacle Pond Flood Plain</u> - Floods occur at the end of Lake Street in the vicinity of a small culvert (A.P. - 7/5).</p> <p>G. <u>Auburn Area</u> - Garden Street has a flash flooding drainage issue before intersection at Laurens Street (A.P. - 5/1). Connected to State Route 95 system with final discharge to Fenner Pond.</p> <p>H. <u>Spring Lakes Flood Plain</u> - Bridge number 99601 carries Seven Mile Road over Clark Brook, and bridge number 84201carries Hill Street in Coventry over the Pawtuxet River to Main Street in Cranston (A.P. - 30/1).</p> <p>I. Rhode Island State Roads 2 and 5.</p> <p><i>Source: Bridge and culvert data provided by David DeNuccio, Cranston Engineering Dept., 06/27/2003. (See Appendix C: Inventory of All Bridges and Culverts).</i></p>	<p>Primary concern is for flooding related to heavy rain and storm surge events. A secondary concern relates to potential earthquake damage to bridges and culverts.</p>	<p>These drainage systems have historically flooded and face a higher potential than other areas in Cranston for future flooding. Flood events of 3 to 4 inches over a 24-hour period have the potential to hinder physical access in and out of these areas, disrupt utility service, cause real property damage, and threaten life.</p> <p>Total potential improvement damages are \$555,428,000 and the total potential population at-risk is 7,727.</p> <p><i>(See Section 3.3 and 3.4 for more detailed discussion).</i></p> <p>The estimated potential improvement damages for the Pocasset River are \$188,740,200 and the estimated at-risk population is 3,785.</p> <p>The estimated potential improvement damages for Meshanticut Brook and Furnace Hill Brook are \$116,021,777 and the estimated at-risk population is 1,447.</p> <p>The estimated potential improvement damages for the Pawtuxet River Main Stem are \$156,955,900 and the estimated at-risk population is 1,447.</p> <p>The estimated potential improvement damages for the Coastal Flood Zone are \$116,021,700 and the estimated at-risk population is 1,020.</p> <p>The estimated potential improvement damages for Spectacle Pond are \$21,482,700 and the estimated at-risk population is 20.</p> <p>The estimated potential improvement damages for Spring Lakes are \$488,000 and the estimated at-risk population is 3.</p>	<p>Protection of property, reduction of cleanup and repair costs, and insurance losses. Improved physical access and the protection of life and public safety.</p> <p>The Pocasset River Flood Plain Management Study, conducted by NRCS, produced a 1.07 benefit/cost ratio for the area of Cranston within the Pocasset River Flood Plain. The total estimated benefits (\$15,895,391) reflect reduced flood damages as a result of installing flood prevention measures. The benefits are net of project administration costs and operation and maintenance costs. The total estimated costs (\$14,856,180) represent the installation costs for planned flood control measures</p>	High

Table 12 Critical Infrastructure

Cranston Hazard Mitigation Plan 2014

RISK	LOCATION	HAZARD	PROBLEM	BENEFITS	LEVEL OF RISK
II. Dams	A. ANGELL'S POND B. ARROW LAKE #1 C. ARROW LAKE #2 D. CLARKE'S POND UPPER (high hazard) E. CLARKE'S POND LOWER F. COLVIN POND G. CRANSTON PRINT WORKS POND (high hazard) H. CURRAN LOWER RESERVOIR (high hazard) I. CURRAN UPPER RESERVOIR (high hazard) J. FEDOROWICZ FARM POND K. JUDGE FARM POND L. MARSELLA FARM POND M. MESHANTICUT PARK POND (significant hazard) N. PAWTUXET RESERVOIR LOWER O. PETTACONSETT P. POWERS POND Q. R.I. PRINTWORKS POND R. SARGENT'S POND S. STATE PRISON UPPER T. STONE POND (high hazard) U. WOOD'S MILL POND V. CONFREDA SEE APENDIX -----FOR DESCRIPTION OF THE DAMS.	Flooding related to heavy rain events, and structural damage due to earthquake. Deterioration due to lack of ongoing maintenance	Extreme rain and earthquake events have the potential to cause structural failure resulting in catastrophic flooding. Calculation of potential improvement damages and populations at-risk is impractical for the City at this time.	Structural preservation preventing catastrophic flooding, reducing property loss and protecting public health, safety, and welfare.	High
III. Care Facilities	A. <u>Public/Assisted Senior Housing</u> 1. Randall Manor - 175 Mathewson Street - 168 units (A.P. - 8/1 Lot 328). 2. Jennings Building - 125 Harris Avenue 152 units (A.P. - 7/1 Lot 787). 3. Arlington Manor - 50 Birch Street - 151 units (A.P. - 7/1 Lot 787). 4. Knightsville Manor - 85 Briggs Street - 99 units (A.P. - 11/2 Lot 232). 5. Hall Manor - 70 Warwick Avenue - 79 units (A.P. - 2/5 Lot 3962). 6. Budlong Manor - 100 Arthur Street - 71 units (A.P. - 5/2 Lot 2556). B. <u>Private Housing</u> 1. Scituate Vista – private/assisted senior housing – 125 Scituate Vista Drive - 233 units (A.P. - 20/2 Lot 2170). 2. Meshanticut Vista – private/assisted senior housing - 225 New London Avenue 99 units (A.P. - 10/3 Lot 666). 3. Park Avenue Apartments – private/assisted housing - 315 Park Avenue - 71 units (A.P. - 3/1 Lot 1011). 4. Victoria Court - private/assisted senior housing - 55 Oaklawn Avenue - 43 units (A.P. - 11/3 Lot 1856). 5. Harris House - private/assisted senior housing - 28 Harris Avenue - 60 units (A.P. - 7/2 Lot 3142). 6. Scandinavian Retirement Home - private/assisted senior housing - 50 Warwick Avenue - 35 units (A.P. - 2/5 Lot 1334) 7. New Life Estates, Inc – private handicapped housing -20 Phenix Avenue – 12 unites (A.P. 11 Lot 4077) C. <u>Private Nursing Homes</u> 1. Cedar Crest – private nursing facility - 125 Scituate Avenue - 99 units (A.P. - 37/4 Lot 611). 2. Cra-Mar – private nursing facility -575 Seven Mile Road - 40 units (A.P. - 30/2 Lot 213). 3. Scandanavian Home – private nursing facility - 1811 Broad Street - 30 rooms with 130 beds (A.P. - 2/5 Lot 1335). <i>Source: Sal Saccoccio, Cranston Tax Assessor 7/2010.</i>	High winds, excessive heat events, as well as concerns for earthquakes given the multistory nature of many of the structures.	These care facilities play a vital role in housing Cranston's elderly and handicapped populations. The occurrence of a natural hazard event creates a higher potential for these special populations to become vulnerable due to their reduced mobility, thus placing their lives and living quarters in danger. Total potential improvement damages are \$66,670,400 and the total potential population at-risk is 1,545. The estimated potential “Public/Assisted Senior Housing” at-risk population is 720. The estimated potential “Private Housing” at-risk population is 570. The estimated potential “Private Nursing Homes” at-risk population is 269.	Protection of life.	High
IV. Critical Municipal Hazard Response Facilities	A. <u>Municipal Offices</u> 1. Cranston City Hall - 869 Park Avenue (A.P. - 6/2 Lot 240) 2. Cranston Fire Department Headquarters/ Cranston Emergency Management Agency Headquarters - 301 Pontiac Avenue (A.P. - 6/2 Lot 260). 3. Cranston Police Station –5 Garfield Avenue (A.P. - 7 Lot 3873). 4. Cranston Public Works Garage – 929 Phenix Avenue (A.P. - 17/1 Lot 200). 5. Cranston Building Inspection and Engineering Department – 1090 Cranston Street (A.P. 7 Lot 2630). B. <u>American Red Cross Approved Emergency Shelters</u> 1. Cranston Senior Services Center – 125-person capacity, 1070 Cranston Street (A.P. - 7/4 Lot 2371). 2. Western Hills Middle School – 250-person capacity, 400 Phenix Avenue (A.P. - 17/2 Lot 1810). 3. Park View Middle School – 378-person capacity, 25 Park View Boulevard (A.P. - 4/4 Lot 1400). 4. Hope Highland Elementary School – 1555 Scituate Avenue (A.P. 34 Lot 8). 4. Cranston Youth Center – 155 Gansett Avenue (A.P. 11 Lot 2984). C. <u>Ocean Avenue - Narragansett Boulevard Evacuation Route</u> <i>Source: A.R.C. approved emergency shelter capacities provided by James Gumbley Fire Chief of the Cranston Fire Department, 6/2010. (See Appendix A: Critical Municipal Facilities.)</i>	Depended upon for responding to all natural hazard events.	Potential loss of physical access, power supply and critical systems, thus hindering the governmental response to natural hazard events. The Cranston Emergency Management Agency is the command center; Cranston's communication tower and facilities are located at the police station and Cranston's heavy-duty response machinery such as backhoes and loaders are stored at the public works facility. The emergency shelters are critical in protecting the lives of Cranston residents. However, Cranston faces a shortage of space with an anticipated evacuation population of 1640 under a 500-year storm, and a shelter capacity for only 753. In addition, there is a need to upgrade the existing shelters to make them more habitable during emergencies. Ocean Avenue and Narragansett Boulevard, in the vicinity of Stillhouse Cove, are primary evacuation routes for the coastal portions of the City. In the event of hurricanes and high wind hazards, these evacuation routes face a serious threat of failure due to wind and wave induced erosion. Total potential improvement damages are \$36,042,100. Population impacts do not apply here, since the properties of concern are not residential in nature.	Protection of essential public services, records, evacuation routes, and the general livelihood of Cranston residents and their property.	Medium

Table 12 Critical Infrastructure

Cranston Hazard Mitigation Plan 2014

RISK	LOCATION	HAZARD	PROBLEM	BENEFITS	LEVEL OF RISK
V. Sewerage Treatment Facilities	<p>A. <u>Pettaconsett Sewage Treatment Facility</u> -Pettaconsett Avenue (A.P. - 10/2 Lot 27)</p> <p>B. <u>Pumping Stations within Flood Plain</u></p> <ol style="list-style-type: none">Allard Pumping Station – Historically has flooded. 85 Allard Street (A.P. - 18/4 Lot 692).Randall Street Pumping Station – Historically has flooded. 176 Randall Street (A.P. - 12/4 Lot 2825).Seaview Avenue Pumping Station – Pumping station within velocity zone. 85 Seaview Avenue (A.P. - 1 Lot 496).Bay View Avenue Pumping Station – 9 Bay View Avenue (A.P. - 2/3 Lot 2769).Dyer Avenue Pumping Station - 399 Dyer Avenue (A.P. - 8/4 Lot 2691).Hollow Tree Pumping Station – 1771 Pontiac Avenue (A.P. - 15/3 Lot 1577).Howard Pumping Station – 103 Kenney Drive (A.P. - 10/4 Lot 1466).Sheldon Street Pumping Station – 115 Sheldon Street (A.P. - 1 Lot 82).Sherman Avenue Pumping Station – 90 Sherman Avenue (A.P. - 17/3 Lot 1822).Woodbury Road Pumping Station - 110 Woodbury Road (A.P. - 1 Lot 467).Worthington Road Pumping Station – 54 Worthington Road (A.P. - 10/4 Lot 767).Youlden Avenue Pumping Station - 7 Youlden Avenue (A.P. - 4/3 Lot 822). <p>13. Pontiac Pumping Station – 900 Pontiac Ave (A.P. 5 Lot 1)</p> <p>14. Mayflower Pump Station – 140 Mayflower Dr. (A.P. 4 Lot 5).</p> <p><i>Source: Jack McGilvray, Cranston Public Works Aide, 05/06/2003. Historical natural hazard events provided by William Wilbur, Collection Supervisor for Veolia Water, 5/14/2003. (See Appendix A: Critical Municipal Facilities).</i></p>	Flooding resulting from heavy rain events or coastal storm surge.	<p>Flooding at these facilities causes two distinct problems. First, there is the potential for sewer backups due to large amounts of storm water infiltrating the piping system and overwhelming the capacity of pumping stations. Second, there is a potential for sewer backups due to short-circuiting of pumping equipment caused by overland flooding of pumping stations themselves.</p> <p>Total potential improvement damages are \$62,226,000.</p> <p>There are 22,870 residential units connected to the sewer system. This figure multiplied by the 2.54 average household size per occupied dwelling unit, indicates the total potential at-risk population is 58,090 dependents. This figure accounts for 71% of the City population.</p>	Reduced cleanup and repair costs and protection of public welfare through the elimination of a potential health concern.	High
VI. High-density Residential Properties within Floodplains	<p>A. <u>Willow Brook Apartments</u> - 825 Pontiac Avenue - 252 units (A.P. - 9/1 Lot 149).</p> <p>B. <u>Riverbend Apartments</u> - 575 Dyer Avenue - 168 units (A.P. - 8/3 Lot 999).</p> <p>C. <u>Johnson and Wales Hospitality Center</u> – 1150 Narragansett Boulevard - 134 units (A.P. - 2/3 Lot 681).</p> <p>D. <u>Pocasset Apartments</u> - 941thru 945 Dyer Avenue -120 units (A.P. - 11/1 Lot 3586).</p> <p>E. <u>Garden Village Apartments</u> - 935 Pontiac Avenue - 95 units (A.P. - 10/2 Lot 4).</p> <p>F. <u>Western Hills Village Apartments</u> - 2 thru 7 Western Hills Lane - 84 units (A.P. - 12/6 Lot 2945).</p> <p>G. <u>Farmington Terrace Apartments</u> - 151 Farmington Avenue - 56 units (A.P. - 8/4 Lot 14).</p> <p>H. <u>Riverview Acres Apartments</u> - 130 Fordson Avenue - 48 units (A.P. - 9/1 Lot 145).</p> <p>I. <u>Rosedale Landings</u> - 1180 Narragansett Boulevard - 34 units (A.P. - 2/3 Lot 1912).</p> <p>J. <u>King Philip Arms Apartments</u> - 2015 Broad Street - 24 units (A.P. - 2/6 Lot 2595).</p> <p>K. <u>Aqueduct Apartments</u> - 292 Aqueduct Road - 17 units (A.P. - 9/2 Lot 2736).</p> <p>L. <u>Harbor Apartments</u> - 1224 Narragansett Boulevard - 11 units (A.P. - 2/3 Lot 2757).</p> <p>M. <u>Bellevue Apartments</u> - 100 Arcadia Avenue - 8 units (A.P. - 4/4 Lot 1230).</p> <p>N. <u>Conetta's Trailer Park</u> - 443 Dyer Avenue - 20 trailers (A.P. - 8/4 Lot 844).</p> <p>O. <u>Johnson and Wales Dormitories</u> - 100 Harborside Boulevard - 148 Student units/576 beds (A.P. 2 Lots 3974, 3935, 3949)</p> <p>P. <u>Springfield Apartments</u> - 100 Elena Street - 216 units (A.P. - 12/3 Lot 2429). <i>Not in a floodplain but part of foundation is situated on a rock wall revetment.</i></p> <p><i>Source: Sal Saccoccio, Cranston Tax Assessor</i></p>	Flooding from heavy rain, as well as concerns for earthquakes given the multistory nature of many of the structures	<p>These alternative housing facilities contribute to Cranston's high residential housing stock. The occurrence of a natural hazard event creates a threat to life and property damage.</p> <p>Total potential improvement damages are \$66,465,000 and the total potential at-risk population is 3,611.</p>	Protection of life and the preservation of diverse and affordable housing stock.	Medium
VII. Marinas and Private Mooring Facilities	<p>A. <u>Edgewood Yacht Club</u> - 1 and 3 Shaw Avenue (A.P. - 2/2 Lots 866, 2852, and 4000).</p> <p>B. <u>Port Edgewood Marina</u> - 1128 Narragansett Boulevard (A.P. - 2/4 Lots 680, 1896, 1966, 2491, 2492, 2865, 3952, 3955, and 3993).</p> <p>C. <u>Pawtuxet Athletic Club</u> – 12 Aborn Street (A.P. - 1 Lots 26 and 27).</p> <p>D. <u>Rhode Island Yacht Club</u> – 1 Ocean Avenue (A.P. - 2/2 Lot 1678, 3793, and 3794).</p> <p>E. <u>Pawtuxet Cove Marina</u> - 8 Aborn Street and 69 Fort Avenue (A.P. - 1 Lots 28, 29, 88, and 91).</p>	Flooding from heavy rain and coastal storm surge; high winds, and earthquake.	<p>These marinas provide residents of Cranston places to go for recreational and leisure activity, as well as the occasional residence. The occurrence of a natural hazard event creates a threat to life and property damage. There currently exist 405 slips and 137 moorings within the City.</p> <p>Excluding vessels, the total potential improvement damages are \$1,366,600. Estimates of vessel value and the number of live-boards is impractical at this time.</p>	Protection of the lives of individuals who reside in the marinas. Reduced potential for property damage, as well as the provision of commercial and recreational water dependant activities	Low
VIII. Electrical Facilities	<p>A. <u>General Transmission Lines</u></p> <p>B. <u>Substations</u></p> <ol style="list-style-type: none">Well Avenue Substation - Well Avenue (A.P. - 5/3 Lot 2538).Huntington Park Substation - Corner of Kenwood Street and Niantic Avenue (A.P. - 7/2 Lot 2581).Knightsville Substation - Corner of Park Avenue and Palmer Street (A.P. - 11/2 Lot 1754).Pontiac Substation - End of Ross Simon Drive (A.P. - 13 Lot 44).West Cranston Substation - Laten Knight Road approximately 500' west of Pippin Orchard Road (A.P. - 28 Lot 47).Elmwood Substation – 510 Wellington Avenue (A.P. – 3/3 Lot 508). <p><i>Source: Steve Marin, Narragansett Electric Engineer, 4/29/2003</i></p>	High winds, ice damage, and earthquake.	<p>High winds and ice damage resulting in falling objects breaking transmission lines and damaging substations.</p> <p>Excluding the service population of 81,686 the total potential improvement damages for the electrical substations are \$58,700.</p>	Provision of essential utility service, reduction in cleanup and repair costs, and the promotion of public health, safety, and welfare.	Medium
IX. Schools within Floodplains	<p>A. <u>Elementary Schools</u></p> <ol style="list-style-type: none"><u>George J. Peters Elementary</u> - Historically has flooded. (Peters also doubles as a YMCA child daycare facility). 15 Mayberry Street - Grades K – 5 (A.P. - 12/4 Lot 3244).<u>Oak Lawn Elementary</u> - 28 Stoneham Street - Grades K - 5 (A.P. - 18/4 Lot 692). <p>B. <u>Cranston West Vocational Facility</u> - 80 Metropolitan Avenue - Grades 9 - 12 (A.P. - 17/2 Lot 1956).</p> <p><i>Source: Historical natural hazard events provided by Joel Zisserson, Cranston School Department Director of Transportation, 07/02/2003 and 07/28/2010. €(See Appendix B: School Inventory and Appendix E: Inventory of Child Daycare Facilities).</i></p>	Flooding, resulting from a coastal storm surge or heavy rain, high winds, and earthquake.	<p>These school facilities play a vital role in educating Cranston's youth. The occurrence of a natural hazard event creates a higher potential for students to be rendered vulnerable, thus placing their lives in danger. Furthermore, the physical structures themselves are put at-risk for severe property damage.</p> <p>Total potential improvement damages are \$8,090,400.</p> <p>The total enrollment for the three facilities is 2,270.</p>	Provision of a safe and secure learning environment, as well as the protection of school infrastructure from property damage.	Low

Table 12 Critical Infrastructure

Cranston Hazard Mitigation Plan 2014

RISK	LOCATION	HAZARD	PROBLEM	BENEFITS	LEVEL OF RISK
X. State Concerns	<p>A. <u>State Adult Correctional Institution Complex and Medical Center</u> – Pastore Center (A.P. - 13 Lot 39; A.P. - 14 Lots 4, 5, 6, 7, 8, 9, and 10; A.P. - 15-3 Lots 7, 19, 50; A.P. 15-4 Lot 1694).</p> <p>B. <u>Boys and Girls Training School</u> - Pastore Center (A.P. - 14 Lot 15).</p> <p>C. <u>Rhode Island National Guard Headquarters/ Rhode Island Emergency Management Agency (R.I.E.M.A.)</u> - 645 New London Avenue (A.P. - 15/4 Lot 1696).</p> <p>D. <u>State Bridges and Culverts</u> - not in Flood Prone Drainage System section of risk identification matrix.</p> <p><i>(See Appendix C: Inventory of All Bridges and Culverts)</i></p>	Heavy rain, high winds, ice damage, and earthquakes.	<p>The state institutions play a vital role in housing the State's handicapped, juvenile delinquent, and adult criminal facilities. The occurrence of a natural hazard event creates a higher potential for these special populations to be rendered vulnerable due to higher security and health concerns.</p> <p>In addition, the R.I.E.M.A. headquarters faces potential loss of physical access, power supply, loss of critical records and systems, thus hindering public response to natural hazard events.</p> <p>Total potential improvement damages are 756,850,400.</p> <p>According to the 2000 Census, the at-risk population within the State institutions is 4,051.</p>	Protection of life and state property, while maintaining high standards for security and potential health concerns. Reducing utility service interruption, repair, and cleanup, thus continuing the provision of essential public services and record maintenance.	Medium
XI. Providence Water	<p>A. <u>Public Drinking Water System</u> – The area bounded by Plainfield Pike to the north, Town of West Warwick to the south, Interstate 295 to the east, and Seven Mile Road to the west. This system is now privately owned by Providence Water.</p> <p><i>(See Appendix A: Critical Municipal Facilities).</i></p>	Earthquake.	<p>Providence Water is currently provided with water through one singular distribution main at South Comstock Road running between Fox Ridge and Tomahawk Trail. If that main were to rupture approximately one-third of the City would be without water. An opportunity exists however to provide a secondary source for water service by connecting a 1500’ gap in service mains. The gap currently extends from the corner of Pippin Orchard Road and Scituate Avenue to the site of the Orchard Farms Elementary School on Scituate Avenue.</p> <p>Estimated cost for the 16” main extension is \$375,000.</p> <p>There are 2,089 accounts for the Public Drinking Water System. This figure multiplied by the 2.54 average household size per occupied dwelling unit, indicates the at-risk population is approximately 5,307 residents.</p>	Creating service redundancy by filling this gap would ensure the provision of public water to a large portion of Cranston in the event of natural hazard induced ruptures in the existing service main.	Low
XII. Tennessee Gas Pipeline	<p>A. <u>Gatehouse Metering Station</u> - 65 Laten Knight Road (A.P. - 28 Lot 132).</p>	Wildfires and earthquake.	<p>The Gatehouse is an above ground processing facility for a major gas transmittal line servicing New England. Because of the presence of natural gas it is extremely important to keep this facility isolated due to the potential for explosion and threat to life.</p> <p>Total potential improvement damage to the Gatehouse is \$38,400. In the event of an explosion, within a 1000’ radius of the facility there would be 32 units impacted. The total potential improvement damages could climb to \$4,842,400 and approximately 79 residents would be at-risk.</p>	Prevention of large wildfires thereby protecting the lives and property of Cranston residents and costly repairs.	Low
XIII. Recreational Facilities	<p>A. <u>CLCF</u> – 970 Pontiac Avenue (A.P. - 10/2 Lot 1471).</p> <p>B. <u>Budlong Pool</u> - 222 Aqueduct Road (A.P. - 9/2 Lot 141).</p> <p>C. <u>Fay Memorial Field</u>- 869 Park Avenue (A.P. – 2 Lot 4004).</p> <p>D. <u>Cranston Stadium</u> – 35 Flint Avenue (A.P. - 6/3 Lot 2700). <i>Not in floodplain.</i></p> <p>E. <u>Cranston Veterans Ice Rink (inflatable dome)</u> – 900 Phenix Avenue (A.P. - 17/1 Lot 1). <i>Not in floodplain.</i></p>	Flooding from heavy rain; high wind, ice damage, and earthquake.	<p>These facilities provide residents of Cranston places to go for recreational and leisure activity. The occurrence of a natural hazard event creates a threat of property damage.</p> <p>Total potential improvement damages are \$1,737,500.</p>	Reducing utility service interruption, repair, and cleanup, thus continuing the provision of recreational and leisure activity.	Low
XIV. Historic Resources	<p>A. <u>National Historic Districts</u></p> <ol style="list-style-type: none">Pawtuxet Village Historic District (A.P. - 1).Oak Lawn Village Historic District (A.P. -18/2, 18/4, and 21/3) - this is also a Local Historic District.Furnace Hill Brook Historical and Archeological District (A.P. - 21/2 and 21/3).Edgewood Historic District- Arnold Farm Plat- Arnold Ave., Albert Ave., Columbia Ave. bound by Broad Street to the west and Narragansett Bay to the east.Edgewood Historic District- Shaw Plat- Shaw Ave., Marrion Avenue. Bound by Broad Street to the west and Narragansett Bay to the east.Edgewood Historic District- Taft Estate Plat- Windsor Avenue, Stratford Rd., Circuit Drive. Bound by Broad Street to the west and Narragansett Boulevard to the east.Lippitt Hill Historic DistrictNorwood Avenue Historic District- Norwood Avenue. Bound by Roger Williams Park to the west, Broad Street to the east. <p>B. <u>National Register Properties</u></p> <ol style="list-style-type: none">Rhodes on the Pawtuxet – 60 Rhodes Place (A.P. - 1 Lot 299).Nathan Westcott House- 56 Scituate Avenue (A.P. – 12 Lot 3096)Sheldon House- 458 Scituate Avenue (A.P. – 20 Lot 2120).Thomas Fenner House- 53 Stony Acre Drive (A.P. – 37 Lot 795)Governor Sprague Mansion – 1351 Cranston StreetThe Joy Homestead- 179 Whiting Street (A.P. – 12 Lot 2877)Knightsville Meeting House- 67 Phenix Avenue (A.P. – 12 Lot 125)Potter Remington House – 571 Natick Avenue (A.P. – 22 Lot 69)Rosedale Apartments – 1180 Narragansett Boulevard (A.P. – 2 Lot 1912)Arad Wood House- 407 Pontiac Avenue (A.P. – 9 Lot 138) <p><i>Source: Lynn Furney, Cranston Senior Planner7/2010. (See Appendix D: Inventory of Historic Properties)</i></p>	Flooding from heavy rain and coastal storm surge; high winds, ice damage, and earthquake.	<p>These historic resources are most susceptible to property damage, which contribute to Cranston's culture, heritage, and general character.</p> <p>Although historic resources are truly irreplaceable, the total potential improvement damages are \$63,324,600.</p> <p>The estimated potential “Pawtuxet Village Historic District” improvement damages are 39,646,000. The estimated potential “Oak Lawn Village Historic District” improvement damages are \$8,563,600. The estimated potential “Furnace Hill Brook Historical and Archeological District” improvement damages are \$333,400.</p>	Protecting irreplaceable property that contributes to Cranston's culture, heritage, and general character.	Low

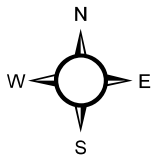
Risk Assessment Maps

Map 1: Community Facilities

Map 2: Public Utilities

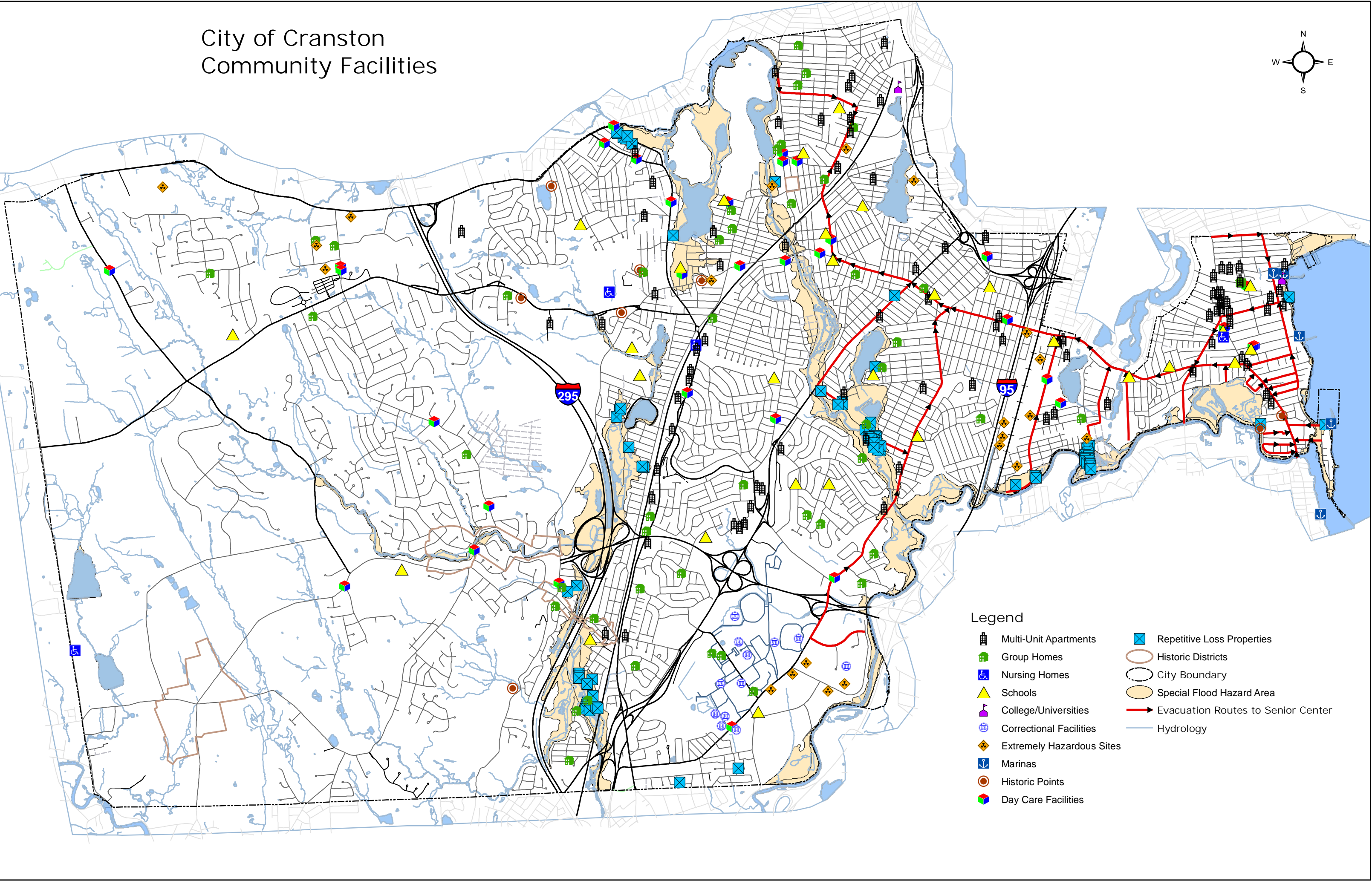
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City of Cranston Community Facilities

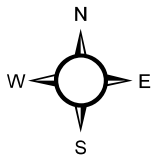


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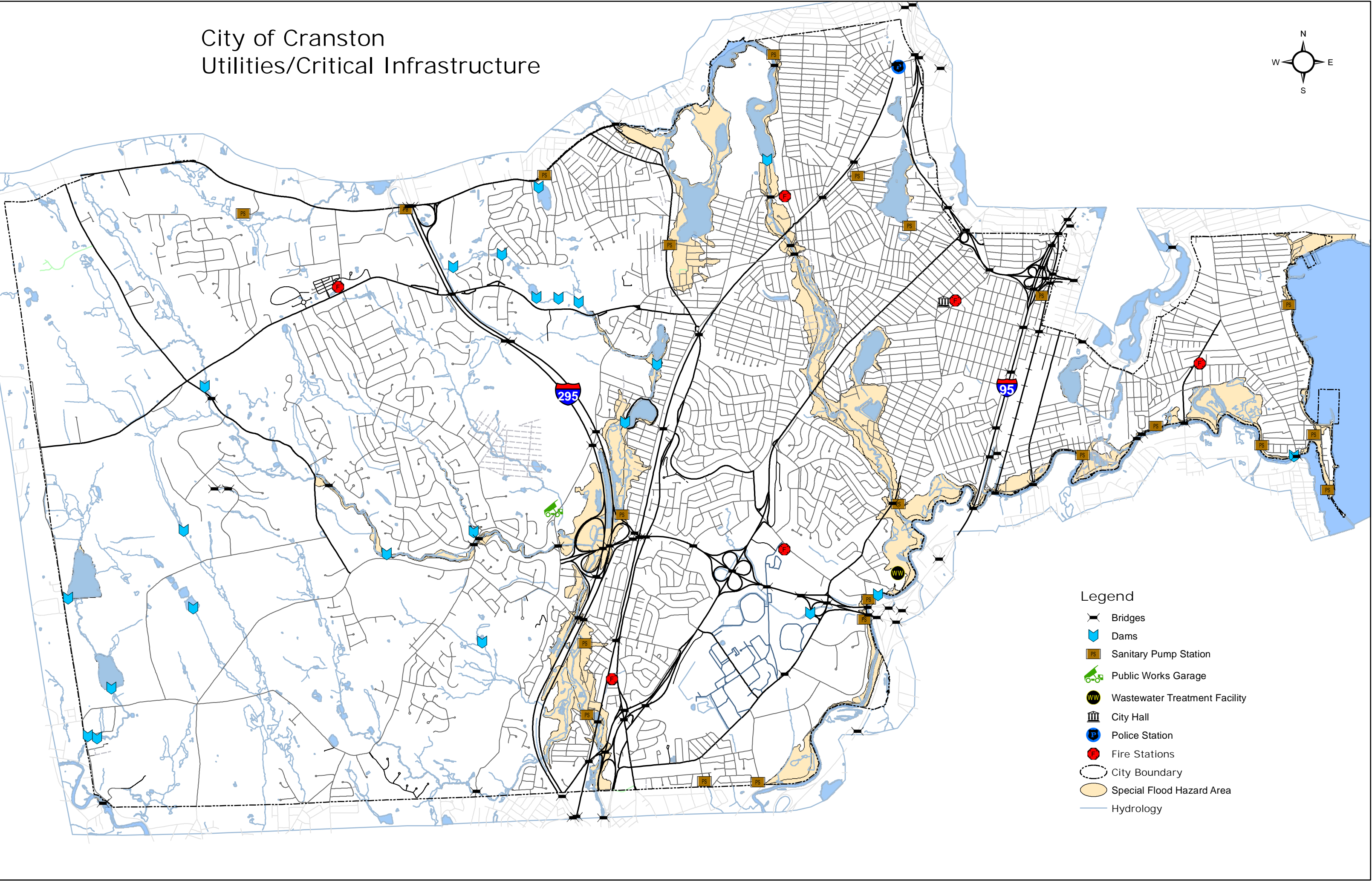
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|---------------------------|------------------------------------|
| Multi-Unit Apartments | Repetitive Loss Properties |
| Group Homes | Historic Districts |
| Nursing Homes | City Boundary |
| Schools | Special Flood Hazard Area |
| College/Universities | Evacuation Routes to Senior Center |
| Correctional Facilities | Hydrology |
| Extremely Hazardous Sites | |
| Marinas | |
| Historic Points | |
| Day Care Facilities | |



City of Cranston Utilities/Critical Infrastructure



- Legend
- Bridges
 - Dams
 - Sanitary Pump Station
 - Public Works Garage
 - Wastewater Treatment Facility
 - City Hall
 - Police Station
 - Fire Stations
 - City Boundary
 - Special Flood Hazard Area
 - Hydrology



Chapter 4: Programmatic Capability Assessment

4.1 Purpose

This capability assessment examines the existing studies, plans, programs, and policies that have incorporated hazard mitigation and other pro-active tools into the City system. The purpose of the capability assessment is to highlight successes, identify shortcomings, and to lay the groundwork for possible improvement. Cranston recognizes that the inclusion of mitigation initiatives would not only benefit the community by reducing human suffering, damages and the costs of recovery, but would also help build and maintain the sustainability and economic health of the City. Section 4.2 details the City's existing plans, programs, and policies.

4.2 Primary Programs

4.2.1. Cranston Comprehensive Plan

The Cranston Comprehensive Plan was originally adopted in February 1992. In 2010 the City updated its comprehensive plan. The updated plan was approved by the City Plan Commission and adopted by the City Council in 2012. The plan outlines the goals, policies, issues, and actions that guide the community to fulfilling its vision for future development. It addresses land use, housing, economic development, natural resources, services and facilities, open space and recreation, and circulation, with some hazard mitigation activities. The City recognizes the importance of hazard mitigation, its interaction with municipal land use and infrastructure planning, and the need for a comprehensive planning approach which accommodates these interdependencies.

4.2.2. Cranston Waterfront Storm Preparedness Plan

The Rhode Island Coastal Resources Management Council (RICRMC) guidelines for Harbor Management Plans require municipalities with approved HMP's to provide waterfront storm preparedness plans. The purpose of these plans is to detail specific measures to be taken in mitigating storm damage, preparing vessels and their structures for storm events, and appropriate response procedures for waterfront boating facilities. On December 17, 2008, the Cranston City Council adopted the City's first Harbor Management Plan and on May 27, 2010 the RICRMC approved said plan had been approved by CRMC. Said plan includes a storm preparedness and hazard mitigation plan for the City's coastal areas.

4.2.3. Subdivision and Land Development Regulations

The subdivision and land development regulations are one of the City's primary tools for regulating development in the City. The purpose of the regulations are to protect the public health, safety, and welfare of the community by ensuring that development respects the natural limitations of specific locals including those presented by natural hazards.²⁴ The subdivision and land development process is overseen by the City's seven member Plan Commission, and it is here, where the majority of the coordination between various regulatory siting and design programs actually occurs.

4.2.4. Cranston Flood Hazard District

In 1984, the Federal Emergency Management Agency (FEMA) completed a scientific engineering report entitled Flood Insurance Study: City of Cranston, Rhode Island with accompanying Flood Insurance Rate Maps (FIRM's). As a result, in accordance with the Code of Federal Regulations Title 44 Chapter 1 Part 9 "The Flood Plain Management and Protection of Wetlands" (44CFR Ch. 1 Part 9), the City of Cranston subsequently adopted its own local flood hazard management ordinance that, in conjunction with the Rhode Island State Building Code, discussed below, provides specific regulations for the building of, or substantial improvement to, structures within Special Flood Hazard Areas. In 2013, FEMA issued updated FIRM's for the City.

The provisions of the Cranston Flood Hazard District are implemented by the Planning Department and the Building Inspections Department. Planning's role is to determine if, in fact, a particular proposal

will take place within a Flood Hazard Area and Building Inspections determines whether construction techniques and calculations conforms to the specifics of the ordinance.

4.2.5 Rhode Island State Building Code

All municipalities within the State of Rhode Island share a single building code (RIGL 23-27.3-100 et. Al.). The Code itself (which incorporates the International Building Code) was last amended in 2012 and provides comprehensive construction requirements designed to mitigate the impacts from natural hazards, such as high wind events. The Code is enforced by the Cranston Building Inspections Department and provides an additional layer of regulatory control to those discussed above.

4.2.6. Cranston Emergency Operations Plan (EOP)

The Cranston EOP was last updated In January 2004. Currently, there is currently a draft 2010 EOP that is pending approval by RIEMA and FEMA. Its primary purpose is to plan for the coordination and execution of specific roles, duties and responsibilities of individual municipal emergency response personnel in the event of a disaster or general emergency. Cranston's plan combines mitigation, preparedness, response, and recovery. It is currently up to date and has been approved by RIEMA and FEMA.²⁵

4.2.7. Cranston Public Education Program

The fire chief/emergency management officer does implement public education programs that are geared toward school-age children and residents of the City residing in elderly housing. In fact, the CEMA does circulate a pamphlet entitled "Sheltering in Place Guidelines" throughout the Cranston School Department. In addition, once a month CEMA does produce a series of public education articles that are published in the Cranston Herald. These articles routinely cover topics ranging from fire safety to natural disaster preparation and response. However, this publication has been temporarily discontinued in order to focus on the enforcement of new fire code safety legislation.

4.2.8 Rhode Island State Dam Safety Program

The City of Cranston participates in the State Dam Safety Program because the Cranston Print Works Dam is classified as one of sixteen high hazard dams within the State. The State Dam Safety Program was created to facilitate the enforcement of the primary dam inspection law (RIGL 46-19, Inspection of Dams and Reservoirs). RIGL 46-19 states that dam owners are responsible for the safe operation, maintenance, repair, and rehabilitation of a dam, which are the essential elements in preventing dam failure; furthermore, dam owners are liable for the consequences of accidents or failures of their dams. According to the Dam Safety and Maintenance Task Force, RIGL 46-19 needs to be updated to address the specifics of a comprehensive dam inspection and permitting program. In addition, the current law does not address the fiscal impacts of dam repairs or removal, and the possible need for state financial assistance to assist dam owners under-take crucial and necessary repairs.²⁶

4.2.9 National Flood Insurance Program (NFIP): Community Rating System (CRS)

The Community Rating System (CRS) is a part of the National Flood Insurance Program (NFIP). The CRS allows participating communities to be rewarded with incentives for doing more than meeting the minimum NFIP requirements to help their property owners prevent or reduce flood losses. These incentives are in the form of flood insurance premium discounts.

Although Cranston does participate in the CRS Program, it is currently ranked in the lowest classification. Steps are being taken by the City to receive credit for what it is already doing, but also to receive credit for the appropriate elements of this plan as they are implemented. There are 10 CRS classes: Class 1 requires the most credit points and gives the greatest premium reductions; Class 10 identifies a community that does not apply for the CRS or does not obtain a minimum number of credit points and receives no discount.²⁷

4.2.10. The Pocasset River Flood Plain Study and Management Plan

The Pocasset River Flood Plain Study and Management Plan was initiated with the Natural Resource Conservation Service (NRCS), as a result of a storm event that occurred in August of 1999. Funded through the Federal Small Watershed Program it analyzes existing conditions, models present and future hydrology, provides updated Flood Insurance Rate Maps, analyzes alternative solutions to flooding concerns, proposes recommended strategies, and provides connections for needed implementation funds.²⁸ Since the 2005 HMP, the NRCS has completed hydrologic studies to a point where public hearing can be held and engineering designs undertaken. However, the need for funding, especially the local match, has caused project to be delayed.

4.2.11. The Meshanticut Brook Flood Plain Management Study: Cranston and Warwick, RI

The Meshanticut Brook Flood Plain Management Study was published in October 1983 and is known as the "Popular Report". This report was produced by the United States Department of Agriculture: Soil Conservation Service (currently known as NRCS); and it identifies problem areas within the flood plain and provides an analysis of potential alternatives and recommended solutions. Five recommendations originate from this study and are as follows²⁹:

1. All property owners in the 100-year flood plain should participate in the NFIP.
2. Flood plain property owners, particularly those within the 10-year flood plain, should consider having a qualified engineer evaluate their property for specific nonstructural measures.
3. Both Cranston and Warwick, with the full participation of and coordination with affected property owners, should develop a flood warning plan.
4. Several wetlands, natural areas, and ponds located along Meshanticut Brook upstream of the Furnace Hill Brook confluence provide significant natural storage for floodwater. These areas moderate flood discharges similar to a dam. Without this existing storage, flood damage would be much worse. The City of Cranston should take action to protect these areas from any alteration that would reduce the volume of storage presently available.
5. The City of Cranston should make full use of the existing erosion and sediment control standards and enforcement ordinances to insure that development projects within the City will be adequately controlled.

Since the 2010 HMP, the City has encouraged property owners in specific flood-prone neighborhoods to participate in the City's voluntary buyout program. To date, the City has acquired seven properties for demolition, and another five are proposed. The City and NRCS have completed all necessary steps for submittal to Congress for adoption.

4.3 Other Resources

The other resources included within this capability assessment are located in Appendices G, and H. Appendix G highlights existing state federal, as well as other entities that provide technical and financial assistance for mitigation. Appendix H identifies existing federal and state protection systems. Lastly, appendix I details additional financing options not identified in Chapter 5.

Table 13: Review of 2010 HMP Mitigation Actions and Objectives

Actions From 2010 Plan		Implementation Status			Implementation Notes <i>(e.g. work completed, next steps, no funds, staff limitations, no longer an issue, carry forward to 2010 plan update)</i>
		Complete	Partially Complete	Not Started	
1	Pocasset River Flooding Improvement		X		The NRCS has completed hydrologic analysis of the Pocasset River Basin and has completed preliminary design. The final engineering design studies have been completed for a floodwall at Fletcher Ave. There is currently no funding available to begin construction.
2	Meshanticut Brook Flooding Improvement			X	No actions have been taken on these proposed activities. In reviewing this action item, the CHMC identified drainage improvements to Wilbur Avenue where it passes under the State's bike path as the primary issue to be addressed. In addition, the CHMC identified other areas with similar flooding issues that should be addressed in a similar manner. These areas are Lake Street, Randall at Atwood Avenue and Cranston Street at Haven Street. The City has been unsuccessful in securing funding for this project.
3	WCWD Service Loop		X		The PWSP has completed design activities. PWSP needs to advertise, award a bid and construct the 16" main.
4	Sewage Infiltration & Inflow Analysis		X		Field Surveys are nearly complete for the Allard Pump Station (including its sub-tributaries) and the Randall / Plainfield Circle pump stations and sub-tributary areas. A draft report was developed and the final report is pending some additional field surveys that are being completed at the time of the report. Study has been completed. Tasks a&b are done. Infiltration and inflow analyses were not and continue not to be a major concern for the City based upon initial survey results.
5	Pump Station Flood Proofing	X			Since the March 2010 flooding, all pump stations in the floodplain have been floodproofed.
6	Flood Proof Peters School	X			As per CHMC's recommendation in 2010, Empirical and historical floodplain data was reviewed by the City and FEMA. It was determined that the school was not in the floodplain. A Letter of Map Revision (LOMR) was submitted and new flood maps were created for the Upper Pocasset area.
7	Tree-Trimming Program		X		The CHMC notes that the electric and telecommunications utilities have an ongoing and highly effective program of tree trimming to remove dangerous limbs. The CHMC has determined that in addition to the above activities identified under that action item, the City has not enacted an ordinance which would prohibit the planting of trees within a utility easement. However, the City does have a fully trained arborist that knows where to plant trees that will not interfere in the future with utility lines.
8	Bridge Retrofitting and Repair	X			This action was reviewed by the CHMC and has been deemed complete. Repairs have been done on non-City maintained bridges such as Dyer Ave. at Park Ave., Reservoir Avenue, and Pontiac Avenue. The RIDOT has surveyed all of the City's bridges. All have acceptable load ratings with the exception of the bridge at Main Street that runs over Clark Brook which needs repairs. The bridge at Furnace Brook Road is no longer accessible due to changes in road design and was recommended to be removed.

Actions From 2010 Plan		Implementation Status			Implementation Notes <i>(e.g. work completed, next steps, no funds, staff limitations, no longer an issue, carry forward to 2010 plan update)</i>
		Complete	Partially Complete	Not Started	
9	Establish Program for Acquisition or Mitigation for Flood Damaged Properties		X		The City is currently implementing an acquisition and mitigation program. They have prioritized their actions and have already engaged in a voluntary acquisition program with residents. To date, the City has acquired seven properties on Perkins Avenue, one on Amanda Street, and another five are proposed for future acquisition and removal from the floodplain.
10	Debris Management Plan		X		The City is in the progress of completing their debris management plan. They currently have contracts for hauling and monitoring
12	NFIP Community Rating System		X		The City is currently preparing documents for the CRS application.
13	Hazard Mitigation Coordinator	X			Due to improved staffing at RIEMA since the 2010 plan, the CHMC recommends eliminating this action and relying on the RIEMA Regional Planner to supplement the City's work.
14	CHMP Evaluation & Update	X			Upon review, the CHMC recommend that it meets annually to update the HMP. The CHMC has prepared this current update as part of its ongoing activities.
15	Long Term Disaster Mitigation Plan		X		The LTCR Planning Committee is also the CHMC. The LTCR Planning Committee has evaluated this action and discussed the elements. There are no funds or needs at this time but have created a framework that can be quickly deployed immediately following a disaster. This is an ongoing action generally managed at the State level.
16	ARC Shelter Capacity		X		Red Cross shelters are managed regionally. The City does support its own shelters which are not managed by the Red Cross
17	Repetitive Loss Strategy			X	Given the number of repetitive loss properties, the City is required to develop a flood plain management plan or repetitive loss analysis as part a CRS application. The City intends to submit a CRS application to FEMA.
18	Small Bus. Outreach Program		X		Ongoing effort between the Greater Cranston Chamber of Commerce and the Cranston Division of Economic Development.

Chapter 5: Identification of Mitigation Actions

Whereas the two preceding Chapters identify risks from natural hazards and programmatic shortcomings, this chapter defines a broad mission for the City in mitigating these risks, re-evaluates the series of hazard mitigation goals and specific implementation actions that were identified in the 2010 HMP.

5.1 Mission Statement

It is the mission of the City and the CHMC to protect and enhance the quality of life, property and resources by identifying areas at risk from natural hazards and implementing hazard mitigation actions to protect the City's residents; infrastructure; economy and its historical, natural and cultural resources.

5.2 Mitigation Goals

To achieve its mission the Cranston Hazard Mitigation Committee established a series of goals that could be used to focus mitigation efforts and provide a framework for discussion of specific actions. These goals include: upgrading infrastructure and protecting property, integrating planning and management approaches, strengthening regulatory control, improving response effectiveness and raising awareness of hazard mitigation benefits and procedures.

Upgrading infrastructure and protecting property refers to improving the structural facilities needed to sustain and protect residential, commercial, and industrial uses and the people who occupy them. Examples include drainage structures, bridges, dams, and municipal facilities such as schools.

Integrating planning and management refers to the incorporation of hazard mitigation principles into the plans, policies, programs and administrative actions of both public and private entities. Examples include development of a debris management plan and participation in the Community Rating System.

Regulatory change refers to improvements to rules or procedures that regulate the location of new development as well as construction techniques. Examples include municipal subdivision regulations; flood hazard overlay districts and building codes.

Preparedness to reduce losses refers to ensuring that needed facilities are in place to assist people during natural hazard events and that the City is ready to respond effectively. Examples include increasing the capacity of American Red Cross approved shelters and development of repetitive loss strategies.

Education and training refers to raising community awareness of how to prepare for and respond to natural hazard events. Examples include flood hazard training workshops for municipal officials, small business disaster outreach programs and public education and preparedness programs.

5.3 Identified Actions and Objectives

The following mitigation actions and objectives were developed by the CHMC with review and opportunity for input from each of the prospective project leads. They are organized in accordance with the topical areas of the five mitigation goals discussed above and each summarizes the specific problem and proposed possible solution, details the primary tasks to be undertaken, identifies an appropriate lead and anticipates funding concerns. Each action was given a priority ranking of low, medium, or high as determined by the CHMC. A low priority does not mean that the action is unimportant, but rather it is being managed by a non-City entity.

5.3.1. Infrastructure Improvement and Property Protection

A. Implement the NRCS Pocasset River Flood Plain Study and Management Plan

1. Summary - The Pocasset River Watershed is 20.6 sq. miles or 13,200 acres in size. Three municipalities are located in the watershed: the Town of Johnston, the City of

Cranston, and the City of Providence. The City of Cranston comprises approximately 29 percent of the watershed. The Pocasset River has experienced numerous major flood events in the past twenty years. Commercial and residential property in the Fletcher Avenue area of Cranston has been particularly vulnerable to damage from these floods.

The floods also pose a threat to the environment and public health and safety. By most accounts, flooding in the past few years is both more frequent and severe. Previous efforts by local, state, and federal interests have failed to solve this problem.

In October 1999, a senatorial appropriation of \$500,000 was earmarked for the Natural Resources Conservation Service (NRCS) Small Watershed Program budget for FY 2001 to complete a watershed study and plan for the Pocasset River. The City of Cranston will support and seek implementation for the NRCS Pocasset River Watershed Flood Plain Management Plan. The plan addresses the repetitive flooding in the watershed. Under the framework of the Small Watershed Program the project completed the following tasks:

- a. Collected data on river flow rates and flood heights.
- b. Inventoried the natural resources in the flood plain including: wildlife habitat, wetlands, and cultural resources.
- c. Located and surveyed structures at risk to flooding.
- d. Estimated past and potential financial losses.
- e. Identified elements contributing to the increased flooding rates.
- f. Drafted alternatives for mitigating future losses.

NRCS and their field crews surveyed cross sections along the Pocasset River and its tributaries. The data collected built the present and future hydrologic and hydraulic models of the watershed. These models in turn were used to analyze the mitigation alternatives. Following the analysis of the mitigation alternatives, NRCS produced benefit/cost ratios for Cranston, Johnston, and the Pocasset Watershed as a whole. A benefit/cost ratio of 1.07 was produced for Cranston. This ratio, being greater than one, indicates a financially beneficial outcome for Cranston. The benefits depict reduced flood damages as a result of installing flood prevention measures.³⁰ Below are the draft mitigation action alternatives presented by NRCS in the *Pocasset River Watershed Flood Plain Management Study*.³¹

2. Primary Tasks

- a. Perform debris removal throughout the Pocasset River Channel to prevent natural damming and increase the flow rates and volume.
- b. Increase the distance between the abutments for the Rhode Island Department of Transportation (DOT) bridge on Garden City Drive (DOT bridge # 75801) - *State task*.
- c. Flood proof structures in the vicinity of the Garden City Drive flood plain.
- d. Flood proof structures and retrofit Lower Eden Park with two floodwalls to control river flow, or have the City obtain land rights for the potential removal of structures in the Lower Eden Park flood plain. (The first floodwall will encompass Willow Brook Apartments. The second floodwall will encompass the Riverview Acre Apartments and Davis Court.)
- e. Flood proof structures and retrofit Upper Eden Park with a floodwall to control river flow, or have the City obtain land rights for the potential removal of structures in the Upper Eden Park flood plain. (This floodwall will encompass the Forest Hills Nursery located on Reservoir Avenue. This is A.P. - 9/2 Lots 2431 - 2436, 2526, 3089, 3500 and 3513).
- f. Flood proof structures in the vicinity of the Park Avenue bridge (DOT # 48001), or have the City obtain land rights for the potential removal of structures in the vicinity of the Park Avenue bridge (DOT bridge # 48001).
- g. Increase the distance between the abutments of Park Avenue bridge (DOT bridge # 48001) - *State task*.

- h. Flood proof structures in the vicinity of the Dyer Avenue bridge (DOT bridge # 49401).
 - i. Increase the distance between the abutments of Dyer Avenue bridge (DOT bridge # 49401) - *State task*.
 - j. Flood proof structures and retrofit the Dyer Avenue Industrial Park with a floodwall to control and channel the river flow.
 - k. Flood proof structures and retrofit Fletcher Avenue Industrial Park Area with a floodwall to control and channel the river flow, or have the City obtain land rights for the potential removal of structures in the vicinity of the Fletcher Avenue Industrial Park.
 - l. Flood proof structures in the vicinity of the Plainfield Street flood plain, or have City obtain land rights for the potential removal of structures at Plainfield Street.
 - m. Increase the distance between the abutments of Plainfield Street bridge (DOT bridge # 8101) - *State task*.
3. *Project Lead* - The NRCS Small Watershed Program has joint sponsorship between the City of Cranston and Town of Johnston to coordinate implementation with regards to securing sufficient funding and ensuring the recommendations are carried out in a timely fashion.
4. *Funding Concerns* - The total estimated cost to implement the corrective measures within the entire Pocasset Watershed is \$30,653,386. The total estimated cost to implement the corrective measures in Cranston is \$14,856,180. The NRCS Small Watershed Program will provide \$11,611,200 in funding toward the estimated cost for the Cranston area. Specifically, the NRCS Small Watershed Program will provide 100% funding for floodwall costs and 75% funding for flood proofing and home removal. The NRCS Small Watershed Program will not pay for utilities.
- Cranston will be responsible for securing the remaining \$3,088,050.00 in funding. In addition, the City will be responsible for the cost of obtaining land rights, if recommendations acted upon include structure removal. Lastly, the City will be responsible for bridge retrofitting costs if the City maintains bridge; and the State will be responsible for bridge retrofitting costs if the State maintains the bridge.³²
5. *Actions Since 2010 HMP* - The NRCS and the City is currently seeking funds so that NRCS can undertake final engineering design and undertake the flood improvements proposed. Action item k: a floodwall system for Fletcher Avenue has been designed and gone out for bid. However, the City is still waiting for Congress to appropriate the funds to NRCS. There will be no adverse downstream impacts. The downstream section of the Pocasset River to Mill pond will not rise. The other proposed floodwalls (items “e” and “j” above) may not be cost effective. The City has asked the NRCS to do another cost-effectiveness study. There may be 50-80 acres of land that can be restored to its natural state and better protect the area. If NRCS is appropriated the funding from Congress, these projects cannot be funded by another federal agency such as FEMA. PRIORITY: HIGH
6. *Time Frame for Completion* – Five years once funding is secured. Partially shovel ready but dependent on federal funding. The City still sees this as a high priority even though the funding may not come soon.
7. *Hazards- Flooding*

B. Flooding Improvements (Meshanticut Brook Flooding Improvements)

- 1. *Summary* - The flooding on Wilbur Avenue occurs east of Warren Avenue and west of Oaklawn Avenue, under the State’s bike path and is the primary area of concern within the Meshanticut Brook Flood Plain. Preliminary opinions suggest that the flooding is a

result of limited water flow capacity due to an inadequately sized drainage system with little to no land slope. The City of Cranston will study and choose the most cost-effective alternative to replace the current drainage system beneath Wilbur Avenue. The alternative will increase the size of the drainage piping and increase the capacity of flow from the intersection of Wilbur and Oaklawn Avenues to the Meshanticut Brook outfall. One option may be the installation of a subsurface retention system to increase temporary storage during the “first flush” of a rain storm.

Similar flooding concerns occur along Lake Street, Randall at Atwood Avenue and Cranston Street at Haven Street. The CHMC decided in 2010 that these areas be addressed in a similar way as Wilbur Avenue, above.

2. Primary Tasks
 - a. Secure funding for study and design components.
 - b. Reassess recommendations of the *Meshanticut Brook Flood Plain Management Study* prepared by the Soil Conservation Service (SCS or NRCS - 1983).
 - c. Study the current condition of the drainage system and flooding concern to assess potential residential, commercial and public property cost damages.
 - d. Conduct a cost-benefit analysis for the design alternatives.
 - e. Design the selected replacement drainage systems.
 - f. Develop a method to monitor and maintain new drainage system.
 - g. Secure implementation funding and obtain necessary permits
 - h. Advertise an invitation to bid and award contract.
 - i. Construct, monitor and maintain new drainage system.
3. Project Lead - City of Cranston Public Works Department.
4. Funding Concerns - The Public Works Department must first obtain funding for study and design and then for implementation. The Department currently estimates design costs to be \$35,000.00, and the study to cost \$5,000.00. The costs for implementation cannot be accurately estimated at this point. However, implementation costs will be identified through the study and design process. The capital improvement planning process, as well as appropriate grant opportunities should be pursued as funding sources for both study and implementation.
5. Actions Since 2010 HMP - No actions have been taking on these proposed activities. The City has been unsuccessful in securing grants to fund this project. The flooding affects nearby businesses, and the road, not homes or lives. PRIORITY: MEDIUM
6. Time Frame for Completion – Depending on funding.
7. Hazards- Flooding

C. Western Cranston Water District Service Loop

1. Summary - The Western Cranston Water District (WCWD) is roughly bounded by Plainfield Pike on the north, the Town of West Warwick to the south, Interstate 295 to the east, and Seven Mile and Pippin Orchard Roads to the west. Currently the primary concern involves the southerly half of the District, which is serviced by only one distribution main. If that main were to be compromised by earthquake damage, servicing the southern portion of the District would not be possible. Therefore, the Providence Water Supply Board (PWSB) will be encouraged to complete this secondary distribution main, lying approximately between Pippin Orchard Road and Alpine Estates Drive. Correcting the problem in this fashion will loop the system; thereby allowing a secondary means of service to the southerly portion of the District.
2. Primary Tasks
 - a. Finalize PWSB Capital Improvement Plan for WCWD.
 - b. Revise WCWD needs assessment and impact fee calculation.

- c. Design 16" distribution main project.
- d. Have project lead address funding concerns and obtain necessary permitting.
- e. Advertise an invitation to bid and award contract.
- f. Construct the most cost-effective 16" distribution main.
3. Project Lead - Providence Water Supply Board (PWSB).
4. Funding Concerns - This project will be funded by the PWSB using monies collected through the Western Cranston Water District Impact Fee Program. Cost is currently estimated at \$375,000.00.
5. Actions Since 2010 HMP – Since the 2005 Plan, the PWSB has completed design activities a. to d. above. All of the design elements have been done. Since the 2010 plan, the PWSP still needs to advertise and award a bid and to construct the 16" main.
PRIORITY: MEDIUM
6. Time Frame for Completion - The PWSB does not have a date for when this will be completed.
7. Hazards- Earthquake

D. Sewage Infiltration and Inflow Analysis

1. Summary - During a large rainfall event, the City of Cranston sewage pump stations may experience sewer backups due to large amounts of storm water infiltrating the piping system and overwhelming the capacity of the pump stations. This creates a serious potential health concern and liability for the City. To alleviate this concern, Veolia Water, operator of the City's sewage treatment facilities, will conduct an infiltration/inflow analysis that will identify illegal entry points of non-effluence into the City sewer system. Flow tests will be performed to model different intensity storms. If the analysis indicates infiltration/inflow contributing to overwhelming the sewage pump station capacity, the City will pursue a form of recourse. This recourse will detail the consequences associated with allowing the infiltration/inflow to exist and the contrary. Lastly, conclusive evidence should guide Veolia Water regarding their ability to eliminate infiltration/inflow or upgrade the pump stations to accommodate the infiltration/inflow.
2. Primary Tasks
 - a. Identify illegal inflow points of non-effluence within the sewage system.
 - b. Calculate an infiltration volume measure to determine whether infiltration is an issue.
 - c. Determine a form of recourse against individuals or entities regarding illegal inflow into the sewage system.
 - d. Conduct a cost-benefit analysis to identify the ramifications associated with allowing the illegal inflow to exist verses removal.
 - e. Evaluate conclusive evidence to guide decisions related to alternatives that limit the illegal inflow within the sewage system or upgrade the pump stations to accommodate the inflow.
3. Project Lead – Veolia Water and the City of Cranston Public Works Department.
4. Funding Concerns - Primary tasks a. and b. have been initiated and the costs to complete these tasks will be approximately \$808,942.00. The costs to complete primary tasks c. - e. have not been identified as of yet since they are dependent on primary task a. and b. All costs are anticipated to be budgeted costs into the Sewer Enterprise Fund and through appropriate grants.
5. Actions Since 2010 HMP – Field Surveys are nearly complete for the Allard Pump Station (including its sub-tributaries) and the Randall / Plainfield Circle pump stations and sub-tributary areas. A draft report was developed and the final report is pending some additional field surveys that are being completed at the time of the report. Study has been completed. Tasks a&b are done. Infiltration and inflow analyses were not and

continue not to be a major concern for the City based upon initial survey results.
PRIORITY: LOW

6. Time Frame for Completion

- a. Primary tasks a. and b. were completed.
- b. Tasks c. - e. are estimated to be completed in approximately three years after tasks a. and b. although this is contingent upon funding.
- c. Inflow and Infiltration Analysis is not a priority for the City but will need to be conducted on an on-going basis.

7. Hazards- Flooding

E. Sewage Pump Station Flood Proofing

1. Summary - The City of Cranston has an additional concern regarding the potential for sewer backups to occur during a large rainfall event. This concern is focused on the short-circuiting of sewage pumping equipment caused by the overland flooding of the sewage pump stations themselves. The first step to resolve this concern will be to conduct a cost-benefit analysis to address which of the nine pump stations within the flood plain could benefit by being flood proofed. The Allard, Randall, Pontiac and Mayflower Pump Stations are of particular concern due to their flood history and the Sea View Pump Station is of concern due to its location within a V-Zone (see Appendix A – Critical Municipal Facilities).
2. Primary Tasks
 - a. Secure funding for study and design components.
 - b. Study the current flooding conditions to assess the potential public property cost damages and the potential for sewage backups.
 - c. Conduct a cost-benefit analysis to determine which of the nine pump stations within the flood plain could most benefit by being flood proofed.
 - d. Design flood proof improvements for selected sewage pump stations.
 - e. Develop a method to monitor and maintain flood proof improvements.
 - f. Secure implementation funding and obtain necessary permits.
 - g. Advertise an invitation to bid and award contract.
 - h. Retrofit selected sewage pump stations with flood proof improvements.
3. Project Lead – Veolia Water and City of Cranston Public Works Department.
4. Funding Concerns - The Public Works Department must first obtain funding for study and design and then for implementation. The Department currently estimates the study and design costs to be \$30,000.00. The costs for implementation cannot be accurately estimated at this point. However, implementation costs will be identified through the study and design process. All costs are anticipated to be budgeted costs into the Sewer Enterprise Fund and through appropriate grants.
5. Actions Since 2010 HMP – Completed. *Since the March 2010 flooding, all pump stations (including their generators) in the floodplain have been floodproofed. Pump stations outside of the floodplain will not be floodproofed.*
6. Time Frame for Completion – Completed.
7. Hazards- Flooding

F. Flood Proof George J. Peters Elementary School

1. Summary - George J. Peters Elementary School is located within the Pocasset River Flood Plain, and has historically flooded. The school plays a vital role in educating

Cranston's youth and also is utilized as a YMCA child daycare facility. The occurrence of a natural hazard event creates a higher potential for recurring and more severe property damage. Flood proofing the school could efficiently minimize these recurring property damage costs and ensure the buildings viability as an educational center.

2. Primary Tasks

1. Secure funding for study and design components.
2. Estimate impact of proposed Pocasset River Drainage Improvements on expected flood levels at the site.
3. Study the current and potential future flooding condition to assess the public property cost damages.
4. Assess and identify appropriate structural flood proofing alternatives.
5. Conduct a cost-benefit analysis that compares the cost of damages with the improvement benefits.
6. Design flood proof improvements for George J Peters Elementary School.
7. Develop a method to monitor and maintain flood proof improvements.
8. Secure implementation funding and obtain necessary permits.
9. Advertise an invitation to bid and award contract.
10. Retrofit George J. Peters Elementary School with selected improvements.

3. Project Lead - Cranston School Department.

4. Funding Concerns - The School Department must first obtain funding for study and design and then for implementation. The Department currently estimates the study and design costs to be \$25,000.00. The costs for implementation cannot be accurately estimated at this point. However, implementation costs will be identified through the study and design process. Cost and funding sources to be identified in Primary Task 2e above.

5. Actions Since 2010 HMP – As per CHMC's recommendation in 2010, Empirical and historical floodplain data was reviewed by the City and FEMA. It was determined that the school was not in the floodplain. A Letter of Map Revision (LOMR) was submitted and new flood maps were created for the Upper Pocasset area. PRIORITY: NOT APPLICABLE

6. Time Frame for Completion – One year after initiation.

7. Hazards- Flooding

G. Coordinated Tree-Trimming Program

1. Summary - Maintaining electrical service provision during and after natural hazard events is critical in mitigating property damages and protecting life. Electricity is not only essential for lighting, heating and refrigeration but is also relied upon for traffic control, health support, communications and security. Unfortunately many of the electrical transmission lines in the city are jeopardized by the ever increasing number of tree limbs that grow in their midst. During high wind and ice events these limbs often break bringing down transmission lines and electrical service. Increasing the strategic removal of these subject limbs beforehand can go a long way in mitigating the impacts of natural hazard events.

2. Primary Tasks

11. Establish a working committee with representation from Cranston Emergency Management, Narragansett Electric, Verizon Telecommunications, and Cox Communications.
12. Identify existing tree trimming programs, priorities and available resources.
13. Identify priority transmission corridors for trimming.
14. Work to better coordinate existing programs in priority areas as a Phase I effort.
15. Seek and secure additional funding for Phase II expansion of coordinated program.

16. Develop a communication network with the public to assist with maintenance and carry out implementation program.
 17. Educate the public regarding the need to properly maintain and trim trees on private property that are adjacent to power lines.
 18. Evaluate program effectiveness and initiate planning process for additional phases if feasible.
3. Project Lead - Cranston Emergency Management Agency (CEMA) in partnership with Narragansett Electric, Verizon Telecommunications, and Cox Communications.
 4. Funding Concerns - Phase I coordination costs are minimal and can be covered by stakeholders existing budgets, whereas the focus of Phase II is to identify additional funding grant opportunities for expanding the program. The anticipated costs associated with the Phase II expansion of the program are \$1,137,500.00 for tree trimming, \$200,000.00 for tree removal, and an additional \$36,400.00 for police details.
 5. Actions Since 2010 HMP – The CHMC notes that the electric and telecommunications utilities have an ongoing and highly effective program of tree trimming to remove dangerous limbs. The CHMC has determined that in addition to the above activities identified under that action item, the City has not enacted an ordinance which would prohibit the planting of trees within a utility easement. However, the City does have a fully trained arborist that knows where to plant trees that will not interfere in the future with utility lines. PRIORITY: MEDIUM
 6. Time Frame for Completion- ongoing through the utility companies
 7. Hazards- Winter weather, hurricanes, wind

H. Bridge Retrofitting and Repair

1. Summary – The City of Cranston recognizes the importance of safe and convenient circulation for residents and commuters traveling about the City. Understanding the extreme likelihood that a natural hazard will occur, all City maintained bridges (see Appendix C) are to be evaluated, regarding their structural integrity and resistance to earthquakes, and retrofitted as needed. All retrofits will be made in accordance to the *RIDOT Standard Specifications for Road and Bridge Construction*.
2. Primary Tasks
 - a. The City of Cranston Public Works Department - Engineering Division must inspect all City maintained bridges to ensure structural integrity and earthquake resistance.
 - b. Identify retrofits needed to bring all City maintained bridges into compliance with *RIDOT Standard Specifications for Road and Bridge Construction*.
 - c. Project construction costs for each individual retrofit.
 - d. Identify total funding available for implementation of bridge retrofits.
 - e. Prioritize desired retrofits given available funding, traffic carried, relation to evacuation routes and alternative circulation options.
 - f. Complete design, funding acquisition and permitting for prioritized retrofits.
 - g. Finalize overall implementation plan and execute.
3. Project Lead - City of Cranston Public Works Department - Engineering Division.
4. Funding Concerns - Bridge inspections have been performed by the Rhode Island Department of Transportation (DOT). Funding needs to be secured through the capital budget or through various grants to hire a consultant to prioritize and design the bridge repairs. The DOT is responsible for providing funding for retrofitting all state maintained bridges.
5. Actions Since 2010 HMP – This action was reviewed by the CHMC and has been deemed complete. Repairs have been done on non-City maintained bridges such as Dyer Ave.at Park Ave., Reservoir Avenue, and Pontiac Avenue. The RIDOT has

surveyed all of the City's bridges. All have acceptable load ratings with the exception of the bridge at Main Street that runs over Clark Brook which needs repairs. The bridge at Furnace Brook Road is no longer accessible due to changes in road design and was recommended to be removed.

6. Time Frame for Completion – Completed.

7. Hazards- Earthquakes

I. Mitigate Wildfire Risk to Vegetated Areas

1. Summary- The John L. Curran Management Area is a 332 acre undeveloped state owned park comprised primarily of deciduous hardwood trees, oaks, maple, and beech. Shoreline habitats along the Upper and Lower Reservoirs provide food and shelter for wildlife.

2. Primary Task- Support the Rhode Island Department of Environmental Management with fire prevention and suppression efforts. This is especially important during dry periods in the summer when temperatures are hotter.

3. Primary Lead- Cranston Fire Department

4. Funding Concerns- fire department staff time and budget as needed

5. Actions Since 2010 HMP:- New action

6. Time Frame for Completion- ongoing

7. Hazards- Wildfire

J. Establish Program of Acquisition or Mitigation for Flood Damaged Properties

1. Summary – As a result of the March, 2010 flood event, the CHMC recognizes the City needs to move beyond the typical, after the fact, response of providing disaster relief. Based on data provided by FEMA, in excess of 218 flood insurance claims were processed after the March event with many of the claims being repetitive. The HMP recommends that the City initiate a pro-active program to provide mitigation to flood damaged properties. Said program will include a range of activities including, but not limited to, acquisition and demolition, acquisition and relocation, elevating or flood proofing structures and elevation or flood proofing of utilities. This mitigation program will initially target those neighborhoods that have suffered a large number of repetitive losses or have experienced substantial damage from flooding. Based on data from the March, 2010 flood event, as supplied by FEMA, the neighborhoods with significant impact to be targeted include, but not limited to, the Perkins Avenue neighborhood, the Amanda Avenue/Warren Avenue neighborhoods, the Fordson/Davis Avenue neighborhoods, the Fletcher Avenue neighborhood, the Pontiac Avenue neighborhood and the Pawtuxet Village area. The HMP recognizes that the costs for providing mitigation will be than offset by the long term costs from insurance claims from future flood events.

2. Primary Tasks –

- a. Identify properties within the above identified neighborhoods that have filed repetitive claims or have experienced substantial flood damage.
- b. Determine the appropriate mitigative measures for the individual properties identified.
- c. Develop criteria for prioritize mitigation projects to meet available resources.
- d. Secure funding to acquire said properties.

3. Project Lead – Mayor's Office and the Planning Department.

4. Funding Concerns - The costs for implementation cannot be accurately estimated at this point. However, implementation costs will be identified through planning and outreach process. A majority of the costs are anticipated to be budgeted from appropriate grants.
5. Actions Since 2010 HMP: The City is currently implementing an acquisition and mitigation program. They have prioritized their actions and have already engaged in a voluntary acquisition program with residents. To date, the City has acquired seven properties on Perkins Avenue, one on Amanda Street, and another five are proposed for future acquisition and removal from the floodplain. PRIORITY: HIGH
6. Time Frame for Completion – Ongoing as long as properties are repetitively affected by flooding and funding is available.
7. Hazards- Flooding

K. Stormwater Drainage System Evaluation

1. Summary – Flash flooding during high intensity rain events has become problematic in several areas of the City. Areas of concern include Wedge/Cranston Street, Garden Street, Lodge/Abbott Street, and Zinnia Drive/Poplar Circle. These flash floods have caused damage to roads, drainage infrastructures, flooded basements and yards, and vehicular damage. There is a need for the City to complete a comprehensive analysis of these drainage areas to determine a course of action for minimizing the effects of this flooding.
2. Primary Tasks
 - a. Secure funding for study and design components
 - b. Complete a condition assessment of the current drainage infrastructure including a structural assessment, and cleaning of drain lines.
 - c. Perform hydraulic analysis of drainage system to determine capacity under multiple design storm events.
 - d. Identify, rank and prioritize drainage improvement projects.
 - e. Prepare estimated construction costs for improvements.
 - f. Secure funding and obtain necessary permits.
 - g. Advertise an invitation to bid and award design.
 - h. Construct, monitor and maintain drainage improvements.
3. Project Lead – City of Cranston Public Works Department
4. Funding Concerns – The public works department has obtained funding for the initial assessment, hydraulic analysis and study of the problem drainage areas. Funding for final design and construction of the improvements will be pursued when estimated costs become available.
5. Actions Since 2010 HMP: This is a new action. PRIORITY: HIGH
6. Time Frame for Completion – Five Years.
7. Hazards- Flooding

5.3.2. Planning and Management

A. Debris Management Plan

1. Summary - Currently, the City does not have a debris management plan. A debris management plan is a critical component to efficient recovery efforts when a disaster strikes. Debris removal is described as the clearance, removal and/or disposal of items such as trees, sand and gravel, building components, wreckage, vehicles and personal property. Having a debris management plan will establish better circulation for people moving back to their properties, allow for the safe passage of emergency vehicles, and increase accessibility to critical infrastructure. The creation and adoption of the debris management plan will consist of two phases. The first phase of the debris management plan will focus on the identification of priority roadways, bridges, dams, and culverts that have a tendency to collect debris and inadvertently contribute to potential road and property flooding. The second phase will concentrate on the scheduled debris clean-up efforts. In addition, it will address the how, who, and where will assist the City in the implementation of clean-up efforts.
2. Primary Tasks
 - a. Prioritize roadways for debris removal.
 - b. Identify the bridges, dams and culverts that are most susceptible to collecting debris.
 - c. Identify waste disposal methods (i.e., dumping, chipping, recycling, etc.).
 - d. Identify and prepare debris storage and reduction sites.
 - e. Obtain appropriate Federal, State and local permits.
 - f. Advertise an invitation to bid and award debris removal contract based on cost and the contractor's debris removal monitoring and staffing plan.
 - g. Implement a public information campaign that instructs the general public on guidelines for dealing with debris.
3. Project Lead - City of Cranston Public Works Department.
4. Funding Concerns - The estimated number of staff hours to complete this task is 200. In light of this, the City of Cranston has estimated the cost for producing this plan to be \$20,000.00. In addition, minimal costs are anticipated to advertise the invitation to bid and public information campaign.
5. Actions Since 2010 HMP – The City is in the progress of completing their debris management plan. They currently have contracts for hauling and monitoring.
PRIORITY: MEDIUM
6. Time Frame for Completion – Three months.
7. Hazards- *Flooding, winter storm, hurricane, wind, tornado, earthquake,*

B. Waterfront Storm Preparedness Plan

1. Summary – Cranston's waterfront is home to 121 moored vessels, five marinas with dockside accommodations for an additional 354, and numerous private recreational boating facilities or docks. These facilities not only face direct risks from severe coastal storms but also pose risks to the people that often inhabit them; to the environment should they become holed; and to adjacent shore-side improvements and public evacuation and response activities should they wash ashore. Proactive steps can and should be taken to limit these risks however in accordance with the Rhode Island Coastal Resource Management Council's Guidelines for Municipal Harbor Management Plan storm preparedness requirements.
2. Primary Tasks
 - a. Form a steering committee composed of waterfront stakeholders to serve as an informational resource and to help guide the process.

- b. Assess the risks including identification of the specific concerns, their level of impact, and their anticipated benefits.
 - c. Identify, assess and select appropriate waterfront mitigation, preparedness and recovery strategies.
 - d. Develop an implementation plan for city and state approval.
 - e. Implement both proactive and re-active strategies as directed.
 - f. Review, evaluate and if necessary revise the storm preparedness plan on an annual basis.
3. **Project Lead** – City of Cranston Harbormaster
 4. **Funding Concerns** – Completion of this action is estimated to cost between \$5,000 and \$10,000.
 5. **Actions Since 2010 HMP**– A Storm Preparedness and Hazard Mitigation Plan is incorporated into the Cranston Harbor Management Plan as adopted by the City Council in December, 2008 and approved by the CRMC in May, 2010. This action has been completed. PRIORITY: NOT APPLICABLE
 6. **Hazards**- Hurricanes, wind, coastal erosion

C. National Flood Insurance Program Community Rating System

1. **Summary** – The Community Rating System (CRS) is a part of the National Flood Insurance Program (NFIP). The CRS allows participating communities to be rewarded with incentives for doing more than meeting the minimum NFIP requirements to help their property owners prevent or reduce flood losses. Currently, Cranston is rated a Class 10.

Other incentives for communities to participate in CRS include free technical assistance in designing and implementing recommended flood plain management activities. Implementing some CRS activities, such as flood plain management planning, can help a community qualify for certain federal assistance programs. With the benefits of participating in the CRS program far outweighing the costs, the City NFIP Coordinator and other relevant City Administrators should prepare and implement those activities that will deal with Cranston's priority problems.

2. **Primary Tasks**
 - a. Establish a working relationship between the City of Cranston NFIP Coordinator and the RIEMA CRS officer.
 - b. Obtain a letter from the FEMA Regional Office detailing the level of the community's compliance with the latest NFIP requirements.
 - c. Inventory the City of Cranston for the 18-flood plain management activities credited by the CRS program.
 - d. Prepare application and appropriate documentation that supports the City's intention for implementing the flood plain management activities recognized in the *CRS Coordinator's Manual*.
 - e. Submit application to RIEMA CRS officer, as well as copies to FEMA and the state NFIP Coordinator.
 - f. Upon feedback given from FEMA and the state NFIP Coordinator to the CRS officer, a verification visit may be scheduled if warranted.
 - g. Continue to recertify application each year that it is continuing to implement those activities specified in the first application.
3. **Project Lead** - City of Cranston National Flood Insurance Program (NFIP) Coordinator.

4. Funding Concerns - The City of Cranston Planning Department has salaried individuals on staff qualified to complete this project. The estimated number of staff hours to complete this task is 400 hours.
5. Actions Since 2010 HMP – Items a. to c. above have been completed. The City is currently preparing documents for the CRS application. PRIORITY: HIGH
6. Time Frame for Completion – During 2014
7. Hazards- Flooding

D. Hazard Mitigation Coordinator

1. Summary – The City will minimize the potential effect of natural disasters by planning proactively. However, this ability to plan proactively is hindered because the full DMA 2000 requirements, as well as the implementation and evaluation of the full plan is beyond the capacity of current staff resources. The City simply cannot carry out these tasks without hiring more people.
2. Primary Tasks
 - a. Secure funding to hire an additional planner on staff for the City of Cranston Planning Department that will specialize in natural hazard mitigation and act as a liaison with the Rhode Island Emergency Management Agency (RIEMA).
 - b. Advertise planning position and hire qualified applicant.
3. Project Lead – City of Cranston Planning Department and the Cranston Emergency Management Agency (CEMA)
4. Funding Concerns – The CHMC has estimated the cost of an additional planner on staff to be \$50,000.00. In addition, minimal costs are anticipated to advertise said position.
5. Actions Since 2010 HMP – Due to improved staffing at RIEMA since the 2010 plan, the CHMC recommends eliminating this action and relying on the RIEMA Regional Planner to supplement the City's work. PRIORITY: NOT APPLICABLE
6. Hazards- All

E. Evaluation, Revision, and Update of the Cranston Hazard Mitigation Plan

1. Summary - The City will bi-annually evaluate the Cranston Hazard Mitigation Plan, complete annual supplemental revisions, and five-year updates. This process of evaluation, revision, and update will identify additional priority problems as they may occur, and will allow the City to monitor project implementation schedules to bring the planning process full-circle.
2. Primary Tasks
 - a. Administer annual project evaluations that assess project completeness.
 - b. Conduct biannual public meetings that evaluate the progress of the mitigation actions within the HMP.
 - c. Complete annual supplemental revisions of the HMP, which will address additional natural hazard concerns as they arise.
 - d. Update the HMP every five years.
3. Project Lead – City of Cranston Planning Department and the Cranston Emergency Management Agency (CEMA).
4. Funding Concerns – The City of Cranston has estimated the cost for the evaluation, revision, and update of the Cranston Hazard Mitigation Plan to be \$5,000.00 in staff time.
5. Actions Since 2010 HMP – Upon review, the CHMC recommend that it meets annually (from date of plan adoption) to update the HMP. The CHMC has prepared this current update as part of its ongoing activities. PRIORITY: MEDIUM

6. Time Frame for Completion –This action item is on-going program.

7. Hazards- All

F. Long Term Disaster Mitigation Plan

1. Summary – Under the National Response Framework, Emergency Support Function (ESF) #14 Long-Term Community Recovery [LTCR] coordinates the resources of federal departments and agencies to support the long-term recovery of States and communities and to reduce or eliminate risk from future incidents. As a result of the March, 2010 flood event, the CHMC realizes the importance and need to develop a Long-Term Recovery Plan. The CHMC further recognizes that said plan needs to focus on those areas that received the greatest impact during said event [i.e. Perkins Avenue and the Fordson Avenue areas]. Long term recovery efforts are driven by State/local priorities, focusing on permanent restoration of infrastructure, housing, and the local economy. ESF #14 recognizes the primacy of affected State and local governments and the private sector in defining and addressing risk reduction and long-term community recovery priorities, and in leading the community recovery planning process. ESF #14 long-term community recovery and recovery planning efforts will be coordinated with State/ local-level stakeholders.

2. Primary Tasks

- a. Appoint LTCR Planning Committee.
- b. Establish a public information and participation program.
- c. Identify the major LTCR issues to be addressed
- d. Identify goals and objectives for the LTCR Plan.
- e. Identify, evaluate and prioritize LTCR projects to be included in a recovery plan.
Project may include:
 - Providing permanent disaster-resistant housing units;
 - Initiating a by-out of flood-prone properties and designating them community open space;
 - Initiating a low-interest business loan program to assist businesses that sustained damages from a disaster or
 - Widening bridges or other roadway improvements to improve evacuation routes.
- f. Designate lead agencies or bodies to implement projects.
- g. Prepare a LTCR funding strategy.
- h. Implement the LTCR Plan.
- i. Evaluate and update the LTCR on annual basis.

3. Project Lead – City of Cranston Planning Department and the Cranston Emergency Management Agency (CEMA).

4. Funding Concerns – Base on its experience with updating its HMP, the City anticipates that it will expend between 100 to 200 hours of staff time at a cost of \$20,000 and will expend an additional \$5,000 in administrative costs [i.e. advertising and printing].

5. Actions Since 2010 HMP- The LTCR Planning Committee is also the CHMC. The LTCR Planning Committee has evaluated this action and discussed the elements. There are no funds or needs at this time but have created a framework that can be quickly deployed immediately following a disaster. This is an ongoing action generally managed at the State level. PRIORITY: LOW

6. Time Frame for Completion – Ongoing.

7. Hazards- All

5.3.3. Preparedness to Reduce Losses

A. American Red Cross Approved Shelter Capacity

1. Summary - Providing sufficient shelter capacity is a primary means for protecting life and thereby mitigating the impact from natural hazards. The primary problem that the City faces in increasing its capacity is the number of options that exist, and the need to find the most cost efficient solutions that balances the need with the City's ability to provide staffing during natural hazard events. Whereas the City has a population of 81,686 it only has three American Red Cross (ARC) approved emergency shelters. The Cranston Senior Center, Western Hills Middle School, and Park View Middle School have all been designated as ARC approved emergency shelters. According to the ARC, "experience nationwide indicates that up to 25 percent of the evacuated population will seek public shelters in most disasters. The remainder of evacuees usually provide for themselves or stay with friends or relatives."³³ If the "evacuated population" is defined as the City population living within flood plains, this would indicate that 1640 residents would seek emergency shelter. The City's three emergency shelters are capable of providing public shelter for 753 individuals. Therefore, the City currently faces a deficit of 887 spaces for public emergency sheltering.
2. Primary Tasks
 - a. Project cost for hiring of consultant to evaluate concern.
 - b. Secure funding for consultant and services.
 - c. Advertise a request for proposal and award contract to consultant.
 - d. Identify desired additional capacity based on the City's ability to staff.
 - e. Identify City owned structures that could be considered for shelter designation.
 - f. Identify requirements for receiving ARC approval - create a matrix.
 - g. Compare existing conditions of individual structures against ARC requirements to determine needed improvements for ARC designation at each facility.
 - h. Estimate cost of providing needed improvements at each facility.
 - i. Estimate additional shelter capacity to be gained with appropriate retrofits.
 - j. Analyze information above to identify most cost efficient means for increasing shelter capacity to the targeted level identified in primary task 2a.
 - k. Select appropriate projects for implementation based on the above as well as geographic location.
 - l. Develop implementation plans including consideration for project design, funding, permitting, contractor selection, official ARC designation and project leadership.
3. Project Lead – The Cranston Emergency Management Agency (CEMA) and the American Red Cross (ARC).
4. Funding Concerns - The City of Cranston anticipates the cost of hiring a consultant for this project to be \$15,000.00. In addition, minimal costs are anticipated to advertise the request for proposal.
5. Actions Since 2010 HMP – Red Cross shelters are managed regionally. Waiting for Warwick to sign on as a regional back-up. The City does support its own shelters which are not managed by the Red Cross. Item 2d: The current personnel in the City's CERT program cannot support more than 2 facilities. Item 2e: Cranston high school West and East have not yet been approved but could serve as additional shelters. PRIORITY: MEDIUM
5. Time Frame for Completion – Two and half years from initiation.
6. Hazards- All

B. Repetitive Loss Strategy

1. Summary - Repetitive loss properties are those properties enrolled in the National Flood Insurance Program (NFIP) that have experienced two or more insurance claims of at least \$1,000 due to natural hazards over a period of ten years. In other words, repetitive loss properties are properties that are regularly impacted by natural hazards and have a

higher than average probability of being impacted in the future and thereby represent a priority for mitigation action. According to the Federal Emergency Management Agency (FEMA) there are currently 593 NFIP holders in the City of Cranston, of which there are 79 repetitive loss properties.

The creation of a repetitive loss strategy simply entails the development of a mitigation plan for each property within the City that experiences repetitive losses. The individual parcel-specific plans can range from structural alterations to complete removal and when combined form a strategy for addressing repetitive losses. In this manner, the development of a repetitive loss strategy directly advances the goals of hazard mitigation planning while also bolstering the City's potential participation in the NFIP Community Rating System Program (CRS).

2. Primary Tasks

- a. Obtain repetitive loss data from NFIP.
- b. Map property location and determine if mitigation recommendations have already been generated through other efforts such as the NRCS Pocasset River Watershed Flood Plain Management Plan.
- c. Estimate cost for hiring of consultant to evaluate concern and produce mitigation designs for repetitive loss properties that have none.
- d. Secure funding for consultant and services.
- e. Advertise a request for proposal and award contract to consultant.
- f. Complete study and design phase, produce final repetitive loss strategy, including individual project estimates, funding sources and implementation schedules.
- g. Initiate implementation.

3. Project Lead - City of Cranston National Flood Insurance Program (NFIP) Coordinator.

4. Funding Concerns – Development of the strategy can be completed by the City's NFIP Coordinator. However, the cost to implement the strategy cannot be identified at this time and it is anticipated that a variety of private as well as public grant funds will be needed. In addition, the City of Cranston has estimated the cost of hiring a consultant to evaluate concern and produce mitigation designs for repetitive loss properties that have none to be \$15,000.00. Lastly, minimal costs are anticipated to advertise the request for proposal.

5. Actions Since 2010 HMP – Given the number of repetitive loss properties (currently 79), the City is required to develop a flood plain management plan or repetitive loss analysis as part of any CRS application. As noted above, the City is in the process of submitting a CRS application to FEMA which will address the Repetitive Loss mitigation actions.
PRIORITY: HIGH

6. Time Frame for Completion – During 2014

7. Hazards- Flooding

5.3.4. Education and Training

A. Flood Hazard Districts Training for Municipal Officials

1. Summary - The purpose of the workshop is to present a greater understanding to municipal officials, employees, boards, and commissions regarding the implications of the amended City Zoning Ordinance for Flood Hazard Districts (Sec. 30-4.2) as indicated in Action III-A. These training workshops will review the amendments made to Sec. 30-4.2, as well as discuss hazard mitigation, particularly flood mitigation, and actions/responsibilities of the City administration during a natural disaster. This action will also support Action IV-B.

Primary Tasks

- a. Establish a working committee that includes: the Cranston National Flood Insurance Program (NFIP) Coordinator, the Cranston Emergency Management Agency

- (CEMA), and the Rhode Island Emergency Management Agency (RIEMA) to conduct necessary trainings on disaster mitigation and preparedness.
 - b. Draft an agenda that includes topics of hazard mitigation to be discussed including flood mitigation and actions/responsibilities during a natural disaster.
 - c. Secure venue for workshops.
 - d. Advertise training sessions that will be deemed necessary for the City Planning Department, Planning Commission, Building Inspections Department and Zoning Board to attend.
- 3. Project Lead – The Cranston National Flood Insurance Program (NFIP) Coordinator.
 - 4. Funding Concerns - Federal certification funding is available. Minimal costs are anticipated to advertise workshops.
 - 5. Actions Since 2010 HMP –The CHPC has reviewed the above action. The workshops offered through RIEMA has minimized, if not altogether eliminated, the need for the City sponsored workshops target to local officials. PRIORITY: LOW
 - 6. Time Frame for Completion – Ongoing.
 - 7. Hazards- Flooding

B. Small Business Hazard Mitigation Training and Disaster Outreach Program

- 1. Summary - The City of Cranston understands the importance of small businesses to the City's economic vitality. The City also realizes that small businesses face larger challenges recovering from natural disasters. Therefore, the City will create a Small Business Disaster Outreach Program that will educate small business owners about the Small Business Administration (SBA) Pre-Disaster Mitigation Loan Program. The Small Business Disaster Outreach Program will present financial options available to small business owners for implementing mitigation measures to protect business property from damage that may be caused by future disasters.
- 2. Primary Tasks
 - a. Compile contact information for all businesses located within all identified risk areas of the City and update annually.
 - b. Identify local contact at the SBA regarding disaster loan programs and establish a working relationship.
 - c. Confirm understanding and availability of programs and procure educational materials.
 - d. Educate small business owners as to the availability of the programs through direct mailings and informational workshops.
- 3. Project Lead – Cranston Department of Economic Development
- 4. Funding Concerns - The Department currently estimates the cost for completing the primary tasks to be \$5,000.00.
- 5. Actions Since 2010 HMP – The CHMC has reviewed this action. Since 2010, the Greater Cranston Chamber of Commerce, in partnership with the Division of Economic Development, have offered informational sessions to business owners based on their needs. Past sessions have focused on flooding, SBA loans, and how to get assistance after a disaster. PRIORITY: LOW
- 6. Time Frame for Completion – Ongoing.
- 7. Hazards- All

C. Hazard Mitigation Public Preparedness & Education Program

1. Summary - The City will seek assistance from the Cranston Emergency Management Official (CEMO) and the American Red Cross (ARC) as a phase I effort to develop public education and outreach programs on disaster mitigation and preparedness, and distribute and make material available concerning: evacuation routes, emergency shelters, critical facilities and maps of City risks. In addition, as a phase II effort, the City will seek assistance from the Cranston National Flood Insurance Program (NFIP) Coordinator to provide property owners information regarding properties that are subject to flooding. Discussion topics will include property protection measures appropriate for flood mitigation and basic facts about the NFIP.
2. Primary Tasks
 - a. Establish a working relationship between the Cranston National Flood Insurance Program (NFIP) Coordinator, the Cranston Emergency Management Agency (CEMA), and the American Red Cross (ARC) regarding topics to be discussed with public.
 - b. Draft an agenda for the phase I effort that includes topics to be discussed such as: materials concerning: evacuation routes, emergency shelters, critical facilities and maps of City risks.
 - c. Draft an agenda for the phase II effort that includes topics to be discussed such as property protection measures appropriate for the flood mitigation and the basic facts about flood insurance.
 - d. Secure venue for workshops.
 - e. Schedule the trainings along with outreach materials that are to be distributed at least 90% of the target audience.
 - f. Advertise public preparedness education workshops available to the public.
3. Project Lead – The Cranston NFIP Coordinator, the CEMA, and the ARC.
4. Funding Concerns - Federal certification funding is available. Minimal costs are anticipated to advertise the public preparedness workshops.
5. Actions Since 2010 HMP – No action has been taken on this activity but it will be one of the first outreach activities with CRS in 2014. PRIORITY: LOW
6. Time Frame for Completion – Two years after initiation.
7. Hazards- All

Chapter 6: Implementation Element

6.1 Prioritization of Mitigation Actions

Having identified appropriate mitigation actions the Cranston Hazard Mitigation Committee set about prioritizing them for implementation. To accomplish this for the 2014 plan, the CHMC ranked the actions as low, medium, or high priority. The prioritized results of this process are displayed in Table 14.

Table 14: Activity Prioritization

	Mitigation Actions	
High Priority	5.3.1.A.	Pocasset River Flooding Improvement
	5.3.1.I.	Acquisition/Mitigation Flood Damaged Properties
	5.3.1.J.	Stormwater Drainage System Evaluation
Medium Priority	5.3.2.D.	NFIP Community Rating System
	5.3.3.B.	Repetitive Loss Strategy
	5.3.1.B.	Meshanticut Brook Flooding Imp.
	5.3.1.C.	WCWD Service Loop
Low Priority	5.3.1.G.	Coordinated Tree-Trimming
	5.3.2.A.	Debris Management Plan
	5.3.2.F.	Update Hazard Mitigation Plan
	5.3.3.A.	Increase ARC Shelter Capacity
	5.3.1.D.	Sewage Infiltration & Inflow Analysis
Completed	5.3.2.G.	Long Term Disaster Mitigation Plan
	5.3.4.A.	Municipal Hazard Training
	5.3.4.B.	Small Bus. Outreach Program
	5.3.4.C.	Public Preparedness Program
	5.3.1.E.	Sewage Pump Station Flood Proofing
	5.3.1.F.	Flood Proof Peters School

	5.3.1.H.	Bridge Retrofitting and Repair
	5.3.2.B.	Waterfront Storm Preparedness Plan
	5.3.2.C.	Comp Plan - Hazard Mitigation
	5.3.2.E.	Hazard Mitigation Coordinator

6.2 Evaluation and Revision

6.2.1. Monitoring, Evaluating and Updating the Plan

The plan is a living document that requires adjustments to maintain its relevance. The CHMC will meet annually to review the status of the mitigation actions; and provide a yearly status report to the Mayor. It is recommended that this review be conducted prior to the City's annual budget process so that any locally funded projects can be considered in the budget process. The plan will be reviewed and updated every 5 years using the same process as the initial plan adoption with public workshops and public hearings. The CHMC will utilize the August 2003 FEMA How to Guide "Bringing the Plan to Life/Implementing the Hazard Mitigation Plan" as a resource document to update this plan. This guide contains worksheets which will help the Committee evaluate and monitor the results of the mitigation actions. The CHMC will also identify potential mitigation projects that can be implemented in a post-disaster scenario taking the opportunity to improve Cranston's disaster reliance.

6.2.2. Continued Public Involvement

Cranston will continue public involvement in the plan maintenance process by:

- a. The approved/adopted plan will be posted on the town's web site;
- b. The annual meeting of the CHMC to review the implementation of the Plan is a public meeting and will be posted per town guidelines.
- c. The CHMC will include the public in the preparation of the five-year Plan Update using the same public participation process as in the development of this plan.

Chapter 7: Public Input and Adoption Processes

7.1 Summary

Prior to public release of the 2014 HMP, the CHMC reviewed and updated the 2010 HMP. Said review was undertaken through a series of committee meetings. While these meetings did not rise to the level of public hearings and were not advertised, they were open to the public. Table 13 below provides a summary of the HMP meeting dates and the activities that they conducted:

Table 13 Summary of CHMC Activities

Date	Meeting Summary
11/22/2013	Kick of meeting. CHMC set strategy for update and established future meeting dated. The CHMC re-ranked the probably hazards and discussed the process for updating the plan.
12/18/2013	The CHMC reviewed the hazards of concern and updated the list of critical infrastructure. The CHMC also began the review of mitigation actions as proposed in the 2010 plan.
1/29/2014	The CHMC reviewed and finished updating the mitigation actions.
	The CHMC review draft of 2014 HMP document for accuracy and revisions.
	Edits made to draft plan.
	Draft of 2014 HMP posted for public comment and presented to City Council
	Changes made as per public comments.
	Sent to RIEMA for review.

This hazard mitigation plan benefits from two distinct types of public input strategies that were utilized by the CHMC during the drafting process and prior to its adoption by the City Council.

The 2010 plan utilized many stakeholders that contributed greatly to the plan's comprehensiveness. Consequently, the 2014 plan was more of an update and required less data gathering. The 2014 CHMC included non-City employees such as representatives of the Cranston Chamber of Commerce, Greylawn Food Corporation (a major business located in Cranston), and a small business owner. The CHMC's roles focused on reviewing the content of the risk assessment matrix to ensure proper classification of problems and estimates of potential impacts; formulation of mitigation actions and sequencing of primary tasks; and identification of feasible implementation methods and schedules. Their comments are incorporated into the final 2014 HMP.

Review and comment was also sort from the Federal Emergency Management Agency as well as the Rhode Island Emergency Management Agency prior to adoption.

The second public input strategy used in the formulation of this plan was geared toward the general public as opposed to specific stakeholders. The general public was encouraged to become involved through a public participation process. A copy of the draft 2014 HMP was posted to the Planning Department's page on the City of Cranston's web site. The posted draft was highlighted on the City's main web page as a hot topic. On [insert new date here], the City Plan Commission conducted a public workshop on the HMP. The public was informed of both the web page posting and the Plan Commission workshop and were encouraged to comment on the HMP and attend the workshop through newspaper articles in the Providence Journal and Cranston Herald [newspapers of general circulation within the City.] Notice of the Planning Commission Workshop was also posted as an agenda item on the City's web site and the Rhode Island Secretary of State's web site and at the Cranston Public Library and City Hall in accordance with state law. In addition, the Cranston City Council conducted a public hearing on the proposed City ordinance which will adopt the 2014 HMP. The this hearing was held on [insert date here] by the Ordinance Committee [the Ordinance Committee public hearing publicized by a legal notice in the Cranston Herald and was the subject of a news article in the Providence Journal]. The ordinance has been referred full City Council for adoption once the HMP has received conditional approval from FEMA (see Appendix J for proposed ordinance). Notices of the Ordinance Committee hearing was also posted as an agenda item on the City's web site and the Rhode Island Secretary of State's web site and at the Cranston Public Library and City Hall in accordance with state law.

APPENDICES

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APPENDIX A***Critical Municipal Facilities Inventory***

Name	Location	Zip Code	A. P.	Lot
Cranston City Hall	869 Park Avenue	02910	6/2	240
Cranston Fire Department - Auburn/Cranston Emergency Management Headquarters	301 Pontiac Avenue	02910	6/2	260
Cranston Fire Department - Edgewood	131 Park Avenue	02905	2/5	1319
Cranston Fire Department - Knightsville	1384 Cranston Steet	02910	8/2	2642
Cranston Fire Department - Garden City	160 Sockanosset Cross Road	02920	14	12
Cranston Fire Department - Oaklawn	1099 Oaklawn Avenue	02920	18/4	1290
Cranston Fire Department - Comstock	1155 Scituate Avenue	02921	36/3	65
Cranston Police Station*	275 Atwood Avenue	02920	12/4	2700
Cranston Public Works Garage	929 Phenix Avenue	02920	17/1	200
Cranston Senior Services Center - ARC	1070 Cranston Street	02920	7/4	2371
Western Hills Middle School - ARC	400 Phenix Avenue	02920	17/2	1810
Park View Middle School - ARC	25 Park View Boulevard	02910	4/4	1400
Pettaconsett Sewage Treatment Facility*	Pettaconsett Avenue	02920	10/2	27
Allard Pumping Station*	85 Allard Street	02920	18/4	692
Amanda Pumping Station	5 Redfern Drive	02920	18/3	1675
Bay Street Pumping Station*	9 Bay Street	02905	2/3	2769
Burnham Street Pumping Station	77 Burnham Street	02921	7/5	1429
Cranston Commons Pumping Station	36 Starline Way	02921	35	207
Dyer Avenue Pumping Station*	399 Dyer Avenue	02920	8/4	2691
East Street Pumping Station	328 East Street	02920	15/3	1603
Gleason Street Pumping Station	11 Gleason Street	02910	6/4	2124
Hollow Tree Pumping Station*	1771 Pontiac Avenue	02920	15/3	1577
Howard Pumping Station*	103 Kenney Drive	02920	10/4	1466
Mayflower Pumping Station	140 Mayflower Drive	02905	4/5	2605
Plainfield Circle Pumping Station	1580 Plainfield Circle	02920	37/2	In Right of Way (Underground)
Pontiac Avenue Pumping Station	900 Pontiac Avenue	02920	5/4	1
Randall Street Pumping Station (Libera, Fletcher and Cross Country)*	176 Randall Street	02920	12/4	2825
Seaview Avenue Pumping Station*	85 Seaview Avenue	02905	1	496
Sheldon Street Pumping Station*	115 Sheldon Street	02905	1	82
Sherman Avenue Pumping Station*	90 Sherman Avenue	02920	17/3	1822
Wellington Street Pumping Station	245 Station Street	02910	5/3	2562
Welsh/I-295 Pumping Station	1970 Plainfield Pike	02921	36/2	55
Woodbury Road Pumping Station*	110 Woodbury Road	02905	1	467
Worthington Road Pumping Station*	54 Worthington Road	02920	10/4	767
Youlden Street Pumping Station*	7 Youlden Avenue	02910	4/3	822
Alpine Estates Water Booster Station	6 Basil Crossing	02921	35	131
Aqueduct/Scituate Water Booster Station Western Cranston Water Facility	430 Scituate Avenue	02921	20/2	2122
Cranston Commons Water Booster Station	34 Starline Way	02921	35	206
Dean Estates Water Booster Station	50 Melody Lane	02920	16/4	1089
Garden Hills Water Booster Station	90 Rockcrest Street	02920	16/3	761

Sources: Jack McGilvray, Cranston Public Works Aide, 05/06/2003. Robert Warren, Chief of the Cranston Fire Department, 05/14/2003.

Note: * Within flood plain.

APPENDIX B***School Inventory***

<i>School Name</i>	<i>Address</i>	<i>Zip Code</i>	<i>A. P.</i>	<i>Lot</i>	<i>Grades</i>	<i>Floors</i>	<i>ADA Compliant</i>	<i>Generators</i>
Arlington Elementary	155 Princess Avenue	02920	7/4	3248	K - 5	1	No	No
Chester Barrows Elementary	9 Beachmont Avenue	02905	3/1	1283	K - 5	2	No	No
William R. Dutemple Elementary	32 Garden Street	02920	6/1	142	K - 5	2	No	No
Eden Park Elementary	180 Oakland Avenue	02910	9/3	2847	K - 5	1	No	No
Edgewood Highlands Elementary	160 Pawtuxet Avenue	02905	2/3	3487	K - 5	2	Yes	Yes
Garden City Elementary	70 Plantation Drive	02910	10/1	709	K - 5	1	Yes	No
Gladstone Elementary	50 Gladstone Street	02920	7/4	2357	K - 5	3	No	No
Glen Hills Elementary	50 Glen Hills Drive	02920	16/4	138	K - 5	1	Yes	No
Hope Highlands Elementary	300 Hope Road	02921	24	6	K - 5	2	Yes	No
Horton Elementary	1196 Park Avenue	02910	9/4	1710	K - 5	2	No	No
Norwood Avenue Elementary	205 Norwood Avenue	02905	2/3	834	K - 5	2	No	No
Oak Lawn Elementary*	28 Stoneham Street	02920	18/4	692	K - 5	2	No	No
Orchard Farms Elementary	1555 Scituate Avenue	02921	34	8 & 9	K - 5	1	Yes	Yes
George J. Peters Elementary*	15 Mayberry Street	02920	12/4	3244	K - 5	1	No	No
Edward S. Rhodes Elementary	160 Shaw Avenue	02905	2/2	1674	K - 5	2	No	No
Stadium Elementary	100 Crescent Avenue	02910	7/5	1900	K - 5	1	Yes	No
Stone Hill Elementary	21 Village Avenue	02920	37/2	268	K - 5	1	No	No
Daniel D. Waterman Elementary	722 Pontiac Avenue	02910	5/2	2109	K - 5	2	No	No
Woodridge Elementary	401 Budlong Road	02920	11/6	3151	K - 5	1	Yes	No
Hugh B. Bain Middle School	135 Gansett Avenue	02910	7/5	1160	6 - 8	2	No	No
Park View Middle School	25 Park View Boulevard	02910	4/4	1400	6 - 8	2	No	No
Western Hills Middle School	400 Phenix Avenue	02920	17/2	1810	6 - 8	2	Yes	Yes
Cranston East High	899 Park Avenue	02910	6/2	550	9 - 12	3	No	No
Cranston West High	80 Metropolitan Avenue	02920	17/2	199	9 - 12	2	Yes	Yes (Just Gym)
Cranston West Vocational Facility*	80 Metropolitan Avenue	02920	17/2	1956	9 - 12	2	Yes	Yes
Cranston Charter School	4 Sharpe Drive	02920	13	61	9 - 12	1	Yes	Yes

Source: Joel Zisserson, Cranston School Department Director of Transportation, 07/02/2003 and 07/08/2003.

Note: * Within flood plain.

APPENDIX C***Bridge and Culvert Inventory***

RIDOT Bridge #	Bridge or Culvert	Structure Carried	Utilities	Feature Intersected	A. P.	Ownership	Maintainee
101*	Bridge	Elmwood Avenue	X	Pawtuxet River	4/2	State	State
2301*	Bridge	Reservoir Avenue		Pocasaset River	9/2	State	State
2401*	Bridge	Providence Street		Meshanticut Brook	18/3	State	State
2501	Bridge	Providence Street		State Bike Path	18/3	State	State
8101*	Bridge	Plainfield Pike	X	Pocasaset River	12/2	State	State
8201*	Bridge	Plainfield Pike	X	Locust Brook	36/1	State	State
15001*	Bridge	Warwick Avenue	X	Pawtuxet River	4/5	State	State
15201	Footbridge	Furnace Hill Road	X	Furnace Hill Brook	19/1	City	City
19001*	Bridge	Broad Street	X	Pawtuxet River	1	State	State
20101*	Bridge	Pontiac Avenue	X	Pocasaset River	10/2	State	State
28601	Bridge	Oaklawn Avenue		State Bike Path	11/3	State	State
32801	Bridge	Gansett Avenue		State Bike Path	11/2	City	City
32901	Bridge	Scituate Avenue		Brook	12/6	State	State
33001*	Bridge	Scituate Avenue		Meshanticut Brook	34	State	State
33101	Bridge	Pippin Orchard Road	X	Brook	34	State	State
33201*	Bridge	Pippin Orchard Road	X	Furnace Hill Brook	34	State	State
33301*	Bridge	Pippin Orchard Road	X	Meshanticut Brook	28	State	State
34701	Bridge	Dean Parkway	X	State Bike Path	17/4	City	City
34901*	Bridge	Phenix Avenue	X	Furnace Hill Brook	17/1	State	City
35701	Bridge	Pontiac Avenue		Branch R.R.	13	State	State
41301	Bridge	Phenix Avenue		Furnace Hill Brook	21/2	City	City
42001	Bridge	State Bike Path		Wilbur Avenue	18/4	State	State
42002	Bridge	State Bike Path		Wilbur Avenue	18/4	State	State
42101	Bridge	Reservoir Avenue		Meshanticut Interchange Lane B	15/1	State	State
42102	Bridge	Reservoir Avenue		Meshanticut Interchange Lane B	15/1	State	State
42201	Bridge	Meshanticut Interchange		Oaklawn Avenue	18/3	State	State
42202	Bridge	Meshanticut Interchange		Oaklawn Avenue	18/3	State	State
42301	Bridge	Meshanticut Viaduct		Oaklawn Avenue & Lane C	15/1	State	State
42302	Bridge	Meshanticut Viaduct		Oaklawn Avenue & Lane C	15/1	State	State
42401*	Bridge	New London Avenue - Lane H		Meshanticut Interchange - Lane A	18/3	State	State
43401*	Bridge	Natick Avenue		Furnace Hill Brook	19/1	State	State
45301	Bridge	Route 10 Viaduct		Cranston Street, SR -3 & AMTRAK	7/1	State	State
45302	Bridge	Route 10 Viaduct		Cranston Street, SR -3 & AMTRAK	7/1	State	State
48001*	Bridge	Park Avenue	X	Pocasaset River	11/1	State	State
49401*	Bridge	Dyer Avenue Extension	X	Pocasaset River	11/1	State	State
54101	Skeleton Valley Bridge	Scituate Avenue		Pedestrian Underpass	12/6	State	State
61601	Bridge	Interstate - 95		Glen Hills Drive	16/4	State	State
61602	Bridge	Interstate - 95		Glen Hills Drive	16/4	State	State
61701	Culvert	Interstate - 95		Three Ponds Brook	13	State	State
62001	Bridge	Cranston Park Ramp E - N		Interstate - 295 S	19/1	State	State
62002	Bridge	Cranston Park Ramp E - N		Interstate - 295 S	19/1	State	State
62101	Bridge	Route 37		Cranston Street	17/3	State	State
62201	Bridge	Route 37		State Bike Path	17/3	State	State
62301	Bridge	Route 37		Oaklawn Avenue	16/1	State	State
62302	Bridge	Route 37		Oaklawn Avenue	16/1	State	State
62401	Bridge	Route 37		New London Avenue	14	State	State
62402	Bridge	Route 37		New London Avenue	14	State	State
62501	Bridge	Route 37		Howard Service Road	14	State	State
62601	Bridge	Route 37		Branch R.R.	10/4	State	State
62701	Bridge	Route 37		Pontiac Avenue	10/4	State	State
62801*	Bridge	Route 37 E		Pawtuxet River (South)	10/4	State	State
62901*	Bridge	Route 37 W		Pawtuxet River (North)	10/4	State	State
66101	Bridge	Interstate - 95		Wellington Avenue	3/3	State	State
66201	Bridge	Interstate - 95 & Ramp CB		Wellington Avenue	3/3	State	State
66301	Bridge	Wellington Avenue and AMTRAK		Interstate - 95	3/3	State	State
66401	Bridge	Route - 10 North Ramp BC		Interstate - 95	3/3	State	State
66402	Bridge	Route - 10 North Ramp BC		Interstate - 95	3/3	State	State

Source: David DeNuccio, Cranston Engineering Dept., 06/27/2003.

Note: * Within flood plain.

APPENDIX C (CONTINUED)***Bridge and Culvert Inventory***

RIDOT Bridge #	Bridge or Culvert	Structure Carried	Utilities	Feature Intersected	A. P.	Ownership	Maintainee
66501	Bridge	Route - 10 Viaduct		Interstate - 95 & AMTRAK	3/3	State	State
66502	Bridge	Route - 10 Viaduct		Interstate - 95 & AMTRAK	3/3	State	State
66601	Bridge	Route - 10 South Ramp DB		Interstate - 95	3/3	State	State
66602	Bridge	Route - 10 South Ramp DB		Interstate - 95	3/3	State	State
66801	Bridge	Pontiac Avenue		Route - 10	6/1	State	State
66802	Bridge	Pontiac Avenue		Route - 10	6/1	State	State
67501	Bridge	Park Avenue East		Route - 10	3/2	State	State
67502	Bridge	Park Avenue East		Route - 10	3/2	State	State
67601	Bridge	Park Avenue		Interstate - 95	3/2	State	State
67602	Bridge	Park Avenue		Interstate - 95	3/2	State	State
67701	Bridge	Laurens Street		Interstate - 95	3/2	State	State
67702	Bridge	Laurens Street		Interstate - 95	3/2	State	State
67801	Bridge	Milford Street		Interstate - 95	5/2	State	State
67802	Bridge	Milford Street		Interstate - 95	5/2	State	State
67901	Bridge	Branch R.R.		Interstate - 95	5/2	State	State
67902	Bridge	Branch R.R.		Interstate - 95	5/3	State	State
68001*	Bridge	Interstate - 95		Pawtuxet River	5/3	State	State
72601	Bridge	Providence Street		Interstate - 295	18/3	State	State
72602	Bridge	Providence Street		Interstate - 295	18/3	State	State
72701*	Bridge	Interstate - 295 N		Wilbur Avenue (Northbound)	18/4	State	State
72721*	Bridge	Interstate - 295 S		Wilbur Avenue (Southbound)	18/2	State	State
72801*	Bridge	Cranston Park East - Route 37		Interstate - 295 N	19/2	State	State
72802*	Bridge	Cranston Park East - Route 37		Interstate - 295 N	19/2	State	State
72821*	Bridge	Cranston Park West - Route 37		Interstate - 295 S	19/2	State	State
72822*	Bridge	Cranston Park West - Route 37		Interstate - 295 S	19/2	State	State
72901	Bridge	Phenix Avenue (Eastbound)		Interstate - 295 N	17/1	State	State
72902	Bridge	Phenix Avenue (Eastbound)		Interstate - 295 N	17/1	State	State
72921	Bridge	Phenix Avenue (Westbound)		Interstate - 295 S	17/1	State	State
72922	Bridge	Phenix Avenue (Westbound)		Interstate - 295 S	17/1	State	State
73001	Bridge	Interstate - 295 N		Water Aquaduct (Northbound)	26/1	State	State
73021	Bridge	Interstate - 295 S		Water Aquaduct (Southbound)	26/1	State	State
73101	Bridge	Interstate - 295		Scituate Avenue	37/3	State	State
73102	Bridge	Interstate - 295		Scituate Avenue	37/3	State	State
73201	Bridge	Interstate - 295 N		Plainfield Pike (Northbound)	36/2	State	State
73202	Bridge	Interstate - 295 N		Plainfield Pike (Northbound)	36/2	State	State
73221	Bridge	Interstate - 295 S		Plainfield Pike (Southbound)	36/2	State	State
73222	Bridge	Interstate - 295 S		Plainfield Pike (Southbound)	36/2	State	State
75801*	Bridge	Garden City Drive		Pocasset River	9/1	State	State
81201	Culvert # 2	Interstate - 295		Meshanticut Brook (Northbound)	18/1	State	State
81221*	Culvert # 2	Interstate - 295 S		Meshanticut Brook (Southbound)	18/1	State	State
81301	Culvert # 3	Interstate - 295		Meshanticut Brook	18/3	State	State
81321	Culvert # 3	Interstate - 295 S		Meshanticut Brook (Southbound)	18/1	State	State
81401*	Culvert # 4	Interstate - 295 N		Meshanticut Brook (Northbound)	18/4	State	State
81421*	Culvert # 4	Interstate - 295 S		Meshanticut Brook (Southbound)	18/2	State	State
81501*	Culvert # 5	Interstate - 295 & Route 37 Ramp		Meshanticut Brook	17/1	State	State
81601*	Culvert # 6	Route 37 Ramp & Interstate 295 S		Meshanticut Brook	19/1	State	State
81701*	Culvert # 7	Interstate - 295 Ramps WS & SW		Meshanticut Brook	19/1	State	State
81801*	Furnace Hill Brook Culvert	Interstate - 295 S & Ramp W - S		Furnace Hill Brook	17/1	State	State
81901*	Culvert	Wilbur Avenue		Meshanticut Brook	18/2	State	State
83101	Bridge	Route 37 Ramp		Cranston Street Ramp	17/3	State	State
84201	Bridge	Hill Street (Coventry)		Pawtuxet River	30/1	State	City
92201	Bridge	Park Avenue		AMTRAK	3/2	State	State
92401	Bridge	AMTRAK		Cranston Street (Providence)	7/1	State	State
93801	Bridge	Providence-Worcester R.R. (track removed)		Cranston Street	7/2	NY, NH & H R.R.	City
99501*	Bridge	Cranston Street		Pocasset River	8/2	State	City
99601*	Bridge	Seven Mile Road		Clark Brook	30/1	State	City
106101*	Bridge	Park Avenue		Elm Lake Brook	4/4	State	State

Source: David DeNuccio, Cranston Engineering Dept., 06/27/2003.

Note: * Within flood plain.

APPENDIX C (CONTINUED)

Bridge and Culvert Inventory

<i>Lot</i>	<i>Bridge or Culvert</i>	<i>Structure Carried</i>	<i>Utilities</i>	<i>Feature Intersected</i>	<i>A. P.</i>	<i>Ownership</i>	<i>Maintainee</i>
844*	Bridge	Dyer Avenue		Pocasset River	8/4	Pocasset Cemetary	Private
2985	Bridge	Burnham Avenue		Bike Path	7/4	City	City
2630*	Bridge	Mill Street		Pawtuxet River	4/5	Ciba - Gelgy	Private
1102*	Footbridge	Mill Street		Pawtuxet River	4/5	Ciba - Gelgy	Private
41	Bridge	Beechwood Drive		Stream	29	Resident	Private
47	Bridge	Beechwood Drive		Stream	29	Resident	Private
2560*	Bridge	Wellington Avenue (Railroad)		Pawtuxet River	5/3	NY, NH & H R.R.	Private
24*	Bridge	Phenix Avenue		Furnace Hill Brook	25/3	City	City
1525*	Bridge	Amanda Court		Bike Path	18/3	City	City
679	Bridge	Natick Avenue		Stream	18/1	City	City

Source: David DeNuccio, Cranston Engineering Dept., 06/27/2003.

Note: * Within flood plain.

APPENDIX D***Historic Properties Inventory***

<i>Historic Districts</i>	<i>Location</i>	<i>A.P.</i>	<i>Lot</i>
Pawtuxet Village Historic District	Bounded easterly on Narragansett Bay; southerly on the Pawtuxet Cove, Bayside Avenue, and South Fair Street; westerly on South Atlantic Avenue; and northerly on the Pawtuxet River and Ocean Avenue (Cranston and Warwick)	1	
Oak Lawn Village National and Local Historic District	Wilbur Avenue, from Natick Road to Oaklawn Avenue	8/4 and 18/2	
Furnace Hill Brook Historical and Archeological District	Phenix Avenue and Hope Road	21/2/ and 21/3	
Edgewood Historic District: Arnold Farm Plat	Arnold Ave., Albert Ave., Columbia Ave., bounded by Broad Street to the west and Narragansett Bay to the east.		
Edgewood Historic District: Shaw Plat	Shaw Ave., Marrion Avenue. Bound by Broad Street to the west and Narragansett Bay to the east.		
Edgewood Historic District: Taft Estate Plat	Windsor Avenue, Stratford Rd., Circuit Drive. Bound by Broad Street to the west and Narragansett Boulevard to the east		
Lippitt Hill Historic District	Burlingame and Hope Roads, and Lippitt Avenue	23, 30/3 and 30/4	
Norwood Avenue Historic District	Norwood Avenue. Bound by Roger Williams Park to the west, Broad Street to the east.	2/5	
<i>National Register Properties</i>	<i>Location</i>	<i>A.P.</i>	<i>Lot</i>
Rhodes on the Pawtuxet*	60 Rhodes Place	1	299
Nathan Westcott House	56 Scituate Avenue	12	3096
Sheldon House	458 Scituate Avenue	20	2120
Thomas Fenner House	53 Stony Acre Drive	37	795
Governor Sprague Mansion	1351 Cranston Street	8/2	201
The Joy Homestead	179 Whiting Street	12	2877
Knightsville Meeting House	67 Phenix Avenue	12	125
Potter Remington House	571 Natick Avenue	22	69
Rosedale Apartments	1180 Narragansett Boulevard	2	1912
Arad Wood House	407 Pontiac Avenue	9/5	138

Source: Lynn Furney, Cranston Senior Planner 7/2010 and National Register of Historic Places

Note: * Within 100 year flood plain

APPENDIX E**Child Daycare Facilities Inventory**

<i>Name</i>	<i>Address</i>	<i>Zip Code</i>	<i>A.P.</i>	<i>Lot</i>
A Safer Start, Child University	117 Woodbine Street	02910	6	47
All About Kids	490 Atwood Avenue	02920	12	2132
Alpine Preschool	400 Pippin Orchard Road	02921	33	56
Budlong Pre School	10 Budlong Road	02920	11	1862
Candy Cane Preschool	54 Olney Arnold Road	02921	21	58
Candy Cane Two	359 Olney Arnold Road	02920	26	9
Carriage House Day Care	156 Shaw Avenue	02905	2	888
CCAP	160 Pawtuxet Avenue	02905	2	2487
CCAP Child Development Ctr.	155 Gansett Avenue	02920	11	2984
CCAP May Westcott School	848 Atwood Avenue	02920	12	720
Cornerstone School	665 Dyer Avenue	02920	8	2780
Creative Ctr.	717 Atwood Avenue	02920	12	454
Doric Day Nursery	145 Pontiac Avenue	02910	6	3255
Faith Nursery School	499 Hope Road	02921	28	65
First Year Learning Center	1400 Elmwood Avenue	02910	4	2617
Henderson Learning Center	74 Alton Street	02910	4	2627
Jendza Creative Center Preschool	1326 Plainfield Street	02920	12	419
Kids Kingdom	116 Puritan Avenue	02920	8	671
Learning Brooke ECE Center	1170 Pontiac Avenue	02920	10	706
Miss Lee Ann's	180 Oaklawn Avenue	02920	11	3419
Noah's Ark (Community World Chapel Outreach)	1308 Phenix Avenue	02921	21	290
Pumpkin Patch Academy	210 Comstock Parkway	02921	36	14
Pumpkin Patch Early Learning Center	220 Comstock Parkway	02921	36	14
St. Paul School	1789 Broad Street	02905	2	1339
Starbirth Day Care	80 East Street	02920	15	20
St. Mary's After School Care	85 Chester Avenue	02920	8	949
Sunshine Preschool	690 Dyer Avenue	02920	8	2725
The Gingerbread House Pre-School	1458 Park Avenue	02920	11	2971
Western Cranston Learning Ctr.	140 Natick Avenue	02921	19	67
Wonderland Early Learning Ctr.	546 Budlong Road	02920	11	3027
YMCA Schools Out	1224 Park Avenue	02910	11	3553
YMCA Community Youth Center	155 Gansett Avenue	02920	11	2984
YMCA -Eden Park School	180 Oaklawn Avenue	09310	11	3419
YMCA (George J. Peters Elementary School)*	15 Mayberry Street	02920	12	3244
YMCA (Edward S.Rhodes Elementary School)	160 Shaw Avenue	02905	12	1674

Source: Cranston Department of Inspection August, 2010

APPENDIX F

DAM INVENTORY

DRAFT

Cranston_Dams_12_2013

STATE ID	DAM NAME	CITY/TOWN	HAZARD	CURRENT INSP DATE	CURRENT COND(E,S,G)	NEXT INSP	COND COMMENT
373	CLARKE'S POND UPPER	CRANSTON	HIGH	10/14/2009	P,P,P		
172	CRANSTON PRINT WORKS POND	CRANSTON	HIGH	10/15/2009	FP,F,P	2013	
198	CURRAN LOWER RESERVOIR	CRANSTON	HIGH	6/7/2010	P,P,P		UNSAFE
166	CURRAN UPPER RESERVOIR	CRANSTON	HIGH	3/9/2010	P,P,P		UNSAFE
340	MESHANTICUT PARK POND	CRANSTON	SIGNIFICANT	5/23/2012	F,G,NA		
320	STONE POND	CRANSTON	HIGH	10/15/2009	FP,GP,NA	2013	

Source: RI Department of Environmental Management

APPENDIX G

Technical and Financial Assistance for Mitigation State Resources

Coastal Resources Center

University of Rhode Island
Narragansett Bay Campus
Narragansett, RI 02882
(401) 874-6224

Coastal Resources Management Council

Stedman Government Center
4808 Tower Hill Road
Wakefield, RI 02879
(401) 222-2476

**Department of Administration/Division of
Planning**

One Capitol Hill
Providence, RI 02908
(401) 222-6478

Department of Environmental Management

Division of Parks and Recreation
2321 Hartford Avenue
Johnston, RI 02919
(401) 222-2635

**Rhode Island Banking
Commission/Associate Director**

233 Richmond Street
Providence, RI 02903
(401) 222-2405

Rhode Island Builders Association

Terry Lane
Gloucester, RI 02814
(401) 568-8006

**Rhode Island Department of Business
Regulations**

233 Richmond Street
Providence, RI 02903
(401) 222-2246

**Rhode Island Emergency Management
Agency**

645 New London Avenue
Cranston, RI 02920
(401) 946-9996

Public Utilities Commission

100 Orange Street
Providence, RI 02903
(401) 222-3500 Ext. 153

State Fire Marshal's Office

272 West Exchange Street
Providence, RI 02903
(401) 222-2335

**State of Rhode Island Building Committee
Office**

Building Commissioner's Office
One Capitol Hill
Providence, RI 02903
(401) 222-3529

APPENDIX G (CONTINUED)

Technical and Financial Assistance for Mitigation Federal Resources

Economic Development Administration

143 North Main Street, Suite 209
Concord, NH 03301
(603) 225-1624

**Federal Emergency Management Agency
Mitigation Division**

Region I Office
J.W. McCormack POCH, Room 462
Boston, MA 02109
(617) 223-9561

Small Business Administration

360 Rainbow Boulevard South, 3rd Floor
Niagara Falls, NY 14303
(716) 282-4612 or (800) 659-2955

**U.S. Department of Agriculture
Natural Resources Conservation Service**

451 West Street
Amherst, MA 01002
(413) 253-4362

**U.S. Department of Commerce
National Weather Service Forecast Office**

445 Myles Standish Boulevard
Taunton, MA 02780
(508) 823-2262

**U.S. Department of Housing and Urban
Development****Community Development Block Grants**

Region I – O'Neill Federal Building
10 Causeway Street
Boston, MA 02222
(617) 565-5354

**U.S. Department of the Interior
National Park Service**

Rivers and Trails Conservation Program
Regional Office
15 State Street
Boston, MA 02109
(617) 223-5203

U.S. Environmental Protection Agency

Region I – JFK Federal Building
Government Center
Boston, MA 02203
(617) 565-3400

U.S. Fish and Wildlife Service

New England Field Office
22 Bridge Street, Unit #1
Concord, NH 03301-4986

APPENDIX G (CONTINUED)

Technical and Financial Assistance for Mitigation Other Resources

The Association of State Flood Plain Managers (ASFPM)

Professional association with a membership of almost 1,000 state employees that assists communities with the NFIP. ASFPM has developed a series of technical and topical research papers and a series of proceedings from their annual conferences. Many mitigation “success stories” have been documented through these resources and provide a good starting point for planning.

Flood Plain Management Resources Center

Free library and referral service of the ASFPM for flood plain management publications. Co-located with the Natural Hazards Center at the University of Colorado in Boulder, staff can use keywords to identify useful publications from the more than 900 flood-related documents in the library.

Institute for Business and Home Safety (IBHS) (formerly Insurance Institute for Property Loss Reduction)

An insurance industry – sponsored, nonprofit organization dedicated to reducing losses – deaths, injuries, and property damage – resulting from natural hazards. IBHS efforts are directed at five specific hazards: flood, windstorm, hail, earthquake, and wildfire. Through its public education efforts and information center, IBHS communicates the results of its research and statistical gathering, as well as mitigation information, to a broad audience.

Volunteer Organizations

Organizations, such as the American Red Cross, the Salvation Army, Habitat for Humanity, Interfaith, and the Mennonite Disaster Service, are often available to help after disasters. Service organizations, such as the Lions, Elks, and VFW are also available. These organizations have helped others with food, shelter, clothing, money, etc. Habitat for Humanity and the Mennonite Disaster Service provide skilled labor to help rebuild damaged buildings incorporating mitigation or floodproofing concepts. The offices of individual organizations can be contacted directly, or the FEMA Regional Office may be able to assist.

Flood Relief Funds

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

New England States Emergency Consortium (NESEC)

NESEC conducts public awareness and education programs on natural disaster and emergency management activities throughout New England. Brochures and videotapes are available on such topics as earthquake preparedness, mitigation, and hurricane safety tips. NESEC maintains a WWW home page that is accessible at <http://www.serve.com/NESEC>.

The New England Flood Plain and Stormwater Managers Association (NEFSMA)

Professional organization for New England flood plain and stormwater managers. Provides workshops, conferences, and a newsletter to membership and interested individuals and companies. Contact: Nicholas Winter, chairman, at (617) 727-0488 or the NEFSMA home page on the Web at <http://www.seacoast.com/~nefsma>.

APPENDIX H

Existing Protection Systems Federal and State

Coastal Barrier Resource Act

Administered by the U.S. Fish and Wildlife Service, this program has mapped public and private land identified as undeveloped coastal barrier areas. These areas may be denoted as “Otherwise Protected Areas” if they are owned by public entities. In the coastal barrier areas shown on FEMA’s flood insurance rate maps, structures newly built or substantially improved after the date shown on the maps are ineligible for federal insurance. This serves to restrict new development in these areas because the purchase of flood insurance is required to obtain backed mortgages and improvement loans for structures located in special flood hazard areas.

Community Rating System (CRS)

A voluntary initiative of the NFIP, the CRS was developed to encourage communities to perform activities that exceed the minimum NFIP flood plain management standards. If a community participating in the CRS performs activities that include maintaining records for flood plain development, publicizing the flood hazard, improving flood data, and conducting flood plain management planning, then the flood insurance premiums paid by policy holders in the community will be reduced by 5 to 45 percent. Developing a flood mitigation plan will help communities gain additional credit under the CRS.

Earthquakes and Hurricanes

A certain amount of funding is allotted to each state per year based on a risk formula for earthquakes. Coastal states are allocated funds based on a risk formula for hurricanes. Each state receiving such funds has the ability to grant project funds to a community. There is not a match requirement on the part of the community, but the funds are limited, and are generally only available once a year. The projects or products proposed for such funding must demonstrate that earthquake or hurricane risk will be reduced or eliminated, and that the proposed project or product is a cost-effective measure (a stringent cost/benefit analysis need not be performed). Information about the amount of funding available per year and the state requirements for eligibility and performance may be obtained from RIEMA at (401) 946-9996.

Economic/Community Development

There may be programs existing to help floodproof homes using Community Development Block Grant funds. There may be housing assistance programs in the community that can be used following a major flood, achieving both objectives of reducing flood damage and improving the communities housing stock (see Appendix F, Federal Resources, for more information).

Evacuation Plans and Systems

Your community’s emergency operations center should have evacuation plans in place. For communities near a nuclear power plant, evacuation plans are required, and may be also used for flood evacuation. RIEMA may have additional evacuation plan information.

Land Use Restrictions

There are several federal and state regulations that serve to restrict land use in certain areas that may help reduce flood hazard vulnerability. If your community has open land owned by the state or federal government, examine what restrictions are placed on its development. In addition, the state Wetlands Protection Act regulates the development of all lands identified as significant to the protection of resources identified in the act.

APPENDIX H (CONTINUED)

Existing Protection Systems Federal and State

Septic Systems

If there are areas in the community not served by a public sewer system, state septic system regulations influence development and may be a consideration for mitigation alternatives that include rebuilding and elevation of structures. Specific design requirements must be met for any construction in coastal velocity zones or river floodways. Generally, an inspection of a septic system is required if there is a change in use of the structure, an increase in flow, or a failed system. Limited inspections are required if the footprint of the structure is being changed. Upgrades are required by the state if an inspection reveals a failed system. However, local regulations may be more restrictive than state requirements, requiring inspections or upgrades in other cases.

State Barrier Beaches

Your community may have barrier beaches, as defined by the state's Coastal Resource Management Program. The regulations applying to these areas are enforced by CRMC. These regulations restrict alteration of the beach and/or dunes and the construction of coastal engineering structures. New or substantially reconstructed buildings generally must be elevated to a minimum of 1 foot above base flood elevation. No new commercial development is allowed on barrier beaches. If a structure is damaged more than 50 percent, it cannot be rebuilt.

Warning Systems and Emergency Operations Plans

Your community may have a flood warning system in place and should have a plan for response to flooding. In addition, RIEMA has offices throughout the state that maintain area-wide plans for flood events.

APPENDIX I

Financing Options

Federal Emergency Management Agency

National Flood Insurance Program (NFIP)

All of Rhode Island's 39 municipalities participate in the NFIP. 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 flood plain management regulations. Communities participating in the NFIP must:

- Adopt the flood insurance rate maps as an overlay regulatory district.
- Require that all new construction or substantial improvement to existing structures in the flood hazard area be elevated or (if nonresidential) floodproofed to the identified flood level on the maps.
- Require design techniques to minimize flood damage for structures being built in high hazard areas, such as floodways or velocity zones.

In return for community adoption of these standards, any structure in that community is eligible for protection by flood insurance, which covers property owners from losses due to inundation from surface water of any source. Coverage for land subsidence, sewer backup, and water seepage is also available subject to the conditions outlined in the NFIP standard policy (see Appendix F, Federal Resources, for contacts regarding insurance coverage and purchase). Since homeowners insurance does not cover flooding, a community's participation in the NFIP is vital to protecting property in the flood plain as well as being essential to ensure that federally backed mortgages and loans can be used to finance floodprone property.

Hazard Mitigation Grant Program (HMGP)

Also known as the 404 Program or HMGP, this program is available only after a federally declared disaster occurs. It represents an additional 15 percent of all the infrastructure and individual assistance funds that are provided to states to repair damages and recover from losses, and is administered by the state in partnership with FEMA. Having a plan or completed mitigation action matrix prior to a disaster event is extremely helpful in meeting the state's deadlines for applications and ensuring the project is eligible and technically feasible. It provides 75/25 matching grants on a competitive basis to state, local, and tribal governments, as well as to certain nonprofit organizations that can be matched by either cash or in-kind services. The grants are specifically directed toward reducing future hazard losses, and can be used for projects protecting property and resources against the damaging effects of floods, earthquakes, wind, and other hazards. Specific activities encouraged under the HMGP include acquiring damaged structures to turn the land over to the community for open space or recreational use, relocating damaged or damage-prone structures out of the hazard area, and retrofitting properties to resist the damaging effects of disasters. Retrofitting can include wet- or dry-floodproofing, elevation of the structure above flood level, elevation of utilities, or proper anchoring of the structure.

For further information contact the state of Rhode Island hazard mitigation officer at (401) 946-9996 or FEMA Region I at (617) 223-9540.

Flood Mitigation Assistance Program (FMA)

Two programs that have been authorized under the National Flood Insurance Reform Act of 1994 include the Flood Mitigation Assistance (FMA) program and a provision for increased cost of compliance (ICC) coverage. FMA makes grants available on a pre-disaster basis for flood mitigation planning and activities, including acquisition, relocation, and retrofitting of structures. FMA grants for mitigation projects will be available only to those communities with approved hazard mitigation plans.

APPENDIX I (CONTINUED)

Financing Options

ICC coverage has recently been implemented for all new NFIP policies and renewals and is intended to be “mitigation insurance” to allow homeowners whose structures have been repeatedly or substantially damaged to cover the cost of elevation and design requirements for rebuilding with their flood insurance claim up to a maximum of \$15,000.00. A certain amount of funding is allotted to each state per year based on a risk formula for floods. Each state has the discretion to award funds to communities or to state government agencies. States may use whatever criteria or method they choose to award the funds as long as the applicant and the proposal are eligible. The program may fund up to 75 percent of the cost of the proposed project, with a minimum of 25 percent of the cost coming from the community. A minimum of half the community share must be cash or “hard match.”

Funds can also be granted to communities to help them prepare local flood mitigation plans. The same match requirements apply. Once a community receives a planning grant, however, it is not eligible to receive additional planning grants for another five years. For further information on the FMA program or ICC coverage contact RIEMA at (401) 946-9996.

Natural Resources Conservation Service (NRCS)

Small Watershed Program and Flood Prevention Program

The Watershed and Flood Prevention Act, P.L. 83-566, August 4, 1954, (16 USC 1001 – 1008) authorized this program. Prior to fiscal year 1996, small watershed planning activities and the cooperative river basin surveys and investigations authorized by Section 6 of the Act were operated as separate programs. The 1996 appropriations act combined the activities into a single program entitled Watershed Surveys and Planning Program.

The purpose of the Watershed Program, including River Basin operations, is to assist Federal, State, local agencies, local government sponsors, tribal governments, and program participants to protect and restore watersheds from damage caused by erosion, floodwater, and sediment, to conserve and develop water and land resources, and solve natural resource and related economic problems on a watershed basis. The program provides technical and financial assistance to local people or project sponsors, builds partnerships, and requires local and state funding contribution.

Resource concerns addressed by the program include watershed protection, flood prevention, erosion and sediment control, water supply, water quality, opportunities for water conservation, wetland and water storage capacity, agricultural drought problems, rural development, municipal and industrial water needs, upstream flood damages, water needs for fish, wildlife, and forest-based industries, fish and wildlife habitat enhancement, wetland creation and restoration, and public recreation in watersheds of 250,000 or fewer acres. Both technical and financial assistance are available.

Wildlife Habitat Incentives Program

The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve habitat primarily on private land. Through WHIP USDA’s Natural Resources Conservation Service (NRCS) provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat. WHIP agreements between NRCS and the participant generally last from 5 to 10 years from the date the agreement is signed.

National Weather Service (NWS)

The Taunton, Massachusetts NWS office has developed a partnership with RIEMA. NWS donates staff time and tide gauges to help gain more lead time for evacuation.

For further information contact NWS at (508) 823-2262. <http://www.nws.noaa.gov/>.

APPENDIX I (CONTINUED)

Financing Options

American Red Cross (ARC)

The ARC chapter of Rhode Island has supplied public education materials and volunteered to conduct training programs and hold seminars for the Rhode Island Hazard Mitigation Project.

For further information contact the Rhode Island Chapter of the American Red Cross at (401) 831-7700. <http://www.redcross.org>.

U.S. Army Corps of Engineers

Beneficial Uses of Dredged Material – Section 204, Water Resources Development Act of 1992, as amended, authorizes projects for the protection, restoration, and creation of aquatic and ecologically related habitats, including wetlands, in connection with dredging an authorized federal navigation project. Non-federal sponsors are responsible for 25 percent of the project cost and 100percent of the cost of operation, maintenance, replacement and rehabilitation. There is an annual appropriations limit of \$15 million. For projects with an estimated federal cost of less than \$5 million, divisions have approval authority.

1948 Flood Control Act, as amended - Section 205 (Small Flood Damage Reduction Projects) aids in the development and construction of small flood damage reduction projects for eligible non-federal sponsors. The 1960 Flood Control Act, as amended, provides 100 percent funding for technical and planning guidance to state and local governments and federally recognized Native American tribes to help develop and interpret flood and flood plain data, such as flood hazard mapping, and for assessment for structural and non-structural flood damage reduction measures.

Under Flood Control Act of 1946 – Section 14, as amended, projects are eligible for construction only after an analysis demonstrates the engineering and environmental feasibility and economic justification of the improvement. The local sponsor must be a municipality or public agency. Funding may also be available for flood damage reduction measures if the community writes a request letter to the U.S. Army Corps of Engineers. The non-federal cost share is 35 percent of the analysis and implementation, and the initial \$40,000 of the analysis is 100 percent federally funded.

The 1974 Water Resources Development Act, as amended – Section 22 (Planning Assistance to States Program) provides technical assistance for such flood projects as erosion and control. This program uses cost-shared studies with a non-federal sponsor. The non-federal share of the cost is 50 percent and in-kind services are not authorized. The federal limit for each state is \$500,000 annually.

For more information, contact the U.S. Army Corps of Engineers at (978) 318-8087 or (978) 318-8647. <http://www.usace.army.mil>.

State of Rhode Island

The capital budget is approved on a 5-year basis and is proposed by the governor. If there is any surplus available in the emergency fund, this could be a possible source of financing for mitigation projects.

Rhode Island Department of Environmental Management (DEM)

In the 1980's, four major open space bond issues were approved that resulted in an investment of more than \$100 million for recreational and open space land acquisition. Each application is reviewed by a committee to assure consistency with local plans and habitat values. The state participates in funding either through a matching grant or of a revolving loan. Funds may be available through the DEM Parks and Recreation Division for tree trimming, dune restoration and bulkhead repair. In

APPENDIX I (CONTINUED)

Financing Options

addition, the state has several funding programs for the acquisition of land or purchase of development rights to protect open spaces. For instance, two Rhode Island municipalities use a real estate transfer tax for land preservation. Rhode Island has incorporated land trusts that work to preserve land and natural resources. Land owners can participate in the Farm, Forest and Open Space Program. Under this program, land may qualify for a reduced property tax assessment if it meets specific criteria as farmland, forest land or open space.

For current funding availability contact the Open Space and Recreational Bond Fund Land Acquisition Program or DEM at (401) 222-2776.

Rhode Island Department of Transportation (DOT)

The State Planning Council designates which Transportation Improvements Plan enhancement projects the state will pursue. Applications for the Federal Wooden Bridge Replacement Program can be made through DOT. In addition, DOT has a debris management program that goes into effect during a storm event. The new federal transportation bill, TEA-21, is a successor to the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA). There are a few categories within this bill that may have available funding for natural hazard mitigation projects. These include transportation enhancement (categories include storm water remediation, storm water runoff protection, and environmental mitigation) and bridge replacement. The municipality must apply for project funds through DOT. The annual funding averages for Rhode Island are \$156,781.00. There is an average of \$26,749 available under the Bridge Rehabilitation and Replacement category.

For further information contact DOT at (401) 277-2481.

North East States Emergency Consortium (NESEC)

Since 1998, RIEMA has been given funds for preventative measures and maintenance. Providence and Woonsocket both received \$5,000 grants from NESEC for mitigation activities that were addressed in their local hazard mitigation strategies.

For further information contact at (781) 224-9874.

Municipal

Several utility companies have prevention and clean-up programs that require cooperation from municipalities. For instance, companies are usually willing to co-sponsor planting low-growing trees as part of a tree replacement program. Utility companies will provide the bucket truck area lift if the town/city helps dispose of tree trunks.

The Clean Water Finance Agency has financing programs for local government units and water suppliers. The clean water state revolving fund uses monies from the Federal Clean Water Act to support sewer work such as sewer extensions and septic system repair, and to give homeowners of all incomes low-interest loans for septic system repairs. The community wide onsite wastewater management plan is a Clean Water Finance Agency program for failing or sub-standard septic systems, and it identifies areas in municipalities where system failures could cause degradation to water quality. Municipal loans for large infrastructure projects are also available through this program at discounted interest rates.

APPENDIX J.



THE CITY OF CRANSTON ORDINANCE OF THE CITY COUNCIL

APPROVING CRANSTON 2010 HAZARD MITIGATION PLAN

No.

Passed:

John E. Lanni, Jr., Council President

Approved:

Allan W. Fung, Mayor

It is ordained by the City Council of the City of Cranston as follows:

WHEREAS, the City of Cranston is vulnerable to natural hazards including hurricanes, flooding, severe winter storms, thunder storms, high wind events, tornados, lightning, hail storms, coastal erosion and wildfire, and

WHEREAS, total vulnerabilities are conservatively estimated at \$1,570,802,700 in property damages with potential risks to each of the City's 81,686 residents, and

WHEREAS, the Cranston Hazard Mitigation Committee has updated the City's 2005 Hazard Mitigation Plan in accordance with the Federal Disaster Mitigation Act of 2000 that documents specific courses of action that can be taken in advance of natural hazard events to reduce the City's vulnerabilities, a copy of which is appended hereto as Exhibit A and

WHEREAS, adoption of a local Hazard Mitigation Plan will qualify the City to compete for implementation funds from the Federal Emergency Management Agency's Pre-disaster Mitigation Grant PROGRAM,

NOW, THEREFORE, IT IS ORDAINED by the City Council of the City of Cranston that the 2010 Hazard Mitigation Plan updated by the Hazard Mitigation Committee is adopted as the City's policy document which assesses the community's risk to natural hazards and which identifies appropriate mitigation actions for potential implementation.

Positive Endorsement

Negative Endorsement (attach reasons)

Christopher Rawson, Solicitor Date

Christopher Rawson, Solicitor Date

Sponsored by: Allan W. Fung, Mayor

End Notes

- ¹ American Planning Association, Growing Smart Legislative Guidebook. 2002 ed. (Chicago, IL: APA Publications, January 2002) Page 7-143.
- ² FEMA, State and Local Mitigation Planning - How to Guide: Getting Started Building Support for Mitigation Planning. FEMA 386-1. (Washington, DC: FEMA Publications, September 2002) Foreword i.
- ³ Ibid. Page 1-9.
- ⁴ Ibid. Page 1-10.
- ⁵ Michelle Wood. "UPSeis: An Educational Site for Budding Seismologists," 21 May. 1997, 5 January, 2004. <<http://www.geo.mtu.edu/UPSeis/intensity.html>>.
- ⁶ FEMA. Flood Insurance Study: City of Cranston, Rhode Island Providence County. (Washington, DC: FEMA Publications, 1 May, 1984) 5.
- ⁷ Michelle F. Burnett, RIEMA - State Flood Plain Manager. Response to a two page E-mail regarding "NFIP Data". 29 July 2010.
- ⁸ NOAA. "Hurricane Awareness: Hurricane Basics." NOAA – National Oceanic and Atmospheric Administration. 22 June, 2002. 22 January, 2004. <<http://www.nhc.noaa.gov/HAW2/english/basics.shtml>>.
- ⁹ RIEMA, State of Rhode Island and Providence Plantations: Hazard Mitigation Plan - 1993-1994. (Providence, RI: RIEMA Publications, 1994) B-4.
- ¹⁰ Providence Journal-Bulletin, 1998 Journal-Bulletin: Rhode Island Almanac 112th ed. (Providence, RI: Providence Journal Company, 1998) 255.
- ¹¹ FEMA, Flood Insurance Study: City of Cranston, Rhode Island Providence County. (Washington, DC: FEMA Publications, 1 May, 1984) 5.
- ¹² Providence Journal-Bulletin, 255.
- ¹³ Ibid. 255.
- ¹⁴ FEMA, Flood Insurance Study: City of Cranston, Rhode Island Providence County. (Washington, DC: FEMA Publications, 1 May, 1984) 5.
- ¹⁵ Providence Journal-Bulletin, 1998 Journal-Bulletin: Rhode Island Almanac 112th ed. (Providence, RI: Providence Journal Company, 1998) 256.
- ¹⁶ NOAA Backgrounder. "Avoiding the Risks of Deadly Lightning Strikes," June 2001, 12 January, 2004. <<http://www.publicaffairs.noaa.gov/grounders/pdf/lightningsafety.pdf>>.
- ¹⁷ RIEMA, State of Rhode Island and Providence Plantations: Hazard Mitigation Plan - 1993-1994. (Providence, RI: RIEMA Publications, 1994) B-7.
- ¹⁸ FEMA. "Hazards: Tornadoes." FEMA - Federal Emergency Management Agency. 18 June, 2003. 15 January, 2004. <<http://www.fema.gov/hazards/tornadoes/>>.
- ¹⁹ NOAA. "Tornadoes." NOAA – National Oceanic and Atmospheric Administration. 10 December, 2003. 15 January, 2004. <<http://www.noaa.gov/tornadoes.html>>.
- ²⁰ FEMA. "Backgrounder: Thunderstorms and Lightning Emergency Information." FEMA - Federal Emergency Management Agency. 11 February, 2003. 22 January, 2004. <<http://www.fema.gov/pdf/hazards/tstormbk.pdf>>.
- ²¹ Salvatore Saccoccio, City of Cranston Tax Assessor. Interviews pertaining to "Assessor's Statement of Assessed Values and Tax Levy" Tax Roll year 2010. July, 2010.
- ²² American Fact Finder, US Census Bureau. 2006-2008 A Community Survey 3-Year Estimates Cranston, RI. <http://factfinder.census.gov/servlet/SAFFHousing?_event=Search&geo_id=16000US4419180&geoContext=01000US%7C04000US44%7C16000US4419180&street=&county=&cityTown=cranston&state=04000US44&zip=&lang=en&sse=on>. 13 October 2003. 04 October 2004

- ²³ American Fact Finder, US Census Bureau. 2000 Population: Group Quarters by Sex Age and Type of Group Quarters for Cranston, RI. <http://factfinder.census.gov/servlet/QTTable?_bm=y&-geo_id=16000US4419180&-qr_name=DEC_2000_SF1_U_QTP12&-ds_name=DEC_2000_SF1_U&-lang=en&-sse=on>. 08 October 2003. 04 October 2004.
- ²⁴ City of Cranston, RI. Subdivision and Land Development Regulations. Adopted December, 1995 with amendments to July, 2010. Page 1.
- ²⁵ City of Cranston, Emergency Management Agency. Emergency Operations Plan. Cranston, RI: EMA, January 2004. Page 4.
- ²⁶ Rhode Island Department of Environmental Management (RIDEM). Final Report: Governor's Task Force on Dam Safety and Maintenance. (Providence, RI: RIDEM, January 2001). Page 7.
- ²⁷ FEMA. National Flood Insurance Community Rating System – CRS Application. (Indianapolis, IN: Flood Publications, January 1999) Page 1.
- ²⁸ Natural Resources Conservation Service (NRCS). Pocasset River Flood Plain Management Study. Draft Report. (Warwick, RI: NRCS, February 2004). As discussed in "Executive Summary".
- ²⁹ Natural Resources Conservation Service (NRCS) (formerly the Soil Conservation Service (SCS)). Meshanticut Brook Flood Plain Management Study: Cranston and Warwick, RI. (Greenville, RI: SCS, Popular Report 1983). Pages 12 and 13.
- ³⁰ Natural Resources Conservation Service (NRCS). Pocasset River Flood Plain Management Study. Draft Report. (Warwick, RI: NRCS, February 2004). As discussed in "Preliminary Alternative Plans with Costs," Page 9.
- ³¹ Joseph Bachand, NRCS - Resource Conservationist. Information provided during three interviews on: 5 August, 2003; 10 October, 2003; and 17 February, 2004.
- ³² Natural Resources Conservation Service (NRCS). Pocasset River Flood Plain Management Study. Draft Report. (Warwick, RI: NRCS, February 2004). As discussed in "Preliminary Alternative Plans with Costs," Page 9.
- ³³ American Red Cross. Mass Care - Preparedness and Operations, Disaster Services Regulations and Procedures. ARC 3041. (Washington, DC: American Red Cross (ARC), April 1987). Page 14.
-