Warren, Rhode Island
Natural Hazard Mitigation Plan

2015

Office of Planning & Community Development
Town of Warren, Rhode Island

Town of Warren, Rhode Island
Natural Hazards Mitigation Plan 2015

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The State Hazard Mitigation Committee identifies current hazard mitigation needs, reviews project applications, sets priorities and recommends updates. The 2014 State Hazard Mitigation Committee consists of representatives:

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Section 1 – Introduction to Hazard Mitigation Planning

Hazard mitigation planning is the development of a formal strategy for limiting the impacts from natural threats faced by a community. Local governments are *required* to develop a hazard mitigation plan as a condition for receiving certain types of non-emergency disaster assistance, including funding for mitigation projects. The Robert T. Stafford Disaster Relief and Emergency Assistance Act (Public Law 93-288), as amended by the Disaster Mitigation Act of 2000, provides the legal foundation for governments to reduce threats from natural hazards through mitigation planning. Adoption and implementation of this Plan will enable Warren to access credits under the Federal Emergency Management Agency's (FEMA) Community Rating System (CRS), which offers discounts on National Flood Insurance Program (NFIP) premiums for property owners in communities that choose to participate. In addition, adoption will increase the Town's competitiveness when applying for federal grants through FEMA and the Rhode Island State Emergency Management Agency (RIEMA).

Warren's original Hazard Mitigation Plan was last approved in 2006. This following revised Hazard Mitigation Plan includes a detailed series of projects and strategies to address the diverse impacts to the natural coastline, infrastructure and structures, including changes to both regulatory and planning procedures. This plan will form part of the Town's Comprehensive Community Plan. Implementation of this plan involves specific projects as well as adjustments to day-to-day organizational operations. In order to keep the Plan viable, the Town will conduct semi-annual evaluations and make revisions as needed. This document will be available electronically on the Town of Warren web site at www.townofwarren-ri.gov upon approval.

Section 2 – Community Profile of Warren, Rhode Island

Situated among three rivers on Rhode Island's East Bay, Warren exhibits both the scenic beauty of its surrounding waters and a clear vulnerability to floods and hurricanes. Despite its 16 miles of coastline, the Town itself is quite small, around 6.5 square miles. Within this limited area is a diverse mix of historic downtown storefronts and homes, suburban style neighborhoods, rich agricultural land and a substantial amount of conserved open space.

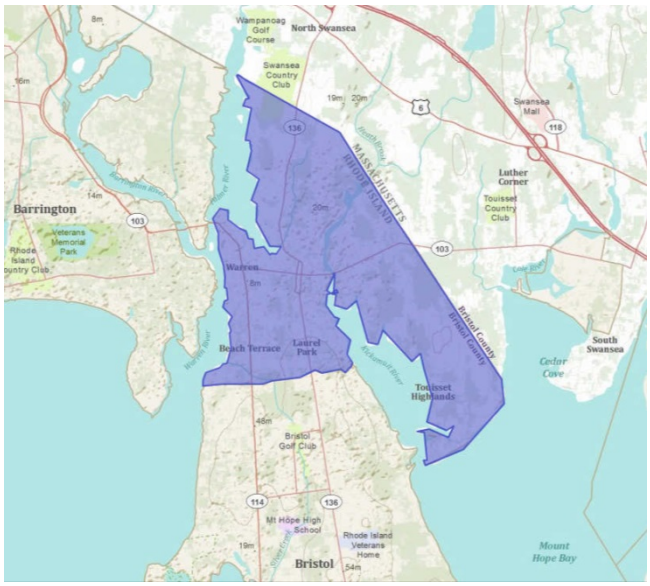


Figure 1. Vicinity of Warren, Rhode Island.
Source: www.esri.com

Along the Warren River to the west, one can find structures dating before the town's establishment in 1787, along with the wharves and buildings from the shipbuilding industry of the mid-1800s. The sprawling Warren Manufacturing Company mill structure occupies much of the waterfront area of

downtown. Surrounding the mill in downtown, the north end and along Main Street are the supporting mill houses remaining from the textile industry of the early 20th century. This area represents Warren's densest development.

Along the north end of the Route 136 Corridor are rural businesses, historic to modern residential developments and coastal wetlands. The northern and eastern portions of Warren are considerably more rural than the west, but pockets of dense summer cottages exist. Most notable among these areas are Touisset Point overlooking Mt. Hope Bay and the Touisset Highlands along the Kickemuit River. The attractiveness of both of these areas means that summer residences are becoming year-round housing, and existing houses are expanding to accommodate increased use. This area of Warren also contains considerable acreage for farming, conservation, schools and parks.

Central Warren, from the Laurel Park area northward to Child Street and westward to the Warren River generally exhibits a gridded street pattern of residential uses flanked by business uses along the main corridors of Metacom Avenue (Route 136) and Main Street (Route 114). Coastal residences along the Warren and Kickemuit rivers tend to reflect historic, cottage-style development, while the neighborhoods between Main Street and Metacom Avenue reflect post-World War II suburban-style development.

According to the U.S. Census Bureau, the population of Warren declined nearly 7% from 2000 to 2010 (11,360 people to 10,611 people). Major employment sectors for the town include manufacturing, health care and food services, which represent about half of all town employment. Business activities are generally located on the waterfront, Main Street, Child Street, Metacom Avenue and Market Street. Many of these businesses are located in areas vulnerable to natural hazards.

Section 2.1 –Planning Process

The Warren Town Council appointed 5 members to the Hazard Mitigation Committee to review and revise the original approved plan of 2005. The following members were the Department of Public Works Director, Fire Chief and Emergency Medical Services Director, Police Chief, Building Official and the Director of Community Development and Planning who led the Committee. The Committee identified information resources most valuable in understanding risks facing the Town, including federal and state agencies including RIEMA, university resources, GIS mapping and media. The Town Planning and Community Development Department researched events that Warren has experienced, as well as new potential hazards arising from changing sea conditions, climate shifts and development patterns. The Town then assessed potential consequences arising from these hazards in terms of how people, buildings and operations would be affected. The Town contacted planning departments of adjacent communities, local schools, elderly facilities, health organizations and emergency responders about response efforts through phone calls and email. Priorities were then established based on the relative risks to safety and welfare as well as costs to repair damage. The Town held a Public Workshop on

January 23, 2012, which was advertised at George Hail Library and the Town of Warren website (see Appendix A), to gather additional public experience and comments. A Public Hearing was held with the Warren Planning Board on July 24, 2012 to discuss the drafted plan and to seek input from the general public, business community and any other interested party. An excerpt of the minutes from this meeting can be found in **Appendix B**. The Planning Board's feedback is incorporated in this plan, and summarized in **Appendix C**. The draft plan continues to be available in hard copy form in the Town Clerk's office and it has been posted on the Town's webpage. In July 2015, the updated drafted plan was forwarded to all Natural Hazard Mitigation Committee members for their review, posted to the Town's web site, at the George Hail Library, Warren Town Clerk's Office and forwarded to the neighboring towns of Barrington, Bristol and Tiverton for input (see **Appendix D**). Any comments or concerns received were explored, researched and incorporated into this plan. The Committee will consider incorporating any comments or concerns it may receive in the future.

Figure 2. Mitigation Planning Overview created by FEMA.
Source: www.fema.gov/plan/mitplanning/overview.shtm

Section 3 – Natural Hazard Risk Assessment

Section 3.1 – Hazard Identification

The hazard identification process consisted of reviewing the previous plan (dated 2004), the RI State Hazard Mitigation Plan, plans from adjacent and similar communities, information from the National Climatic Data Center (NCDC) and the National Weather Service, and relevant newspaper articles on natural hazards. The Town of Warren's Hazard Mitigation Committee consists of the Fire Chief/Emergency Management Director, Building Inspector, Police Chief, Director of Public Works and Director of Planning & Community Development. The collective experience of these officials helps define and prioritize natural hazards for Warren (**Table 1**). As a result of this process, eight natural hazards were identified as having the most potential to impact Warren:

Table 1. Potential Natural Hazards to Warren

Section	Hazard	Probability
3.2.1	Flooding	Likely
3.2.2	Winter Storms	Likely
3.2.3	Hurricanes	Likely
3.2.4	Tornadoes	Possible
3.2.5	Wildfires	Possible
3.2.6	Hailstorms	Possible
3.2.7	Earthquakes	Unlikely
3.2.8	Drought	Unlikely

Frequency of Occurrence

Unlikely = less than 1% probability in the next 100 years
Possible = between 1 and 10% probability in the next year; or at least one chance in next 100 years
Likely = between 10 and 100% probability in the next year; or at least one chance in next 10 years

The most significant effects of natural hazards were inland and coastal flooding, high winds, ice and snow. While these hazards are the most frequently experienced, it is acknowledged that weather events such as hurricanes and tornadoes could create large scale, catastrophic disasters for coastal towns such as Warren. Moreover, sea level rise resulting from accelerated rates of global warming will affect the Warren over the next century, exacerbating some natural hazards and requiring a greater consideration for coastal development now to save lives and property in the future.

The Hazard Mitigation Committee also reviewed relevant plans, studies, reports, and technical information to ensure mutual consistency and to incorporate relevant regulations and policies into this Hazard Mitigation Plan. The Town Planner reviewed the existing Comprehensive Plan and the Zoning Ordinance and noted strengths and deficiencies in preventing damage and loss from natural hazards. These policies will be built on in the Comprehensive Plan revisions currently in process, and will include new data on climate change. The Comprehensive Plan also includes a Build Out Analysis, an assessment of how much more development *could* occur in Warren based on zoning and site conditions. In addition, the Emergency Operations Plan was concurrently completed by the Fire Chief/Emergency Management Director. Technical information from federal and state agencies are incorporated in the plan and cited in the hazard profiles. Engineering studies of storm water inundation and drainage are incorporated into the goals and actions. Finally, a historic preservation study by Roger Williams University noted the absence of specific policies to protect the Town's historic (and economic) assets from natural hazards and this feedback was incorporated into this plan's actions.

Section 3.2 – Hazard Profiles

3.2.1 Flooding

Flooding is the accumulation of large amounts of water in areas that are typically dry, usually from heavy rainfall (including thunderstorms, tropical storms and hurricanes), storm surges and melting snow. Warren is a lowland community with expanses of coastline along three rivers and encompassing substantial reservoirs of inland water. This coastal exposure makes Warren particularly susceptible to flooding. By their very nature, floodplains are the low, flat, periodically flooded lands adjacent to rivers, lakes and oceans and subject to geomorphic (land-shaping) and hydrologic (water flow) processes. It is only during and after major flood events that the connections between a river and its floodplain become more apparent. These areas form a complex physical and biological system that not only supports a variety of natural resources but also provides natural flood and erosion control. In addition, the floodplain represents a natural filtering system, with water percolating back into the ground and replenishing groundwater. When a river is divorced from its floodplain with levees and other flood control structures then natural benefits are either lost, altered, or significantly reduced. FEMA defines different types of flooding in the *NFIP Floodplain Management Requirements*, Unit 1, including the three types experienced by Warren:

Coastal Flooding: This phenomenon occurs when surges of waves inundate the shores of bays, tidally influenced rivers, streams and inlets. The astronomical tide and meteorological forces such as nor'easters and hurricanes influence the movement of coastal water.

River Flooding: River floods result when streams and rivers overflow their banks, usually following large scale weather patterns that bring heavy rainfall for a prolonged period over wide areas. This type of flooding may involve the overflow of small streams that eventually flow into larger basins.

Flash Flooding: Flash flooding occurs when quick, heavy rainfall occurs in inland (often urban) areas with poor drainage. The construction of "impervious surfaces"—that is, asphalt roads, parking lots, driveways, sidewalks, expansive roofs accelerates the potential for flash flooding because these surfaces do not allow natural absorption by open ground. As a result, storm drains are often overwhelmed, and water rushes to "low spots" such as basements and underpasses.

Urban/Storm Water Flooding: Urban flooding occurs where there has been development within stream floodplains. Floodways and wetlands which are the natural storage basins for flood waters were filled to accommodate development. Urbanization increases the magnitude and frequency of floods by increasing impermeable surfaces, increasing the speed of drainage collection, reducing the carrying capacity of the land and, occasionally, overwhelming sewer systems. The most common result from these areas flooding is due to poor or insufficient storm water drainage,

high groundwater levels, and high percentage of impervious surfaces which prevent groundwater recharge.

Flooding damages property and incapacitates utilities, leaving residents without power. Moreover, flooding impacts Town services which are called upon to pump out roads, remove debris, divert traffic and supply emergency shelters to those in need.

FEMA has designated flood zones for Rhode Island according to varying levels of flood risk. Each zone reflects the potential severity or type of flooding in the area. High risk areas of Warren are designated as Zone A and Zone V. The A Zone identifies areas with a one percent or greater chance of flooding in any given year and where the base flood elevation has been determined (see **Map 1: Flood Zones**). The V Zone identifies the Velocity Zone, which includes coastal areas with a one percent or greater chance of flooding with additional hazards associated with storm-induced waves, or velocity action (see **Map 2: Storm Surge Areas**). The Flood Insurance Rate Maps (FIRMs) for Warren that are currently available from FEMA and used for this Multi-Hazard Mitigation Plan were effective July 7, 2014. Current flood zone mapping for Warren shows several areas in the VE Zone:

- The western coast along the Warren River (from Jacob's Point along the Warren Waterfront area up to the southern corner of the American Tourister property).

- The western and eastern shoreline of the Kickemuit River (south of the "Broken Bridge"). The eastern shore of the Kickemuit River extends southward to the Touisset Marsh/Audubon property.

- Portions of Touisset Point, particularly the southernmost tip fronting Mt. Hope Bay and the Maple Road/Seaview Avenue coastline that faces Mt. Hope Bay.

Much of the Velocity Zone along the Warren River is located in the dense industrial, commercial and residential areas of the Warren Waterfront, which may worsen the effects of flooding. Areas of undeveloped coastal wetland can be found along Jacob's Point, the Kickemuit River and the Touisset Marshlands. These areas help minimize the effects of localized flooding and buffer adjacent development.

Extent (Impact and Vulnerability)

Based on the 2014 State Mitigation Plan, populations and property statewide are extremely vulnerable to flooding. This fact is particularly true of Warren. Homes and business may suffer damage and be susceptible to collapse due to heavy flooding. Floodwaters can carry chemicals, sewage, and toxins from roads, factories, and farms; therefore, any property affected by the flood may be contaminated with hazardous materials. Debris from vegetation and man-made structures may also be hazardous following a flood. In addition, floods may threaten water supplies and water quality and initiate power outages.

The flood hazard varies by location and type of flooding. Coastal areas are most at risk from flooding caused by hurricanes, tropical storms and nor'easters. Low-lying coastal areas in close proximity to the

shore, sounds or estuaries are exposed to the threat of flooding from storm surge and wind-driven waves, as well as from intense rainfall. Areas bordering rivers may also be affected by large discharges caused by heavy rainfall over upstream areas. Inland areas are most at risk from flash flooding caused by intense rainfall over short periods of time. Stream flow tends to increase rapidly. Large amounts of impervious surfaces in urban areas increase runoff amounts and decrease the lag time between the onset of rainfall and stream flooding. Man-made channels may also constrict stream flow and increase flow velocities.

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

Previous Occurrences

Warren regularly experiences storms and heavy rains that result in localized flooding. The National NCDC records 24 different flooding events in Bristol and Providence County since 2000, with a total damage estimate of $37.41 million. Several of the most significant recent floods to occur in Bristol County are highlighted in **Table 2 Flood Events in Bristol County, Rhode Island, 2000-2013** below. In March 2010, storms and periods of heavy rain resulted in significant flooding in Rhode Island and resulted in a Presidential Major Disaster Declaration for the state, including Bristol County. Warren saw substantial flooding in some areas. The Rhode Island Department of Transportation (RIDOT) closed areas more than 100 roads across the state due to the March floods; however, no road closings occurred in Warren. This area has been identified on the currently available FIRM as the 100 year Flood Zone. Finally, the National Flood Insurance Program (NFIP) documents 8 Repetitive Loss (RL) properties in Warren. There are currently 7 residential and 1 commercial RL properties. A Repetitive Loss property is any insurable building for which two or more claims of more than $1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling ten-year period, since 1978. A RL property may or may not be currently insured by the NFIP.

Table 2. Flood Events in Bristol County, Rhode Island

Date	Type	Notes
March 2001	Flood	Heavy rain
March 2005	Flood	Heavy rain
Oct. 2005	Flood	Tropical storm
June 2006	Coastal Storm	River and coastal flooding
Oct. 2006	Flood	Winds, rainfall 2-4”, minor flooding
April 2007	Coastal Flood	Winds, Rainfall 3-5”, River and roadway flooding
Feb.2008	Flood/Coastal storm	Heavy rain, poor drainage
March 2008	Coastal Flood	Heavy rain, snowmelt, road washouts
Dec. 2008	Flood	Winter storm, flooding, wind
March 2010	Flood	Record rainfall (8”) and river flooding statewide
Aug. 2011	Flood	Tropical Storm Irene
Aug. 2012	Flood	Flooding, wind, road washout
Oct. 2012	Flood	Hurricane Sandy (winds, storm surge, coastal flooding)
Aug. 2013	Flood	Torrential downpours, flash flooding

Sept. 2013	Flood	Winds, flash flooding

Source: National Climatic Data Center, Storm Events Database at: http://www.ncdc.noaa.gov/stormevents/listevents.jsp?beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=2009&endDate_mm=04&endDate_dd=30&endDate_yyyy=2013&eventType=%28Z%29+ALL&county=ALL&zone=BRISTOL&submitbutton=Search&statefips=44%2CRHODE+ISLAND. Also, RIDOT, http://www.dot.state.ri.us/Flooded_streets_March2010.asp#Closures;http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=416570

Probability of Future Flooding in Warren

Based on previous occurrences, the likelihood of flooding in Warren in the future is likely. While it is difficult to predict flood events, FEMA has determined that properties in A or V Zones have a 26% chance of flooding over the life of a 30 year mortgage. Flooding can be intensified by hurricane damage, where debris from high winds can block drainage and increase the potential for river flooding.

Flooding from dam failure represents another possible threat to localized areas of town. Inventoried dams in Rhode Island are classified by size and hazard rating by the Rhode Island Department of Environmental Management (RIDEM). The size classification provides a relative description of small, medium, or large dams, based on the storage capacity and height of the impounded water. The hazard classification relates to the probable consequences of failure or poor operation of the dam. Warren has four dams in the inventory:

1. Warren Reservoir Lower Dam (Child Street)
2. Warren Reservoir Upper Dam (north of Schoolhouse Road)
3. Manchester Pond (a Kickemuit River tributary)
4. Touisset Highland (a Kickemuit River tributary)

The Warren Reservoir is classified as a high hazard by the RIDEM inventory and both upper and lower sections are located in the AE Zone. Prior experience indicates that the Reservoir routinely floods its banks in heavy rainstorms, and can present potential threats to adjacent roads and properties. Manchester Pond Dam is also high hazard, and the Touisset Highland Dam is considered a significant hazard.

In addition to dam failure, a rise in sea level between 3 and 5 feet is predicted by the RI Coastal Resources Management Council (CRMC) by 2100 and should be a consideration as development continues along the waterfront. Sea level rise is a direct consequence of global climate change. Greenhouse gas emissions to the atmosphere increase surface warming which, in turn, warms ocean waters and accelerates the melting of glacial ice (RI CRMC, *Sea Level and Climate Change Policy*, Section 145). Even a 1 foot coastal rise would endanger a number of properties and assets in Warren, and FEMA maps do not account for future sea level rise. NOAA maintains two stations in Rhode Island that measure sea rise, Newport and Providence, which have measured sea level rise since the 1930s. The Newport Station records in increase of sea level of about .64 feet between 1930 and 2006. Because greenhouse gas emissions continue to rise, it is expected that this trend will accelerate in the coming decades—that is, the coastal sea level will rise higher and at a faster rate with each decade.

3.2.2 Winter Storms

Winter storms are a regular occurrence in Warren, with snowfall ranging from a few inches to blizzard conditions, including sustained winds or frequent gusts up to 35 mph or greater. These storms bring considerable falling snow, broken tree limbs, loss of power, and reduced visibility to less than a quarter mile. Warren's coastal location makes it somewhat less prone to heavy snowfall than inland communities, but virtually any area of town could be hit by a severe winter storm. Frequent impacts from winter storms include power outages and transportation problems, traffic accidents as well as school closings and business/civic service interruption. These conditions create hazards during storms and after snow melt and flooding occurs.

Extent (Impact and Vulnerability)

Based on the 2014 State Mitigation Plan, the impact of a winter storm is primarily measured in terms of the financial costs associated with preparing for, responding to, and recovering from the event. Modeling the relationship between actual financial impact and winter storm magnitude is difficult. The NCDC data set provides estimates of property damage from many of the significant events in the period of record that begins 1993. Though the data is not necessarily complete or entirely consistent in its reporting from event to event, it provides a basis for meaningful initial analysis.

Previous Occurrences

Overall, Bristol County experiences storms with 6 or more inches on average less than twice in the winter season. According to the NCDC, Bristol County saw 20 storms involving snow and ice since 2001 that brought about $375,000 in total property damage. The U.S. Weather Bureau defines a blizzard as a snow storm where winds exceed 35 mph and the temperature is 20 degrees Fahrenheit or below. A blizzard is severe when winds exceed 45 mph, snow is blowing and temperatures are 10 degrees Fahrenheit or below. Warren has experienced several notable blizzards and winter storms over the years (refer to **Table 3 Significant Snowstorms for Bristol County, RI, 1993-2013** below). A storm is dubbed a "Nor'Easter" when a coastal warm front storm (typically in February) brings warm moist air from the tropics and moves north up the coast and a mass of polar air from Eastern Canada and the North Atlantic moves south. The warm air moves up and over the cold layer, creating snow. If the storm moves quickly, cold rain or snow will fall for six to eight hours. If the warm air stalls against a high pressure wall, the snowfall may last 12-24 or more hours as it did in the blizzards of 1888, 1969, 1978, and 1996. The Blizzard of 1978 is perhaps the most significant and memorable snowstorm to hit Rhode Island, resulting in a virtual shut down of commerce and transportation across the state for several days, 21 deaths, and millions of dollars of damages. A key aspect of blizzards is reduced visibility (to about a ¼ of mile) for at least three hours.

Table 3: Significant Snowstorms for Bristol County, RI 1993-2014

Date	Snowfall (inches)	Notes
Dec. 1993	6-9	School cancelled; slow commute
Jan. 7, 1994	NA	No information

Jan. 8, 1994	6-7	Snow became freezing rain; severe traffic accidents, power outages
Feb. 8, 1994	6-10	
Feb. 11, 1994	8-13	Closings; major traffic problems
Feb. 1995	NA	No information
Jan. 1996	12-24	Closed schools, businesses, transportation disrupted
Feb. 1996	6-8	Evening storm, travel conditions slow
Mar. 2, 1996	6-11	Moderate to Heavy snow
Mar. 7, 1996	7	Heavy, wet snow on power lines
Apr. 1996	7	Heavy, wet snow on power lines
Jan. 11, 1997	6	Minor (fast moving storm)
Jan. 31, 1997	Ice	Ice meant skidding on roads; bridge closings around state
Mar. 1997	6-8	Heavy, wet snow; high winds; downed tree limbs; power outages
April. 1997	19	Heavy, wet snow; downed trees/limbs, power outages; schools closed
Feb. 1999	8-13	Closed schools, hazardous road conditions
Mar. 1999	6-9	Poor travelling conditions; schools/businesses shut down
Feb. 2000	6-8	Transportation problems; most flights cancelled; heavy traffic
Jan. 2001	8	Heavy snow, minor accidents
Feb. 2001	Ice	Freezing rain; holiday week meant fewer traffic problems
Dec. 2002	7-8	Heavy Snow
Feb. 7, 2003	8-11	Minor fender-benders
Feb. 17, 2003	16-17	Few problems (holiday)
Mar. 2003	7-8	Minor traffic problems (fast moving storm)
Dec. 2003	15	Major transportation problems
Dec. 2004	7-8	50 mph winds; car accidents from lack of visibility/slick roads
Jan. 2005	18	Heavy snow, high winds, coastal flooding
Feb. 2005	8-10	Heavy snow
Mar. 2005	6-9	Heavy winds
Feb. 2006	9-14	Blizzard
Dec. 2007	8-10	Early dismissals created traffic—made roads hard to plow
Dec. 2008	10-11	Heavy snow
Dec. 2009	18-21	Flights cancelled; schools closed; roads unplowable
Dec. 2010	6-10	Winter storm
Feb. 2013	3-4	Blizzard
Mar. 2013	12-24	Heavy snow
Jan. 2, 2014	6-9	Heavy snow, bitter temperatures, strong winds
Feb. 15, 2014	6-8	Strong winds, heavy snow
Jan. 26, 2015	10-20	Blizzard; Flights cancelled; schools closed
Jan. 29, 2015	10-20	Heavy snow
Feb. 2, 2015	6-7	Heavy snow, gusty winds
Feb. 8, 2015	10-20	Heavy snow, extreme cold
Feb. 14, 2015	9-14	Blizzard conditions, coastal flooding
Mar. 5, 2015	7-9	Accumulating snow

Source: National Climatic Data Center, Storm Events Database at: http://www.ncdc.noaa.gov/snow-and-ice/rsi/nesis

Probability of Future Winter Storms in Warren

Given the consistency of winter storms, the probability of future winter storm events is likely. Based on historical data, Warren should expect snowfall of at least 10 inches every 6 years, although consecutive years of heavy snowfall occur.

3.2.3 Hurricanes

NOAA (National Oceanic and Atmospheric Administration) defines a hurricane as the most severe category of the meteorological phenomenon known as the "tropical cyclone." Tropical cyclones rotate counterclockwise and spur thunderstorms. At low wind speeds (38 mph or less) this occurrence is called a “tropical depression.” When winds reach 39-73 mph, it is called a “tropical storm.” Hurricanes occur when the winds exceed 74 mph. These seasonal storms are created by low pressure depressions moving over warm, tropical waters and occur over the Atlantic Ocean between June and October (most typically in September in Rhode Island). Hurricanes are measured on the Saffir/Simpson Hurricane Intensity Scale (see **Table 4 Saffir/Simpson Hurricane Intensity Scale** below). While strong winds from hurricanes can pose a threat to life and property, the greatest threat posed by hurricanes in Rhode Island is generally heavy rainfall and flooding caused by storm surge. NOAA defines storm surge as “an abnormal rise of water generated by a storm, over and above the predicted astronomical tides.” When coupled with normal tides, storm surge can raise the mean water level 15 feet or more.

Table 4: Saffir/Simpson Hurricane Intensity Scale

Hurricane Category	Wind Speed	Storm Surge (ft. above sea level)	Damage Potential
1	74-95	4-5	Minimal-Damage primarily to shrubbery and trees; some signs damaged.
2	96-110	6-8	Moderate-Some trees toppled, some roof coverings damaged
3	111-130	9-12	Extensive-Large trees toppled, structural damage to roofs, small homes and utility buildings
4	131-155	13-18	Extreme-Extensive damage to roofs, windows, doors, roof systems on small buildings completely fail, some curtain walls fail.
5	>155	>18	Catastrophic-Roof damage is considerable and widespread, window and door damage severe, extensive glass failures, entire buildings could fall.

Source: National Weather Service, National Hurricane Center, http://www.nhc.noaa.gov/sshws.shtml

The New England District of the U.S. Army Corps of Engineers, using data from the National Hurricane Center, developed maps depicting the worst case scenario for hurricane surge inundation for Category 1 through 4 hurricanes striking the coast of Rhode Island (please see **Map 2**: Storm Surge). Hurricane surge values were developed using the SLOSH (Sea Lake and Overland Surge from Hurricanes) model, which estimates storm surge heights through hypothetical measures of pressure, size, forward speed, track and winds. Warren's coastal location and low elevation make it susceptible to hurricane hazards and the town's small size means that the majority of properties are vulnerable to hurricane impacts. Across town, elevations vary from 4 meters above sea level at Town Beach to 19 meters (62 feet) above sea level at the Touisset Marsh.

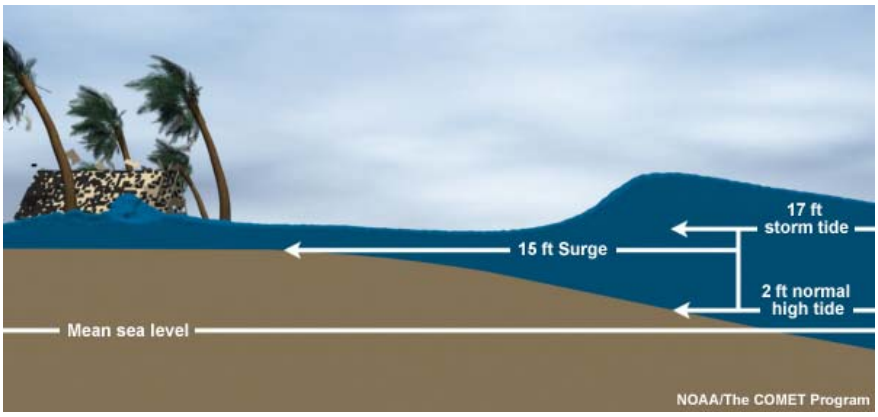


Figure 3. Illustration of storm surge rising over sea level and normal high tides.

Source: NOAA National Hurricane Center website at http://www.nhc.noaa.gov/surge/.

Storm surge and hurricanes can also greatly contribute to coastal erosion. Erosion from hurricanes impacts housing, beaches and infrastructure like streets and sidewalks. The amount of erosion from storms is directly related to their number, intensity and duration. Beaches protect the shoreline, but storms erode the beach, putting vulnerable properties at even greater risk. A home constructed in the V-zone, or velocity zone, may be destroyed as the beach erodes and the barrier or headland is washed over by high water in a storm.

Extent (Impact and Vulnerability)

As described above the Saffir Scale is designed to give public officials and the general public usable information on the magnitude of a storm. It gives an indication of the potential flooding and wind damages associated with each hurricane category. The scale rates the intensity and effects of hurricanes based on wind speed and barometric pressure measures. Warren has already experienced the severity of storm surge events as well as catastrophic hurricane damage. If these two hazards occur concurrently the damages to property, public infrastructure and the risks to public safety may present a situation that is overwhelming to responders.

Previous Occurrences

Rhode Island has experienced seven significant hurricanes (see **Table 5** below) since the unnamed hurricane of 1938.

Table 5: Significant Hurricanes in Rhode Island

Date	Name	Category	Total Property Damage (millions)	U.S. Deaths
Sept. 1938	NA	3	100	262
Sept. 1944	NA	3	2	0
Aug. 1954	Carol	2	200	19
Sept. 1954	Edna	2	0.1	0
Aug. 1955	Diane	Tropical Storm	175	0
Sept. 1960	Donna	2	19.8	2
Sept. 1985	Gloria	2	19.8	2
Aug. 1988	Chris	Tropical Storm		
Aug. 1991	Bob	2	115	0
Aug. 1994	Beryl	Tropical Storm		
July 1996	Bertha	Tropical Storm		
Oct. 1996	Josephine	Tropical Storm		
Sept. 1999	Floyd	Tropical Storm		
Sept. 2000	Gordon	1		
Aug. 2004	Hermine	Tropical Storm		
Aug. 2004	Charley	4	17.3 billion	1
June 2007	Barry	Tropical Storm		
Sept. 2008	Hanna	1		
Aug. 2011	Irene	Tropical Storm		
Oct. 2012	Sandy	1		72

Sources: RI Hazard Mitigation Plan (2005), Town of Warren Hazard Mitigation Plan (2004), National Weather Service Forecast Office, Boston, MA, http://www.erh.noaa.gov/box/hurricane/tropicalCycloneReview.shtm

Probability of Future Hurricanes in Warren

The probability that Warren will be hit by a hurricane is likely. According to the National Hurricane Center, six Atlantic tropical storms mature into hurricanes in an average year. The RI State Hazard Mitigation Plan indicates that Rhode Island is particularly vulnerable to hurricanes because of its location and features, such as Narragansett Bay, which can act as a funnel for hurricane surges. The State plan indicates that in any given year, the probability of a hurricane reaching Rhode Island is 6%.

3.2.4 Tornadoes

Tornadoes develop from thunderstorms and hurricanes when cold air overrides a layer of warm air, causing the warm air to rise rapidly. The winds produced from hurricanes and wildfires have also been known to produce tornadoes. A tornado appears as a rotating, funnel-shaped cloud that extends from a thunderstorm to the ground with whirling winds that can reach 300 miles per hour. Damage paths can be in excess of one mile wide and 50 miles long. The average tornado moves southwest to northeast, but tornadoes have been known to move in any direction.

According to FEMA, every state is at some risk from tornadoes. Rhode Island is located in FEMA Wind Zone II, which is associated with maximum winds of 160 mph, and is also located in a hurricane-

susceptible region. Tornado damage severity is measured by the Fujita Tornado Scale, which assigns numerical values based on wind speeds. The Fujita Scale ranges from F0 (winds of 4- to 72 miles per hour) to F5 (winds of 261 to 318 mph) as shown in **Table 6**. Winds of 113 to 157 mph, such as are generally associated with Wind Zone II, are identified as an F2 on the Fujita Scale, and can cause considerable damage.

Table 6: Fujita Tornado Measurement Scale

Category	Wind Speed	Damage Potential
FO	Gale (40-72 mph)	Light damage to chimneys, branches, signs
F1	Moderate (73-112 mph)	Moderate damage to roof surfaces, moving cars are pushed off the road
F2	Significant (113-157 mph)	Considerable damage. Roofs torn off frame houses, train cars pushed over, large trees snapped or uprooted, cars lifted or thrown
F3	Severe (158-206 mph)	Roofs and walls torn off well-constructed houses, trains overturned, most trees uprooted
F4	Devastating (207-260 mph)	Well-constructed houses leveled, structures with weak foundations blow off some distance, cars thrown
F5	Incredible (261-318 mph)	Strong frame houses lifted off foundations and carried considerable distance to disintegrate, auto-sized missiles fly through the air in excess of 100 yards.

Source: National Oceanic and Atmospheric Administration, http://www.outlook.noaa.gov/tornadoes/fujita.htm.

Extent (Impact and Vulnerability)

Based on the 2014 State Mitigation Plan, electrical utilities and communications infrastructure are vulnerable to tornadoes. Damage to power lines or communication towers has the potential to cause power and communication outages for residents, businesses and critical facilities. In addition to lost revenues, downed power lines present a threat to personal safety. Further, downed wires and lightning strikes have been known to spark fires.

A structure's tornado vulnerability is based in large part on building construction and standards. In general, mobile homes and wood-framed structures are more vulnerable to damage in a tornado than steel framed structures. Other factors, such as location, condition and maintenance of trees also plays a significant role in determining vulnerability. Human vulnerability is based on the availability, reception and understanding of early warnings of tornadoes (i.e. Tornado Warning issued by the NWS) and access to substantial shelter. In some cases despite having access to technology (computer, radio, television, outdoor sirens, etc.) that allows for the reception of a warning, language differences are sometimes a barrier to full understanding of the risk. Once warned of an impending tornado hazard, seeking shelter indoors on the lowest floor of a substantial building away from windows is recommended as the best protection against bodily harm.

Previous Occurrences

From 1985 to 2009, the NCDC reports 7 tornado events in Providence and Bristol County. On July 23, 2008, an F1 scale tornado began off Rumstick Point in Barrington and then moved inland to Warren at

Hanley Farm Road. It then moved eastward across the Kickemuit River in the Touisset Highlands section of Warren, crossed over the Cole River and continued to Ocean Grove, Swansea.

Figure 4.

Photo of a funnel cloud off Rumstick Point by Nicholas Caisse of Barrington, printed in *The Boston Globe*, July 24, 2008.

The tornado's path was 4.2 miles long and the tornado itself was only 40 yards wide. Most of the damage had a rating of EF0 on the Fujita Scale with wind speeds of 65 to 75 mph. One section of Warren near Route 136 and Harris Avenue (including Overhill Road in the Laurel Park area) reflected EF1 damage—wind speeds in that area were estimated at 90 mph. The majority of damage was to trees, some which fell onto power lines and houses, and swirling debris. A large tree near Harris Avenue was lifted and thrown 40 feet onto Route 136. Damage was estimated at $45,000. No injuries were reported (Source: CBS3 Springfield at http://www.cbs3springfield.com based on Police and Fire reports).

Probability of Future Tornadoes in Warren

Tornadoes are a rare occurrence in Rhode Island, but a risk exists in hurricane season (June through November) and tornadoes have occurred in Warren recently. Thus, the probable occurrence assigned to tornados is possible. Unfortunately, there is no long-term forecasting system that can accurately predict the likelihood of a tornado event in Rhode Island. The NOAA's Storm Prediction Center constantly monitors changing weather conditions and is able to provide short-term tornado predictions—these predictions are produced in a matter of minutes, rather than days, which limits responder's ability to prepare. In the case of the 2008 tornado, the NWS issued a special marine warning for Narragansett Bay, followed by a severe thunderstorm warning 15 minutes later. A tornado warning was issued after another 15 minutes. Broadcasting tornado warnings through an extensive communication network is now the best means for mitigating tornado hazards.

3.2.5 Wildfires

A wildfire is an uncontrolled fire spreading through vegetative fuels, exposing and possibly consuming structures. Heavy fuel contributes to the size and spread of the fire, as do steep slopes and dry, windy weather conditions. Overall, Rhode Island generally exhibits a humid continental climate with hot, rainy summers and chilly winters and thus often has a low or medium (Class 1 or 2) fire class rating. However, dry, windy weather does occur, and fire conditions can be exacerbated by drought, particularly during the summer months. The peak fire season for the state is typically between mid-March and mid-May, when higher fire class ratings do occur periodically.

Figure 5.

In April 2008, a manmade fire set in the Audubon property spanning both Warren and Bristol quickly spread across the marshes towards Jacob's Point.

The fire began near Hanley Farm Road in Warren and spread southward, bounded by the East Bay Bike Path. Much of the damage impacted the Audubon Boardwalk in Bristol, which cost about $1 million to construct.

(Source: *Providence Journal*, Meaghan Wims and Alex Kuffner, April 18, 2008).

Larger deciduous forested tracts are located on the northern and eastern side of the Town, especially in the Touisset area, along the Kickemuit Reservoir and on both sides of Route 136. In Touisset, much of this forest is wetland, but these areas can still be impacted by wildfire. In central Warren, other patches of forest can be found on the National Grid easement, which runs north to south, along the bike path, South Cemetery and the properties north of Franklin Street.

Extent (Impact and Vulnerability)

Based on the 2014 State Mitigation Plan, vulnerability to wildfire is influenced by a variety of factors, such as land cover conditions, weather, and the effectiveness of land management techniques. Highly urbanized areas are less vulnerable to wildfire, but suburban neighborhoods located at the Wildland Urban Interface area are very vulnerable to wildfire. Individual buildings may be more or less vulnerable to damage from wildfire based on factors such as the clear distance around the structure, and the structure's construction materials. Wildfire primarily impacts timber and forest ecosystems, although the threat to nearby buildings is always present.

The accurate prediction of the potential risk of a wildfire and the forewarning of dangerous wildfire conditions can help reduce the incidence and seriousness of wild fires. It can also provide firefighters the critical time needed for important preparation and readiness for wildfire suppression, as well as assist decision makers in the appropriate uses and activities for the public at large during times of extreme fire danger to aid in the prevention efforts.

Previous Occurrences

Significant wildfires have not been known to occur in Warren, although occasional brush fires have occurred in the wooded parts of town. In 2008, a manmade fire spread across Jacob's Point in Warren, creating significant damage to the Audubon properties and threatening nearby housing (see photo, above).

Probability of Future Wildfires in Warren

The probability of a future wildfire varies with seasonal and daily weather conditions, and site-specific vegetation composition. For the purposes of this plan, a forest fire is considered possible. Much of Warren is relatively flat, including wooded areas. This flat topography, along with the overall humid weather, puts Warren at a lower risk for future wildfire.

3.2.6 Hailstorms

Hail is a showery precipitation in the form of irregular pellets or balls of ice more than 5mm in diameter. Hail is often associated with severe thunderstorms and occurs primarily during the summer months in Rhode Island. While significant hailstorms are infrequent in Warren, there is a potential for a hailstorm of any magnitude anywhere in town. Hail can not only damage cars and buildings, but can devastate farm fields during the growing season.

Extent (Impact and Vulnerability)

Based on the hailstorm event in 2013, Warren is vulnerable to hail damage. The extent of this damage may be severe with larger sized hail, resilient winds and the duration of the storm. Damage to power lines or communication towers has the potential to cause power and communication outages for residents, businesses and critical facilities presenting a threat for personal safety. Hail size also proposes a threat and may leave buildings, structures and personal property vulnerable.

Previous Occurrences

Hailstorms have been infrequent in Warren. The NCDC does not list any hailstorms for the town of Warren (although Barrington experienced three and Bristol experienced one in the last decade). Hail sizes were listed at .75 inches to 1.5 inches in diameter. Hail also was produced by Tropical Storm Irene in October 2011. More recently Warren experienced a hailstorm in 2013 with quarter sized hail.

Figure 6.

Hail up to the size of quarters fell over Barrington and Warren. This is a picture of hail in Barrington from Michelle Muscatello.

Source: http://wpri.com/blog/2013/09/04/barrington-warren-hailwind-storm/

Probability of Future Hailstorms in Warren

The probability for a hailstorm in Warren is possible. No long-term forecasting system exists for determining the probability of a future hailstorm in Warren.

3.2.7 Earthquakes

An earthquake is caused by the breaking and shifting of rock beneath the Earth's surface. Earthquakes strike suddenly, violently and without warning at any time of the year. Earthquakes are measured on the Richter Scale, which is a logarithmic measurement of the amount of energy released by an earthquake. The Richter Scale ranges from 1 to 10. Earthquakes with a magnitude of at least 4.5 are strong enough to be recorded by sensitive seismographs all over the world (see illustration, below). The intensity of a series of certain key responses such as people awakening, movement of furniture, damage to chimneys and ultimately, total destruction. The intensity scale currently used in the U.S. is the Modified Mercalli Scale (see **Table 6** below). The scale is composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction. Different levels are designated by Roman numerals but the scale does not have a mathematical basis; instead it is an arbitrary ranking based on observed effects. There are no significant geologic fault lines in Rhode Island or New England, and the U.S. Geological Survey (USGS) Earthquake Hazards Program identifies all of Rhode Island as occurring in a low seismic risk area (<2%g peak acceleration). Historically, earthquakes originating in other states have been felt in various parts of Rhode Island. Should an earthquake strike or its effects be felt in Warren, old masonry structures that do not meet current earthquake codes could potentially be at risk of damage or collapse.

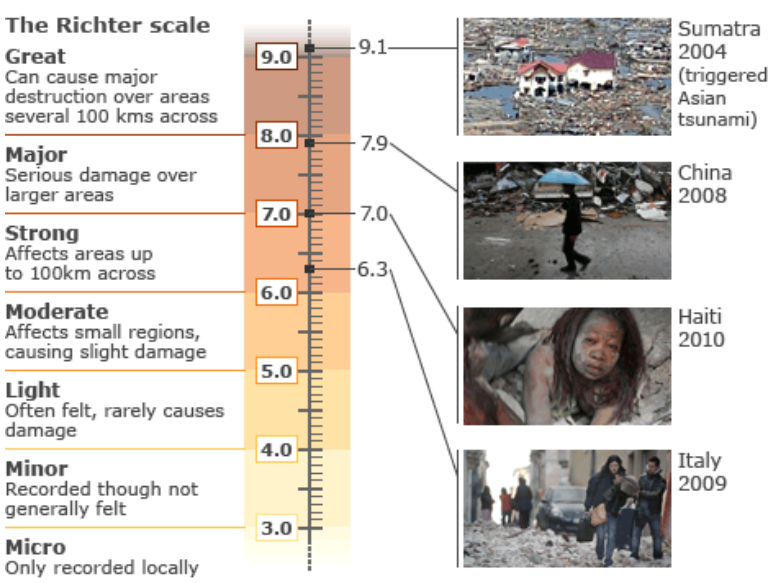


Figure 7.

A visual illustrating the Richter Scale by Greenfield Geography. The Richter Scale is matched here to recent global disasters to describe the level of destruction.

Figure 8. Modified Mercalli Scale

I. Instrumental	Generally not felt by people unless in favorable conditions.
II. Weak	Felt only by a couple people that are sensitive, especially on the upper floors of buildings. Delicately suspended objects (including chandeliers) may swing slightly.
III. Slight	Felt quite noticeably by people indoors, especially on the upper floors of buildings. Many do not recognize it as an earthquake. Standing automobiles may rock slightly. Vibration similar to the passing of a truck. Duration can be estimated. Indoor objects (including chandeliers) may shake.
IV. Moderate	Felt indoors by many to all people, and outdoors by few people. Some awakened. Dishes, windows, and doors disturbed, and walls make cracking sounds. Chandeliers and indoor objects shake noticeably. The sensation is more like a heavy truck striking building. Standing automobiles rock noticeably. Dishes and windows rattle alarmingly. Damage none.
V. Rather Strong	Felt inside by most or all, and outside. Dishes and windows may break and bells will ring. Vibrations are more like a large train passing close to a house. Possible slight damage to buildings. Liquids may spill out of glasses or open containers. None to a few people are frightened and run outdoors.
VI. Strong	Felt by everyone, outside or inside; many frightened and run outdoors, walk unsteadily. Windows, dishes, glassware broken; books fall off shelves; some heavy furniture moved or overturned; a few instances of fallen plaster. Damage slight to moderate to poorly designed buildings, all others receive none to slight damage.
VII. Very Strong	Difficult to stand. Furniture broken. Damage light in building of good design and construction; slight to moderate in ordinarily built structures; considerable damage in poorly built or badly designed structures; some chimneys broken or heavily damaged. Noticed by people driving automobiles.
VIII. Destructive	Damage slight in structures of good design, considerable in normal buildings with a possible partial collapse. Damage great in poorly built structures. Brick buildings easily receive moderate to extremely heavy damage. Possible fall of chimneys, factory stacks, columns, monuments, walls, etc. Heavy furniture moved.
IX. Violent	General panic. Damage slight to moderate (possibly heavy) in well-designed structures. Well-designed structures thrown out of plumb. Damage moderate to great in substantial buildings, with a possible partial collapse. Some buildings may be shifted off foundations. Walls can fall down or collapse.
X. Intense	Many well-built structures destroyed, collapsed, or moderately to severely damaged. Most other structures destroyed, possibly shifted off foundation. Large landslides.
XI. Extreme	Few, if any structures remain standing. Numerous landslides, cracks and deformation of the ground.
XII. Catastrophic	Total destruction – everything is destroyed. Lines of sight and level distorted. Objects thrown into the air. The ground moves in waves or ripples. Large amounts of rock move position. Landscape altered, or leveled by several meters. Even the routes of rivers can be changed.

Source: https://www.google.com/search?q=Modified+Mercalli+Scale&biw=1280&bih=852&tbm=isch&tbo=u&source=univ&sa=X&ved=0CDwQsARqFQoTCK6MyIiC6sYCFQSkiAodX5wN_w#imgrc=xTAIckuP2V5ekM%3A

Extent (Impact and Vulnerability)

Based on the 2014 State Mitigation Plan, the severity of an earthquake can be expressed in terms of both intensity and magnitude. Intensity is based on the observed effects of ground shaking on people, buildings, and natural features. It varies from place to place within the disturbed region depending on the location of the observer with respect to the earthquake epicenter. Although numerous intensity scales have been developed over the last several hundred years to evaluate the effects of earthquakes, the one currently used in the United States is the MMI Scale (see **Table 7**). Impacts from earthquakes can be severe and cause significant damage. Ground shaking can lead to the collapse of buildings and bridges and disruption of gas and electric lines, phone service, and other critical utilities. Death, injuries, and extensive property damage are possible vulnerabilities from earthquakes.

Previous Occurrences

Historically, Rhode Island has experienced earthquakes on a regular basis, including the earliest citation of a violent earthquake in June of 1638 (see **Table 7** below). Additional earthquakes were felt in 1658, 1727, 1732, 1755, 1783, 1791, 1848 and 1860. Few details are noted about these earthquakes. A number of earthquakes were cited by settlers in Rhode Island in the 17th century. These quakes were believed to have originated elsewhere, some as far away as Quebec. In 1883, an earthquake believed to have been centered on Rhode Island was felt (Intensity V effects) from Bristol to Block Island. The largest earthquake to be felt in Rhode Island occurred in 1976 and had Intensity VI effects and measured 3.5 on the Richter Scale.

Table 7: Earthquakes in Rhode Island Vicinity

Date	Epicenter	Richter Scale	Notes
Feb. 1883	RI	NA	New London, Fall River; Intensity V from Bristol to Block Island
Feb. 1925	Quebec	7	Intensity V at Block Island, Providence and IV at Charlestown
Nov. 1929	Newfoundland	7.2	Marine earthquake, minor vibrations felt
Nov. 1935	Quebec	6.25	Intensity IV at Block Island, Providence, Woonsocket
Dec. 1940	New Hampshire	NA	Intensity V at Newport; Intensity IV at Central Falls, Pascoag, Providence, Woonsocket
Oct. 1963	MA	4.5	Intensity V at Chepachet
Dec. 1965	NA	NA	Intensity V felt in Warwick: windows, doors shaken.
Feb. 1967	NA	2.4	Intensity V felt Middletown, Newport, N. Kingstown—no damage
Feb. 1973	NA	NA	Noises (boom/explosion) but no damage
June 1973	Maine	5.2	Intensity at IV in Charlestown; I to III in Bristol, East Providence, Providence
Mar. 1976	NA	3.5	Intensity VI effects to Newport
Aug. 2011	Virginia	NA	Tremors from 5.9 earthquake in Virginia
Nov 29, 2013	Leynard, CT	2.1	Intensity III Jamaica, NY
Jan. 9, 2014	Freetown, MA	1.9	Intensity III in Pawtucket, RI and Worcester, MA

Feb. 11, 2014	Bliss Corner, MA	2.4	Intensity II in Providence, RI and Westport, MA
Aug 14, 2014	Westbrook, CT	2.7	Intensity I in Narragansett
Jan. 12, 2015	Plainfield, CT	3.3	Intensity III in Warren, Intensity II in Portsmouth
Jan. 14, 2015	Plainfield, CT	2.0	Intensity II Moosup, CT and Cambridge, MA
Feb. 3, 2015	Norwich, CT	2.0	Intensity I in Warwick

Source: USGS, http://earthquake.usgs.gov/earthquakes/states/rhode_island/history.php; http://www.wpri.com/news/local/providence/providence-earthquake-tremors-felt-in-rhode-island

Probability of Future Earthquakes in Warren

The USGS Earthquake Hazards Program identifies all of Rhode Island as occurring in a low seismic risk area (<2%g peak acceleration), therefore the probability of a significant earthquake occurring in the future is low. Marine earthquakes, which generate tsunamis, are most commonly felt in the Pacific Ocean. Therefore, the probability of future events in Rhode Island is considered unlikely.

3.2.8 Excessive Heat and Drought

According to the NOAA, all types of drought originate from a lack of precipitation resulting from an unusual weather pattern. If the weather pattern lasts a short time (a few weeks or a couple months), the drought is considered short-term. But if the weather or atmospheric circulation pattern becomes entrenched and the precipitation deficits last for several months to several years, the drought is considered to be a long-term drought. According to the Bristol County Water Authority, locally the drought conditions are evaluated on a regional basis across the state and are assigned based on conditions represented by major hydrologic indices, including precipitation, groundwater levels, stream flow, and the Palmer Drought Index. The RIWRB and Drought Steering Committee evaluate the major hydrologic indices and adjust drought levels both statewide and on a regional basis, accordingly. Precipitation in Rhode Island, measured at T.F. Green Airport, averages about 40 inches per year. Historically, the driest year occurred in 1965, with less than 26 inches of rainfall. Dry weather occurs most commonly in late spring and the first half of summer, with rainfall less than an inch within 4 to 6 weeks. Often droughts occur over several years (as was the case in the mid-1960s). These periodic "droughts of record" occur every 20 years or so in Rhode Island. In these years, concerns are raised about water supplies, and in the case of Warren, endangered crops.

Extent (Impact and Vulnerability)

*Safe*Water RI has ranked Bristol County Water Authority at low risk for drought. Based on the 2014 State Mitigation Plan and according to the Natural Weather Service, Rhode Island receives more rain annually than the average for the United States. However, Rhode Island does experience extended periods of dry weather. Summer dry spells, during which crops and lawns may require irrigation, are fairly common. Thus, droughts, while not frequent, do occur.

Most of Warren's water is supplied by the Bristol County Water Authority who currently obtains all of its supply from Providence Water, with its own supplies actively maintained so that they are available in

emergencies. According to BWCA's WATER SUPPLY SYSTEM MANAGEMENT PLAN (2014 Revision), BCWA works in conjunction with Providence Water to aid in drought management through demand management and system management activities. The direct effects of drought on the BCWA system potentially include reduction of available wholesale water from Providence Water. A reduction in Providence Water's surface water levels can adversely impact water quality in addition to water quantity. This would also result in a reduction of BCWA's surface water levels which could restrict water use in the event of a drought or emergency, in accordance with their Emergency Response Action Plan. Further, economic impact to industries can include loss of production due to use restrictions or increased costs for alternate water supplies and local farmers can lose livestock or crops. Water suppliers may lose income if they impose restrictions or face increased costs for developing alternate water supplies.

Previous Occurrences

According to the RI Water Resources Board, Rhode Island has had at least 6 major droughts since 1929. RI Water Resources Board also reports that the most severe long-term droughts during the years of 1965-1967 and 1981 statewide resulted in crop damage, groundwater deficiency, water restrictions and well replacements. According to BCWA, during 1987 the county experienced a serious drought that required a ban on non-essential uses of water and mandated water use restrictions.

Probability of Future Droughts in Warren

The probability of a substantial, long-term drought in Warren is unlikely.

This plan summarizes the natural hazards that are most likely to affect Warren; however, it should be noted that not all natural hazards can be accounted for or predicted. Natural hazards such as dam breeches, lightening, landslides, etc. could damage property or harm Warren residents, but are not considered significant enough to include in this analysis. Natural hazards can occur randomly, and historical examples may not be instructive for all potential events.

Section 3.3 – Summary of Potential Hazards for Warren

Flooding represents the most likely natural hazard to impact Warren. Flooding can result from improper drainage during even moderate storms, but is most apparent during heavy storms and periods of melting snow and ice. Flood damage can be exacerbated during the high wind conditions of hurricanes, tornadoes and winter storms, when debris accumulates and blocks drainage. Based on the SLOSH models, even Category 1 and Category 2 hurricanes will produce storm surges that inundate large areas of town. Belcher's Cove shorelines will be likely impacted by a Category 1 hurricane and the densely developed North End neighborhood may see considerable damage to housing structures. Other developed areas include the Warren Waterfront reaching toward Main Street and neighborhoods within the reach of the Upper Kickemuit Reservoir and along Schoolhouse Road. Businesses and residents along Market Street may also feel storm surge impacts with a lower level hurricane. At higher categories of hurricanes, the reach of storm surge may be even greater in these areas and extend inland

to Main Street, Franklin Street and further along Schoolhouse Road into Swansea, MA. Since Warren has such extensive coastlines and inland waters, special attention should be paid to mitigating flood hazards through strategic land conservation of coastal buffers, enforcement of regulations for flood hazards and infrastructure improvements.

Unlikely risk natural hazards for Warren include hailstorms, earthquakes, tornadoes and wildfires. These phenomena have occurred in the area before and possible will again, but the estimate of their harm to public safety, housing and other infrastructure is comparatively low.

Section 4.0 – Warren's Vulnerable Assets

Local municipalities are required by 44 CFR Part 201.6(c)(2)(ii) to include a description of the jurisdiction's vulnerability to each of the hazards previously identified and described in this plan. Vulnerability is defined as the exposure or susceptibility of the Town to the effects of the identified hazards. The vulnerability assessment process helps identify vulnerable points in the community's infrastructure and population. All buildings listed in the Warren Tax Assessor's database, including residential and commercial structures, as well as outbuildings, warehouses and industrial structures are considered in the assessment. Public infrastructure, such as bridges, roads and utilities, natural resources and areas subject to environmental vulnerability (such as beaches prone to erosion), are also assessed for vulnerability. Finally, special populations (children, elderly and disabled populations) are assessed for their proximity to hazards.

Section 4.1 – Vulnerability of Critical Assets

Risk Assessment Matrix for Warren: **Table 8** below identifies Warren's Critical Assets, including transportation systems, emergency centers, utility infrastructure, special population centers such as nursing homes and schools, and natural resources, such as beaches and coastal parks. The table also identifies the approximate location of each critical asset, which natural hazards each asset is vulnerable to, and where feasible, an estimate of effects from each vulnerable asset.

Table 8. Risk Assessment Matrix for Warren

Critical Asset	Location	Ownership	Primary Natural Hazards	Primary Problem/Effect
Special Population Centers				
Senior Center/Kickemuit Village	20 Libby Lane	Public	Flooding, winter storms, wind damage	Public safety. Property damage. Disruption of services.
Crestwood Nursing Home	568 Child Street	Private	Flooding, wind damage	Public safety. Property damage. Disruption of services. Economic loss.
The Willows	47 Barker Avenue	Private	Flooding	Public safety. Property damage. Disruption of services. Economic loss.
Grace Barker Nursing Home	54 Barker Avenue	Private	Flooding	Public safety. Property damage. Disruption of services. Economic loss.
Warren Skilled Nursing and Rehabilitation	642 Metacom Avenue	Private	Wind damage, winter storms	Public safety. Property damage. Disruption of services. Economic loss.
Preferred Health Care Services	633 Metacom Avenue	Private	Wind damage, winter storms	Public safety. Property damage. Disruption of services. Economic loss.
Almy Avenue Group Home	71 Almy Avenue	Private	Flooding, wind damage, winter storms	Public safety. Property damage. Disruption of services. Economic loss.
Daniel Childs House	767 Main Street	Private	Flooding, wind damage, winter storms	Public safety. Property damage. Disruption of services. Economic loss.
Edgemont Sheltered Care Home	24 Buffalo Avenue	Private	Flooding, wind damage, fire	Public safety. Property damage. Disruption of services. Economic loss.
Corliss Institute	292 Main Street/ 20 Norbert Street	Private	Flooding, wind damage, fire	Public safety. Property damage. Disruption of services. Economic loss.

Schools				
Hugh Cole Elementary	50 Asylum Road	Public	Flooding, winter storms, wind damage, fire	Public safety. Property damage. Disruption of services.
Kickemuit Middle School	525 Child Street	Public	Flooding, winter storms, wind damage	Public safety. Property damage. Disruption of services.
East Bay Educational Collaborative	317 Market Street	Private	Flooding, winter storms, fire	Public safety. Property damage. Disruption of services.
Child Care Connection	410 Child Street	Private	Wind damage, winter storms, fire	Public safety. Property damage. Disruption of services.
Raggedy Ann Nursery School	210 Metacom Avenue	Private	Flooding, wind damage, winter storms	Public safety. Property damage. Disruption of services.
The Garden Playschool	84 Cutler Street	Private	Flooding, wind damage, winter storms	Public safety. Property damage. Disruption of services.
The Highland Charter School	360 Market Street	Private	Flooding, wind damage, winter storms, fire	Public safety. Property damage. Disruption of services.
Govt./Emergency/Operating Centers				
Government Center	1 Joyce Street	Public	Wind damage	Property damage. Disruption of services. Public safety risk if access is compromised.
Town Hall	514 Main Street	Public	Wind damage	Property damage. Disruption of services.
DPW/Transfer Station	Birch Swamp	Public	Wind damage, fire	Public safety. Property damage. Disruption of services.
Community Center (Mary V. Quirk)	Main Street	Public	Wind damage, flooding	Public safety. Property damage. Disruption of services.
Fire Station	Town wide	Public	Flooding	Property damage. Disruption of services. Public safety risk if access is compromised.
Warren Animal Shelter	Wood Street	Public	Flooding, wind damage, winter storms, fire	Animal safety/well-being. Property damage. Disruption of services. Service cost for emergency relocation.

Dams				
Upper Kickemuit Reservoir		Public	Flooding	Property damage. Infrastructure damage.
Lower Kickemuit Reservoir		Public	Flooding	Property damage, infrastructure damage.
Utilities				
Sewer Department/sewer system	Water Street and through most of Warren	Public	Flooding, debris from wind damage	Risk to public health. Economic loss. Disruption of services.
Pump Stations	Town wide	Public	Flooding	Risk to public health. Economic loss. Disruption of services.
Water Supply	Town wide	Public	Flooding, severe weather	Risk to public health. Economic loss. Disruption of services.
Transportation				
Warren River Bridge	Main Street/Warren River	Public	Flooding, wind damage from debris, ice/winter storms	Public safety. Disruption of access. Economic loss. Disruption of services.
Evacuation Routes	Main Street/Metacom Avenue and connecting streets	Public	Flooding, wind damage debris	Public safety. Disruption of access. Economic loss. Disruption of services.
Child Street/Kickemuit Reservoir Pass	Child Street	Public	Flooding, wind damage debris	Public safety. Disruption of access. Economic loss. Disruption of services.
Natural Resources				
Town Beach/Burr's Hill	Water Street	Public	Flooding, wind damage debris, ice	Coastal erosion, damage to archaeological site
Jamiel's Park	80 Wood Street	Public	Flooding, debris from ice/winter storms	Property damage. Coastal erosion. Disruption of services
Audubon - Touisset	Touisset Road	Private	Flooding	Coastal erosion.
Warren Bike Path	Long Lane to Kickemuit	Public	Flooding, debris from wind, winter storms, ice	Property damage, disruption of access.
East Bay Bike Path	West Warren	Public	Flooding, debris from wind, winter storms, ice	Property damage, disruption of access.

4.1.1 Vulnerability of Special Population Centers

Warren has several special population centers, including 7 education facilities ranging from pre-school to middle school, 3 elderly nursing home and/or rehabilitation centers, the Senior Center and Kickemuit Village (senior housing), several group homes for adults with developmental and mental health disabilities. The populations using or inhabiting these facilities may require additional assistance in the event of a natural hazard. Rhode Island Building Code requires residential and commercial structures in the Warren area to be able to withstand 110 mile per hour winds, or a Category 2 hurricane. Most of the facilities housing Warren's special populations were built in the 1960s and 1970s. All special needs population centers may be vulnerable to wind-borne damage from higher caliber hurricanes. For more in depth details including specific location, ownership, at risk Hazard and the effects may be found in **Table 8**.

1. **Special Population Critical Facilities.** Of Warren's three elderly facilities, the most vulnerable are the **Grace Barker Nursing Home** and **The Willows** on Barker Avenue, which are located in a Category 1 Hurricane area (see **Map 5**) and are vulnerable to Flooding. Most of the buildings in **Kickemuit Village** are located in a Category 3 Hurricane Area, although 1 building on the eastern shore is located in a Category 2 Hurricane area, it is vulnerable to Flooding, Winter Storms and Wind Damage. **Crestwood Nursing Home** is located just outside of the Category 4 Hurricane area and is vulnerable to Flooding and Wind Damage. Grace Barker Nursing Home and The Willows are both located in the 100-year Flood Zone (see **Map 6**). Kickemuit Village has land in the Velocity Zone and the 100-year Flood Zone, but none of the buildings are located in these zones. Similarly, Corliss Institute's buildings appear to be outside of the FEMA delineated Special Flood Hazard Area (SFHA), but their land along the East Bay Bike Path is in the SFHA. Snow and ice storms would not impact Warren's special needs population in terms of structural damage; however, severe winter weather would limit the mobility of these populations and may impede emergency responder's ability to access the buildings. Power outages, fallen trees or debris may create further hazards.

   Assisted living centers for either the elderly or disabled are scattered throughout Warren. **Riverwood Mental Health Services Inc.** maintains administrative offices at 25 Railroad Avenue, and offers outpatient assistance as well as permanent supportive housing (apartment assistance) for three sites in Warren. The office on Railroad Avenue is located in a Category 4 Hurricane and is vulnerable to Wind Damage. The **Main Street Apartments**, owned by East Bay Housing/Riverwood MHS, consists of 10 units for the disabled. Most of this property is located in a Category 3 Hurricane area and is vulnerable to Flooding and Wind Damage.

   St. Mary of the Bay Church operates a group home for young women on **945 Main Street** through the North American Family Institute, which is vulnerable to Flooding and Wind Damage. Also on Main Street is the Corliss Institute at 292 Main Street. Corliss' main offices are located in a Category 2 Hurricane area, while some of its rear properties (along the East Bay Bike Path) in the Category 1 Hurricane area. Both of these properties are vulnerable to Flooding, wind Damage and Fire.

2. Schools. 5 of Warren's 7 public and private schools are located in a storm surge inundation area (refer to **Map 3**) based on the SLOSH worst case scenario model. The schools most at risk are **The Garden School** on Cutler Street and the **Raggedy Ann Nursery**, which are at risk from storm surge associated with a Category 1 hurricane. Also vulnerable is **Child Care Connection**, which is at risk in a Category 3 Hurricane and Hugh Cole Elementary and the East Bay Collaborative, which are at risk in a Category 4 hurricane. **Kickemuit Middle School** is located just outside the inundation area, but the fields to the south are located in surge area. Most of Warren's schools are located outside of the Velocity Zone and the 100-year Flood Zone (see **Map 4**), except for **Raggedy Ann Preschool** at 210 Metacom Avenue. This school is situated in the 100-year Flood Zone. For additional vulnerabilities of the Schools see **Table 8**.

3. Government/Emergency Operations Critical Care Facilities. Warren maintains six fire stations around Town, Town Hall and the Government Center (which houses the Police Department and the Central Fire Station). These facilities are supplied with emergency generators and are staffed in natural hazard conditions. Kickemuit Middle School, on Child Street (Route 103), is the main emergency shelter during major storms and disasters. The Town Hall is occasionally used as an emergency shelter as well and is located along a major evacuation route, and admits pets during emergencies in certain areas of the building. None of these facilities are located in a floodplain, however for vulnerabilities see **Table 8**.

4. Dams, Utilities, Transportation and Natural Resources. Special populations can be particularly affected by compromised public infrastructure. In Warren, two dams are considered "significant" by the RIDEM Dam inventory. If breeched, these dams could block key transportation connections to and from critical care facilities, or block emergency or supply access from nearby Route 103. Similarly, blocked bridges and evacuation routes could prevent access to hospitals and supplies. The Warren Bridge, which separates Barrington from Warren, is particularly vulnerable to flooding and blockage because of the low lying land where the bridge connects to Main Street in Warren. For details of the vulnerabilities see **Table 8** above. Natural Resources, such as parks and conservation areas, often provide buffers that protect private property from damage and floods. The East Bay Bike Path represents a significant connector for residents, particularly when streets are blocked.

4.1.2 Vulnerability of Residential, Commercial and Other Structures

Residential Structures

FEMA's high risk flood zones are the areas projected to be the most susceptible to flooding during major weather events. Property owners in either an A or V zone with a mortgage are required by NFIP mandate to carry flood insurance. In Warren, 3,316 residential structures are located in the AE and VE Zones. As detailed in **Table 9**, 2,555 residential structures are single family homes and another 740 are multi-family or apartments. Although building age is not necessarily an indicator of sturdiness, 1,099 (33%) of these structures were built before 1950, including 341 that were built prior to 1900. In western Warren, the Velocity Zone extends inward over waterfront parcels often reaching the East Bay Bike

Path. Most of the residential structures in the Velocity Zone are located on town's western half along the Warren River, from the southern border of the American Tourister Mill complex toward the Bristol line. Tax values for both the AE Flood Zone and the VE Flood Zone total $117,259,400.

Table 9: Residential Structures Most At Risk from Hurricanes (as of 2014)

Structure Type	Total Number of Structures in Warren	Number of Residential Structures in the AE and VE Zones	Tax Value of Residential Structures in the AE and VE Zones
Single Family	2,555	409	$ 89,808,200
Multi-Family (2-6 units)	695	177	$24,814,000
Apartments	28	5	$ 1,510,700
Seasonal/Beach	21	9	$486,900
Residential Condo	17	2	$ 639,600
Total	**3,316**	**602(18%)**	**$117,259,400**

About 49% of residential structures in Warren are located in an area predicted to be impacted by storm surge up to 18 feet (1,635 structures total). Property owners within the storm surge areas should maintain coverage through the NFIP. According to FEMA, 474 policies are currently active in Warren as of 2014. Total coverage in force is $92,967,600. Since 1978, 135 claims have been made through the NFIP, with $1,219,035 paid for damage. The tax value of residential structures located in storm surge areas totals $238,290,400 as indicated in **Table 10**.

Table 10: Residential Structures Most at Risk from Storm Surge (as of 2014)

Structure Type	Total Number of Structures in Storm Surge Area	Tax Value of Residential Structures in Storm Surge Areas
Single Family	1,019	$ 143,410,800
Multi-Family (2-6 units)	523	$ 75,436,700
Apartments	23	$ 6,279,200
Combination	50	$ 10,733,100
Seasonal/Beach	11	$ 581,800
Residential Condo	9	$ 1,848,800
Total	**1,635(49%)**	**$ 238,290,400**

Development Trends and Future Build Out

Based on the Town's Build Out Analysis (the potential for development based on zoning and site conditions), Warren has the potential for an additional 1,415 single family units. In the R40 zoning district (which is defined as residential zoning with lots of at least 40,000 square feet and includes much of the rural eastern half of Warren), there are 112 existing lots that have the potential for creating about 450 additional lots and 506 additional units. A few of these properties front the Palmer River, Kickemuit Reservoir and the Kickemuit River, which could exacerbate flood hazards. In 2011, the Town purchased a conservation easement on 63 acres of farmland along the Kickemuit River, reducing the build out potential for this area. Of all new residential units in Warren it is estimated that 32% would be within

R40 zoning district. In the R20 zoning district there are five existing lots that have the potential for an additional 68 units, or an increase of 46% of units in that zone. However, the overall effect is < 5% of total new units in Warren. In the R10 zoning district there are 253 existing lots that have the potential for an additional 607 units, or an increase of 28% units in that zone. Of all new residential units in Warren it is estimated that 43% would be within R10. In the R6 zoning district there are 71 existing lots have the potential for an additional 147 units, or an increase of 14% of units in that zone. Of all new residential units in Warren approximately 10% would be within R6. The other zoning districts (R15, R30, VB and W) are projected to create a total of 50 new lots or 57 additional units. Of all new residential units in Warren a total of 3% would be within the R15, R30, VB and W zones combined. These districts have little potential for new residential development under this scenario. Warren has seen little residential development since 2008 with the decline of the housing market, but positive economic trends may revive this market.

Impact of Development Trends on Vulnerability

Overall, Warren's buildable lots in the R40 and R10 zoning districts may increase vulnerability to natural hazards. These areas account for 574 new residential development structures. Of these potential structures, many lie along the eastern shoreline of the Kickemuit River, are dispersed throughout the Touisset Neck area and are located west of the Warren Reservoir. For the developable properties on the eastern shore of the Kickemuit River, the AE Zone and the VE zones do not extend far inland, possibly because the elevation of these parcels is fairly high (about 62 feet above sea level). Therefore, vulnerability of these parcels to flooding is fairly low, although this could change in the decades as sea levels rise. The properties on Touisset Neck are similarly high and off of the coastline, so flooding is not estimated to be a large threat. By contrast, developable properties along the eastern side of the Warren Reservoir are covered widely by the AE flood zone, and would have to meet elevation requirements of the building codes for this zone. Development in this area is further complicated by extensive wetland buffers, which are currently 50 feet from wetlands as regulated by the DEM, as well as the Town of Warren's Zoning Ordinance, which restricts certain uses in these areas and requires advisory review by the Conservation Commission. These parcels are still developable, however, and vulnerability of new development to flooding is high. Because all of these locations are near forests, wildfires may also present an elevated vulnerability.

Vulnerability of Non-Residential Structures

280 non-residential structures exist in Warren overall with a total building tax value of $40,193,900. Many commercial structures in the AE Zone are located close to the Warren River, along Belcher's Cove on Market Street and on western side of Market Street toward Swansea. As indicated in **Table 11**, 57 commercial structures are located in the AE and VE zones, with a total tax value of $21,173,100. About 17% of the value of Warren's commercial structures is located in areas with high risk for flooding, storm surge and high winds. In addition, 23 industrial buildings exist in Warren with a total tax value of $18,065,100. Only 12 of these industrial building structures are in the AE and VE zones with tax valued at $8,305,200. 20 industrial structures may experience storm surges, putting over $16 million at risk for damage (**Table 12**).

The remaining non-residential structures in Warren include government buildings, churches/non-profits and utility structures. Only 25 government land parcels actually have associated buildings, and these properties have a total tax value of $8,077,100. Of these structures, only 5 occur in the AE and VE zones: the Warren Animal Shelter, Veteran's Field improvements and the State-owned facility on Market Street near Jamiel's Park. Most Town-owned buildings in the AE and VE zones are of minimal tax value, except the Wastewater Treatment Plant at $ 1,508,700. The Animal Shelter's importance in emergency operations is discussed further in the other sections. Church and non-profit structures also maintain 21 buildings in Warren, with 6 structures in the AE and VE zones.

Table 11: Non-Residential Structures Most at Risk from Hurricanes

Structure Type	Total Number of Structures in Warren	Number of Non-Residential Structures in the AE and VE Zones	Tax Value of Non-Residential Structures in the AE and VE Zones
Commercial	205	57	$21,173,100
Industrial	23	12	$8,305,200
Utility	6	5	$600,400
Government	25	5	$8,077,100
Church/Non-Profit	21	6	$2,038,100
Total	**280**	**85 (30%)**	**$40,193,900**

Table 12: Non-Residential Structures Most at Risk from Storm Surge

Structure Type	Total Number of Structures in Storm Surge Area	Tax Value of Structures in Storm Surge Area
Commercial	138	$ 41,867,100
Industrial	20	$16,271,600
Utility	6	$1,644,100
Government	16	$4,489,400
Church/Non-Profit	21	$13,211,600
Total	**201 (72%)**	**$77,483,800**

Section 4.2 – Summary of the Vulnerability of Warren's Critical Assets

The main hazards for Warren's critical assets are flooding, storm surge and the effects of winter storms. Because of the attractiveness of the coastline, development along the shores is desirable not just for residences but also for senior facilities and special population uses. Caution should be taken in supporting such development, as sea rise and climate change is expected to accelerate in the coming decades. These conditions will exacerbate flooding effects and create burdens on emergency response as well as risking property damage, infrastructure and public safety.

Critical assets could be impacted by other hazards, such as earthquakes, tornadoes and wildfires. Reducing these risks will require adherence to the Rhode Island Building Code and the International Building Code, which prescribe that all structures in Warren must withstand wind speeds of 110 miles per hour or a Category F1 tornado. Finally, wooded parcels scattered throughout Warren are in close proximity to houses and schools. These structures may present some risk from wildfire damage, but based on historic occurrences, this risk is unlikely.

Section 5 – Hazard Mitigation

Warren Town staff assessed the risks to the town and developed mitigation actions that address a mix of structural initiatives (building code enforcement, repair and retrofit of existing structures, and removal of vulnerable structures) and nonstructural initiatives (educational programs, preventing construction in high-hazard areas, enforcing regulations) to minimize the effect of future hazards. By creating this strategy and making it part of the Town's Comprehensive Planning and incorporating the strategies into the Zoning Regulations (see **Appendix D**), Warren has established an ongoing process that will make hazard mitigation a routine part of municipal government. Based on the activities planned for in the **2004 Hazard Mitigation Plan**, adopted by the Town of Warren, the following actions have been addressed as follows:

Time frames are defined as:	Short Term	1 month to a year
	Medium Term	1 to 3 years
	Long Term	3 years to an ongoing process

Table 13: Updated Status of Actions from the 2004 Hazard Mitigation Plan

2004 HMP Action	Description	Status	Cont. to 2015 HMP Action	Timeframe
Action 1	Complete survey of main roads/properties that flood	Complete	N/A	Short Term
Action 2	Work with RIDOT to begin drainage improvements	Complete	N/A	Long Term
Action 3	Inspect historic structures/private buildings for code compliance. Flood proof commercial and historic structures located in the flood zone.	Initiated for private buildings. Historic structures will need separate initiative.	Action 2.1	Long Term
Action 4	Implement public education series focusing on flood hazards, building regulations and fire prevention for property owners	Initiated - Fire hazards emphasized so far.	Action 1.2	Medium Term
Action 5	Expand tree-trimming program	Initiated – National Grid began tree trimming in 2015.	Action 1.3	Medium Term
Action 6	Monitor sewer lines via camera for leaks	Initiated – Sewer line along Kickemuit River analysis completed.	Updated to focus on water distribution Action 4.4	Medium Term

Action 7	Repair/replace infrastructure problems	Initiated – RIDOT and Public Works initiated infrastructure improvements on Water Street.	Action 4.1	Medium Term
Action 8	Develop a town wide inventory of small streets that flood/wash out	Completed – updated street map in progress.	N/A	Short Term
Action 9	Begin drainage improvements with innovative water catchments in areas subject to annual flooding	Initiated at Town Beach.	Updated to focus on green infrastructure Action 3.5	Short Term
Action 10	Protect wetlands, marshes and other fragile areas along Town rivers/streams by purchasing land, cleaning up areas and restoring wetlands	Initiated. Zoning ordinance should be updated to protect wetlands and streams; evolving legislation at state level. Completed- Open space abutting wetlands is now protected by Open Space purchase.	Action 3.4	Long Term
Action 11	Purchase high output emergency generators for 3 of the Town's emergency shelters	Completed	N/A	Medium Term
Action 12	Purchase generators for the Government Center and Town Hall.	Completed	N/A	Medium Term
Action 13	Establish a satellite communications center for the Fire Department as a separate building, or as a self-contained portion of a building	Completed	Updated for future Fire Dept. requirements 4.2	Medium Term
Action 14	Upgrade marine communication equipment to ensure safety along the Town's waterways.	Completed	N/A	Long Term
Action 15	Complete parcel mapping and street centerline using GIS.	Complete	N/A	Long Term
Action 16	As required by NFIP standards, ensure that structures experiencing losses over 50% of structural value be brought into compliance with state/federal code and current FIRMs.	Ongoing	Update to public education Action 1.2	Medium Term
Action 17	Discourage variances from flood regulations for new construction located in a flood zone. In National Historic District, establish aesthetic criteria for new structures in the flood plain.	Initiated	Action 2.3	Short Term
Action 18	Retrofit/replace communication tower at Town Hall to withstand high winds.	Complete	N/A	Long Term
Action 19	Inspect public housing (Housing Authority and other non-profit housing) and implement flood mitigation measures.	Ongoing	Action 2.4	Medium Term
Action 20	Periodically inspect and evaluate school buildings for code compliance.	Completed	N/A	Long Term
Action 21	Replace and elevate bridge at Warren/Barrington Town line.	Completed	N/A	Long Term

Action 22	Protect Warren's water sources and distribution method for clean water supply through the expansion of distribution lines to reservoirs in MA as approved by State Referenda.	Initiated	Action 4.4	Long Term

As indicated by the table, most of the Actions proposed by the 2004 plan have been initiated and some completed. Others are programmatic (and therefore ongoing) or the result of actions from other agencies over which the Town does not have full control. In updating the 2015 Hazard Mitigation Policies and Actions, the Town removed completed actions and added new actions that address new concerns arising from accelerated climate change and sea level rise.

Section 5.1– Mitigation Goals and Actions

The Risk Assessment Matrix, presented in **Table 13** above, was created in 2004 and several hazard mitigation actions are carried over in the 2015 plan. The new matrix reflects updated priorities, including response to climate change and accelerated sea rise. Priorities are indicated as: High, Medium and Low, based on their ability to affect mitigation of probably hazards in Warren. These priorities have been updated, with an increased emphasis on planning for climate change. This matrix also is based on historic damage, safety of the population, property protection and overall consistency with the strategies presented in the updated Comprehensive Plan and the Emergency Operations Plan. The goals of the 2015 plan include:

1. Strengthen planning efforts to identify, clarify and communicate natural hazards and use them for public information and outreach.
2. Ensure that the regulatory structure through the Building Inspections, Planning and Zoning review reduces exposure to natural hazards, particularly in coastal areas, wetlands, streams and waterways.
3. Protect property through structural projects and maintenance as well as the acquisition of land that serves as a natural buffer.
4. Protect essential public services.

These goals are implemented through a series of actions, based on the 2004 plan but intended to address each of the four goals above. During the development process each goal was reviewed for relevancy and to determine their current validity in this update and where necessary new goals were defined to achieve the overall mitigation strategy.

An established time frame will begin upon final adoption of the plan by the Town.

Goal 1: Strengthen planning efforts to identify, clarify and communicate natural hazards and use them for public information and outreach.
Action 1.1: Maintain GIS records of major flood events to locate patterns of flooding for future mitigation activities, including secondary roads.
Action Type: Planning
Priority: High
Lead Department: Planning and Community Development, RIEMA, Statewide Planning
Time Frame: Short term with quarterly updates. (1 month to a year)
Benefit: Future mitigation planning
Cost: $6,000 per year (as part of GIS program)
Financing Source: Town budget, FEMA grants
Action 1.2: Expand public education efforts focusing on flood hazards, building regulations and fire prevention for property owners. Include education on home insurance coverage for natural hazards and measures that homeowners can take to reduce their home insurance deductibles and personal liability for wind damage during hurricanes or severe storms. This action has been brought over from the 2004 plan.
Action Type: Planning
Priority: High
Lead Department: Planning and Community Development
Time Frame: Long Term (3 years or more)
Benefit: Future mitigation planning
Cost: $1,000 per year (tax bill mailing, website, printed flyers)
Financing Source: Town budget, FEMA
Action 1.3: Educate the public on tree species appropriate for property protection and proper upkeep. This action has been brought over from the 2004 plan.
Action Type: Planning
Priority: High
Lead Department: Public Works, Tree Commission, URI Outreach Center
Time Frame: Long Term (3 years or more)
Benefit: Future mitigation planning
Cost: $500 per year (website, printed flyers)
Financing Source: Town Budget, RIDEM grants, private grant sources
Action 1.4: Maintain information connections with state and federal agencies on sea level rise and its impacts on Warren property and public infrastructure.
Action Type: Planning
Priority: High
Lead Department: Public Works, Planning and Community Development, URI Coastal Resources Center, CRMC
Time Frame: Long Term (3 years or more)
Benefit: Future mitigation planning
Cost: $0
Financing Source: NA
Action 1.5: Pursue funding for hazard mitigation planning and implementation
Action Type: Mitigation
Priority: Medium
Lead Department: Planning and Community Development, RIEMA, FEMA

Time Frame: Long Term (3 years or more)
Benefit: Future mitigation planning
Cost: Variable. Depends on grant matching requirements
Financing Source: FEMA grants, Town budget
Goal 2: Ensure that the Town's regulatory structure reduces exposure to natural hazards, and is built into Building Inspections, Planning and Zoning review.
Action 2.1: Inspect and evaluate structures and privately owned buildings/facilities for code Compliance. This action has been brought over from the 2004 plan.
Action Type: Mitigation
Priority: High
Lead Departments: Planning and Community Development, Building and Zoning, Public Works
Time Frame: Short Term--Comprehensive Plan, Zoning Ordinance in rewrite. (1 month to a year)
Benefit: Public safety
Cost: Variable. Incorporated within Comprehensive Plan, Planning Board Subdivision Regulations, Zoning Ordinance revisions.
Financing Source: Depending on source, public/private grants, Town budget
Action 2.2: Review best practices and implement hazard mitigation policies for historic structures and utilize the Town's tax credit program for historic property improvements
Action Type: Mitigation
Priority: Medium
Lead Department: Planning and Community Development, Building and Zoning, State Historic Preservation Office, RIEMA
Time Frame: Short Term--Comprehensive Plan, Zoning Ordinance in rewrite. (1 month to a year)
Benefit: Preservation of historic and cultural assets
Cost: $2,000 in staff time
Financing Source: NA
Action 2.3: Disallow variances from flood regulations for new construction located within a flood zone. This action has been brought over from the 2004 plan.
Action Type: Planning
Priority: High
Lead Department: Building and Zoning
Time Frame: Short Term--Comprehensive Plan, Zoning Ordinance in rewrite. (1 month to a year)
Benefit: Public safety and property protection
Cost: $5,000 in staff, legal contractors' time
Financing Source: Town budget
Action 2.4: Ensure that housing and structures primarily used by Special Populations are routinely inspected *with the establishment of an annual inspection schedule* and that future construction of Special Population facilities are not located in areas of known flooding and/or storm surge.
Action Type: Planning
Priority: High
Lead Department: Building and Zoning

Time Frame: Long Term (3 years or more)
Benefit: Public safety and property protection
Cost: $3,000 in staff time
Financing Source: Town budget
Goal 3: Protect property through structural projects and maintenance as well as the acquisition of land that serves as a natural buffer.
Action 3.1: Work with RIDOT to **complete** drainage improvements through the installation of innovative water catchments and removal technology in areas subject to severe flooding. With RIDOT, pursue immediate corrective action on evacuation routes that are obstructed by frequent and significant flooding. This action has been brought over from the 2004 plan.
Action Type: Mitigation
Priority: High
Lead Department: Public Works, Planning and Community Development
Time Frame: Long Term (3 years or more)
Benefit: Public safety, property protection, protection of infrastructure
Cost: Variable depending on RIDOT programming and funding.
Financing Source: Clean Water Finance Agency, RI DEM, FEMA, Town budget
Action 3.2: Continue tree-trimming program and planting programs for severe weather-resistant tree species. Identify trees that may cause wind damage to emergency shelters, power sources or power lines and have them removed.
Action Type: Mitigation
Priority: High
Lead Department: Public Works, Tree Commission
Time Frame: Long Term (3 years or more)
Benefit: Public safety, protection of infrastructure
Cost: $3,000-$10,000
Financing Source: National Grid, Town budget, RI DEM
Action 3.3: Pass a Tree Ordinance that defines how utility companies and the Town must trim trees to maintain tree strength and symmetry to withstand high wind events.
Action Type: Planning
Priority: Medium
Lead Department: Public Works
Time Frame: Medium Term (1 to 3 years)
Benefit: Public safety, protection of infrastructure
Cost: $2,000 in staff time, legal contracting
Financing Source: NA
Action 3.4: Protect wetlands, marshes and other fragile areas along Town rivers and streams by purchasing land, cleaning up areas and restoring wetlands that serve as natural buffer. This action has been brought over from the 2004 plan.
Action Type: Planning
Priority: High
Lead Department: Planning and Community Development
Time Frame: Short Term--part of Comprehensive Plan, Zoning Ordinance in rewrite. (1 month to a year)
Benefit: Public safety, protection of property, protection of infrastructure

Cost: TBD. The Town maintains a Local Open Space Bond authority, but sensitive property acquisition can be supported by grant funding as well.
Financing Source: USDA, RI DEM**,** Town Open Space Bond funds
Action 3.5: Implement projects for high flood areas for green infrastructure improvements to reduce water retention (pervious pavement, bioswales).
Action Type: Mitigation
Priority: Medium
Lead Department: Public Works
Time Frame: Long Term (3 years or more)
Benefit: Public safety, protection of infrastructure, protection of private property
Cost: $200,000 per project (depending on scale), eligible for State Revolving Fund loans.
Financing Source: Clean Water Finance Agency, RI DEM, FEMA, Town budget
Goal 4: Protect public services and infrastructure.
Action 4.1: Continue monitoring sewer lines to identify maintenance and replacement needs and repair sewer lines where leakages are found. This action has been brought over from the 2004 plan.
Action Type: Planning
Priority: High
Lead Department: Public Works, Sewer Department
Time Frame: Short Term (1 month to a year)
Benefit: Protection of infrastructure, public safety
Cost: Monitoring estimated at $15,000 annually. Repairs estimated at $1.5 million or more. Grant funding can support both monitoring and repairs.
Financing Source: Town budget, RI DEM
Action 4.2: Continue to meet the national requirements for the Fire Department. This action has been brought over from the 2004 plan.
Action Type: Planning
Priority: High
Lead Department: Fire Department
Time Frame: Long Term (3 years or more)
Benefit: Public safety
Cost: $5,000
Financing Source: Town budget, grants
Action 4.3: Upgrade marine communication and equipment procedures to ensure safety along the Town's waterways. This action has been brought over from the 2004 plan.
Action Type: Planning
Priority: Medium
Lead Department: Harbormaster
Time Frame: Long Term (3 years or more)
Benefit: Public safety, protection of property, protection of infrastructure
Cost: $5,000
Financing Source: Town budget, grants
Action 4.4: Protect Warren's water sources and distribution method for clean water supply. This action has been brought over from the 2004 plan.
Action Type: Planning
Priority: High

Lead Department: Bristol County Water Authority
Time Frame: Long Term (3 years or more)
Benefit: Public safety, protection of property, protection of infrastructure
Cost: TBD
Financing Source: Clean Water Finance Agency, RI DEM, Town budget

Section 6 – Plan Implementation and Maintenance

Section 6.1 – Plan Adoption

The Warren Hazard Mitigation Plan is a strategy that the Town will implement to increase its resiliency to natural hazards. The Plan went through much iteration before formal adoption and approval. When the update was completed by the Warren Hazard Mitigation Committee, the Warren Hazard Mitigation Plan was forwarded to the Warren Planning Board for review and recommendation. Following the Planning Board's approval, the Plan was sent to RIEMA and FEMA for review. The Plan then received the Approval Pending Adoption (APA) notice from FEMA, which confirms that it has met all requirements. The document was then forwarded to the Warren Town Council for adoption. The updated plan will be available on the Town of Warren's web site. Approval by the FEMA will increase the Town's eligibility for enrollment in FEMA's Community Rating System (CRS). In addition, RIEMA and FEMA grant priority to municipalities that have completed a risk assessment and established mitigation projects with detailed information on the timeline, cost, and municipal department responsible for completing the project. Adoption of this plan by the Warren Town Council will also assist the Town in applications for federal and state level grants to be utilized in mitigation efforts.

Section 6.2 Implementation, Evaluation and Revision of Strategies

Implementation

By assigning a time frame to each recommended mitigation action the Town of Warren is setting parameters for implementation of needed projects. The Town of Warren Hazard Mitigation Committee recognizes the importance of establishing a workable time schedule for implementation to insure that actions are coordinated within governmental departments, on the local, state and federal level. The assigned time frame for implementation provides a method for project tracking and enables the committee to develop progress reports for each action item. The Hazard Mitigation Committee with the risks and vulnerabilities in mind has recommended that the mitigation actions be implemented into the appropriate components of the Comprehensive Plan and Zoning Regulations. Understanding the importance of hazard mitigation as a long-term planning goal, the Town of Warren will include in the Warren Comprehensive Plan and Zoning Regulations. At the time of the Hazard Mitigation Plan's

adoption, it will be officially incorporated in the Warren Comprehensive Plan by reference, and the full legal weight of the Comprehensive Plan will support this Hazard Mitigation Plan. The Hazard Mitigation Committee also recognizes that the needs of this plan may change and therefore may require adjustments to maintain its relevance. The Hazard Mitigation Committee will utilize the FEMA How-to Guide "Bringing the Plan to Life/Implementing the Hazard Mitigation Plan" as a resource document to update this plan and will work hand-in-hand with the Fire Chief, who serves as both a member of the committee and as the Warren Emergency Management Director. The Town Planner will serve as the Hazard Mitigation Plan lead, coordinator and point person for the public. Warren has historically utilized the background training and skills of the Fire Chief, and the Fire Department to implement hazard mitigation strategies, emergency operations procedures and post disaster evaluation – this will continue under the implementation of this plan and through the bi-annual evaluation and revision process.

The Town of Warren has participated in the National Flood Insurance Program (NFIP) since 1972, and will continue to comply with NFIP requirements. To ensure compliance with the NFIP in the future, the Town will implement this plan through the following actions and regulations:

1. *Warren Comprehensive Community Plan* Policy 8, (**Table 14)** see below:

Policy 8: Manage and protect floodplains)	Planning Board, DPW
• Action 8.1 Protect and enhance natural floodplain function to protect property	DPW, Conservation Commission
• Action 8.2 Adopt standards that meet the • National Flood Insurance Program	Town Council, Planning Board
• Action 8.3 Amend land use regulations to accommodate development under requirements of the NFIP.	Town Council, Planning Board

2. *Zoning Ordinance* (Article XVII Special Flood Hazard and Fringe Lands), see **Appendix D** for full text.

3. *Rhode Island State Building Code*. The code defines standards for flood hazard at Section 3107.0 B. These provisions are enforced through the Town's Building Inspector's Office and are in compliance with the NFIP.

4. Capital Improvement Plans (CIP)/Annual Town Budget. Each year, the Town of Warren incorporates Fire prevention, drainage projects, storm water management and green infrastructure projects into its annual budget.

These regulations limit development in hazardous areas and integrate NFIP requirements. The Warren Comprehensive Community Plan is currently being updated, after which the Zoning Ordinance will also be rewritten for consistency. These documents will integrate and cross-reference hazard mitigation standards.

Evaluation

The Town of Warren, through the Hazard Mitigation Committee will meet bi-annually (July 1st and December 1st) or after each disaster to review and update the plan utilizing FEMA's How-to-Guide which contains worksheets that assist with evaluation and monitoring the results of the mitigation actions. The Committee will also review flood maps and internal procedures to insure that the mitigation actions laid out in this plan are being implemented in the time frame set forth and approved. This schedule is more frequent than in previous Hazard Mitigation Plans (which were reviewed annually). The Committee will monitor and document the progress of action implementation and report its findings to the Planning Board and Town Council. Both the Planning Board and Town Council will involve the public in the plan maintenance process by holding an annual advertised public meeting via web site, posted fliers and or local newspaper, to discuss the results and findings. During recovery of a disaster the Committee will determine the effectiveness of the implemented actions. The Committee will make any necessary changes to the specific mitigation actions and their priorities as set forth previously in this plan.

Revision

44 CFR Part 201.6 (d)(3) requires local multi-hazard mitigation plans to be updated every five (5) years. The Hazard Mitigation Committee will evaluate and update the Plan with the best available data (including FEMA HAZUS data, a GIS-based program used to estimate the physical, economic and social impacts of disasters. Review and revision of the strategies based on the Committee's evaluation occur bi-annually, after any major disaster, or as funding for mitigation projects becomes available. Actions identified in this plan will also be reviewed on a regular basis by the Town Planner in order to initiate grant applications for various mitigation items. As the plan is implemented and local strategies or priorities change, the Town will amend the Warren Hazard Mitigation Plan and, after approval at the municipal level, will submit the amended plan to RIEMA for review. In this way, the State will remain abreast of the Town's current strategies and the progress of implementation. Public workshops and hearings will be held prior to the enactment of any document amendments. The public hearing process calls for all proposed changes to be publicly advertised three weeks prior to a public hearing, and the amendments will be presented for public review at the Town Clerk's office, Town Library and via the Town website.

Communication

Historically, the Town of Warren has not provided a consistent means for communication with the public prior to natural hazards (this was noted by the Planning Board as well during its review of this plan). The Town has since implemented the CODE RED system in 2012. This high speed emergency and communication system will allow notification by the local emergency response team in the event of emergency situations or critical community alerts. Examples include, by are not limited to, evacuation notices, bio-terrorism alerts and boil water notices. The Town will also provide reminders to residents through the website, newspaper, mailers, tax bill inserts and other media. The Warren population, like many places, must utilize multiple media sources to impact public awareness. This communication is especially important as FEMA distributed the new floodplain maps in 2014.

Funding Improvements

An array of funding can be drawn to finance improvements to mitigate hazards. The Town of Warren can budget for such projects in its Capital Improvements Plan and finance improvements locally through bonds. Grants such as the State Revolving Fund and the USDA NRCS programs have already funded storm water management and buffer conservation projects in Town, and can be utilized in the future. State Department of Transportation projects (often through the Federal Highway Administration), through their planning and street improvement grants can address storm water runoff and flood management as part of their scope. Department of Urban Development Community Development Block Grant can fund improvements in the low-moderate income/neighborhood revitalization areas. Finally, university/college programs may be able to donate resources to help plan, communicate risks or implement mitigation activities. Private entities, such as the Nature Conservancy and the Champlin Foundation, routinely fund acquisition of natural buffer easements. FEMA provides assistance for mitigation activities through the Hazard Mitigation Assistance Grants and Preparedness Grants can be targeted to specific improvements. At this point, the Town does not participate in FEMA's CRS. This system offers discounts to a participating community's flood policyholders if the community meets three goals: reduce flood damage to insurable property, strengthen and support the insurance aspects of the NFIP and encourage a comprehensive approach to floodplain management.

Section 7 - Technical Resources

Town Resources

Town of Warren
Office of Planning and Community Development
514 Main Street
Warren, RI 02885
www.townofwarren-ri.gov

State Resources

Rhode Island Emergency Management Agency
645 New London Avenue
Cranston, RI 02920
(401)-946-9996
www.riema.ri.gov

Rhode Island National Flood Insurance Program
645 New London Avenue
Cranston, RI 02920
(401) 946-9996
www.riema.ri.gov

Rhode Island Fire Marshal's Office
118 Parade Street
Providence, RI 02909
www.fire-marshal.ri.gov

Coastal Resources Management Council
Stedman Government Center
4808 Tower Hill Road
Wakefield, RI 02879
p.: 401-783-3370
www.crmc.ri.gov

Department of Administration
Division of Planning
One Capitol Hill
Providence, RI 02908
p.: 401-222-6800
www.admin.ri.gov

Rhode Island Department of Environmental Management
235 Promenade Street
Providence, RI 02908
p.: 401-222-6800
www.dem.ri.gov

Rhode Island Department of Transportation
Two Capitol Hill
Providence, RI 02903
p.: 401-222-2378
www.dot.ri.gov

State of Rhode Island Building Commissioner's Office
One Capitol Hill
Providence, RI 02903
401-222-3033
www.ribcc.ri.gov

Rhode Island Builders Association
450 Veterans Memorial Parkway, #301
East Providence, RI 02914
(401)-438-7400
www.ribuilders.org

Public Utilities Commission
89 Jefferson Boulevard
Warwick, RI 02888
(401)-941-4500

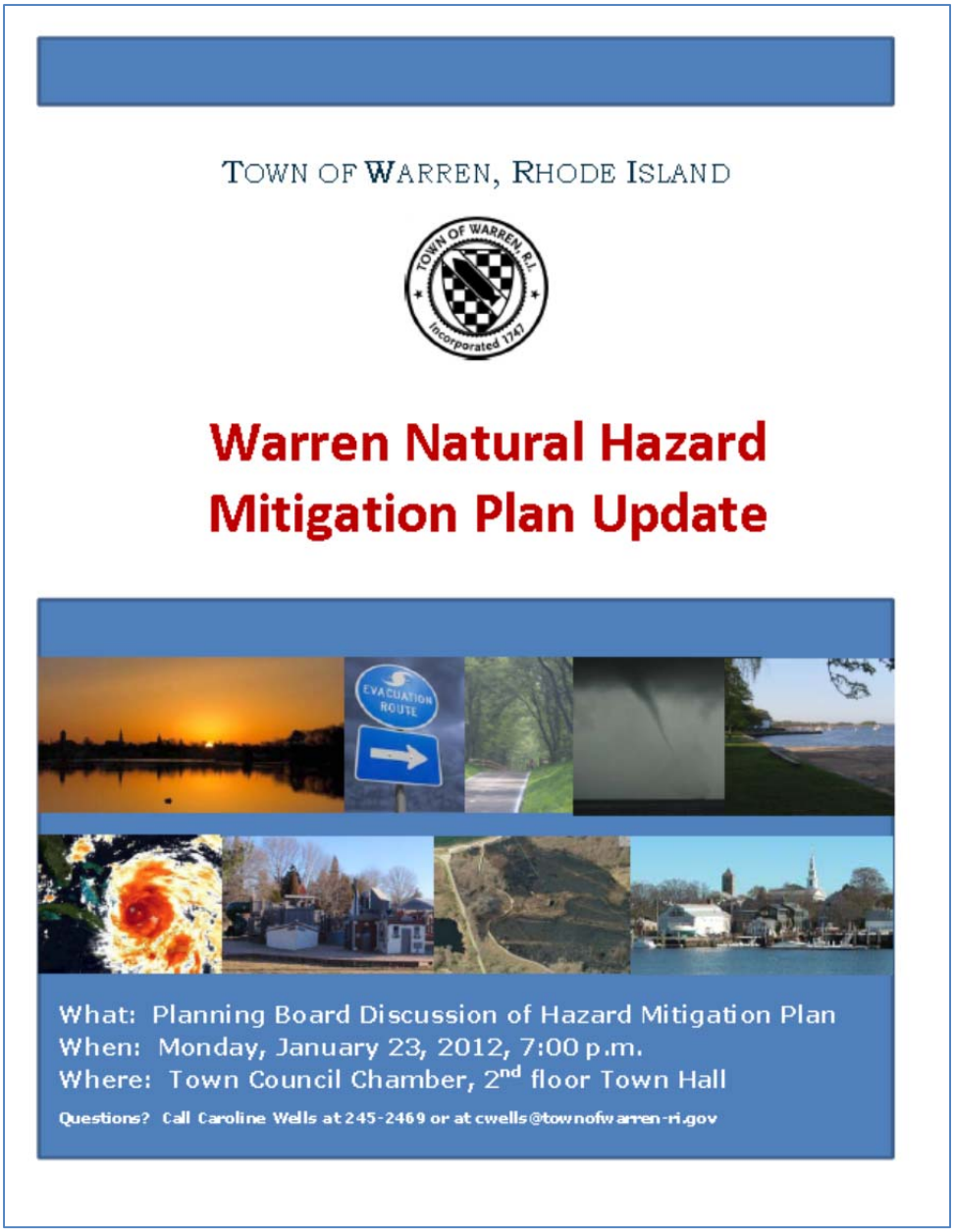
Federal Resources

Federal Emergency Management Agency
Region 1 Office
99 High Street, Sixth Floor
Boston, MA 02110
(617)-956-7506
www.fema.gov

National Weather Service Forecast Office
445 Myles Standish Boulevard
Taunton, MA 02780
(508) 823-2262

U.S. Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742
(978) 318-8111

Appendix A: Public Workshop Advertisement



Methodology: The Planning Board held a workshop discussion as part of its regular meeting format. While few were in attendance, the Planning Board gave anyone wishing to comment the ability to speak. Notes and audio recording was taken at the meeting. The Planning Board Chair formalized points of agreement in the form of a motion for inclusion in the Draft Hazard Mitigation Plan.

Appendix B: Planning Board Minutes, July 23, 2012 (excerpt)

WARREN PLANNING BOARD
MINUTES
JULY 23, 2012

The regular scheduled meeting of the Warren Planning Board began at 7:00 PM. Present were F. Massie, J. Piepowski, R. Silva, M. Heald, D. Kallfelz, and M. Rousseau. M. Jamiel, C. Thibaudeau, and R. Mello were absent. Also present were W. Nash, Attorney S. Federico, Town Planner Caroline Wells, Attorney William Dennis, Edward J. Cox, and Councilman Davison Bolster of the Warren Town Council.

New Business:

The Warren Hazard Mitigation Plan was presented to the Planning Board by Town Planner Caroline Wells for Board review prior to the meeting. Based on their review, the Board noted the need for several revisions to the Plan's section ***5.0 Hazard Mitigation Policies and Actions*** (pages 29 & 30). Specifically:

Action 2 & 9 – Extensive street flooding occurring after significant rainfalls in the 103/114 street area adjacent to the side entrance to the American Tourister complex must be specifically addressed. As this
roadway is a designated escape route in times of emergency, and, as the street flooding during a storm could prevent the use of this route, the Planning Board strongly recommends immediate corrective action, taken in concert with the Rhode Island Department of Transportation, must be a priority of the Hazard Mitigation Plan and this must be reflected in the Plan.

Action 4 – The noted public education series must include a section, developed after reviewing common insurance industry requirements detailing steps residents may take to minimize their personal liability for wind damage during hurricanes and/or other high wind situations.

Action 5 – The Town must develop a tree ordinance that will guide the Town and National Grid in tree-trimming to minimize damage to above-ground utility wires and poles during significant storm events**.**

Action 13 & 18 – The Plan must reflect the current Fire Department/emergency communications infrastructure relative to a satellite/cell communications center and towers.

M. Rousseau made a motion, seconded by D. Kallfelz, to recommend the Warren Town Council accept the Hazard Mitigation Plan with inclusion of the revisions noted above. The motion was approved unanimously.

Appendix C: Planning Board Memorandum, July 24, 2012

MEMORANDUM

July 24, 2012

To: Warren Town Council, c/o Council President Christopher Stanley

From: Warren Town Planning Board Chairman Frederick Massie

Subject: Warren Planning Board Recommendations to Warren Town Council

At its regularly-scheduled meeting, at 7:00 pm, on Monday, July 23, 2012, the Warren Planning Board considered applications and requests for the Board's recommendations to the Warren Town Council. The applications and requests Planning Board actions regarding these applications and requests are as follows:

2. The Warren Hazard Mitigation Plan was presented to the Planning Board by Town Planner Caroline Wells for Board review prior to the meeting. Based on their review, the Board noted the need for several revisions to the Plan's section ***5.0 Hazard Mitigation Policies and Actions*** (pages 29 & 30). Specifically:

Action 2 & 9 – Extensive street flooding occurring after significant rainfalls in the 103/114 street area adjacent to the side entrance to the American Tourister complex must be specifically addressed. As this roadway is a designated escape route in times of emergency, and, as the street flooding during a storm could prevent the use of this route, the Planning Board strongly recommends immediate corrective action, taken in concert with the Rhode Island Department of Transportation, must be a priority of the Hazard Mitigation Plan and this must be reflected in the Plan.

Action 4 – The noted public education series must include a section, developed after reviewing common insurance industry requirements detailing steps residents may take to minimize their personal liability for wind damage during hurricanes and/or other high wind situations.

Action 5 – The Town must develop a tree ordinance that will guide the Town and National Grid in tree-trimming to minimize damage to above-ground utility wires and poles during significant storm events.

Action 13 & 18 – The Plan must reflect the current Fire Department/emergency communications infrastructure relative to a satellite/cell communications center and towers.

Based on the inclusion of the revisions noted above, the Planning Board voted unanimously to recommend the Warren Town Council accept the Warren Hazard Mitigation Plan.

Appendix D: Natural Hazard Mitigation Review and Comment Outreach

Rhonda Fortin

From:	Rhonda Fortin
Sent:	Friday, July 10, 2015 11:24 AM
To:	Caroline Wells; Gareth Eames; John Massed; peterachilli@warrenripd.com; Al Galinelli; Thomas Gordon
Cc:	'gbessette@barrington.ri.gov'; 'acorvi@barrington.ri.gov'; 'phervey@barrington.ri.gov'; 'petemdpw1@gmail.com'; 'Kmcbride@bristolri.us'; 'dianew@bristolri.us'; 'bobmartin@bristolri.us'; 'chief@tivertonfire.com'; 'planner@tiverton.ri.gov'; 'dpw@tiverton.ri.gov'; 'Jessica.Stimson@ema.ri.gov'; Julie Coelho
Subject:	Town of Warren Natural Hazard Mitigation Plan

Good Morning,

I am contacting you today on behalf of the Warren Fire Chief, Alexander R. Galinelli. The Town of Warren is in the process of updating its Natural Hazard Mitigation Plan. We would like to invite you to review our plan at http://www.townofwarren-ri.gov/documentlibraries/plans.html and respond to AGalinelli@townofwarren-ri.gov with any comments or concerns no later than July 22, 2015.

Thank you for your assistance and cooperation with this matter.

Rhonda Lee Fortin

Town of Warren
Town Clerk's Office

Disclaimer: The information in this e-mail is confidential and is legally privileged. It is intended solely for the addressee. If this e-mail is not intended for you, you cannot copy, distribute or disclose the included information to anyone and request that the mail be deleted. While all reasonable steps have been taken to ensure the accuracy and integrity of all data transmitted electronically, The Town of Warren does not accept liability if the data, for whatever reason, is corrupt or does not reach its intended destination.

1

Appendix E: Zoning Regulations

Sec. 32-98. - Purpose.

The provisions herein governing the development and use of inland and tidal land subject to flood hazards shall be minimum provisions, shall take precedence over any other conflicting laws, ordinances or codes, but shall consider any flood plain management programs in neighboring areas, and are established for the following purposes:

A. To avoid or lessen the various hazards to persons resulting from inland and tidal flooding and the damage to property resulting from accumulation or runoff of storm and flood waters;
B. To protect floodways from encroachment;
C. To maintain the capability of the flood plain to retain flood waters;
D. To provide for the development of the flood plain with uses not subject to severe damage by flooding and which are compatible with other uses permitted in the various zones;
E. To permit only uses, improvements and practices in the flood plain that are not hazardous during flood periods;
F. To establish areas in which the elevation and flood proofing of structures and facilities must be regulated;
G. To avoid the creation of new flood problems; and
H. To complement and enhance an overall conservation program.

Sec. 32-99. - Definitions.

For the purpose of this article, and this ordinance generally, the following terms shall have these meanings:

A. *Special flood hazard areas:* Those areas of special flood hazard identified as "A" zones (Al-30) and "V" and V1-30 zones by the Federal Emergency Management Agency (FEMA) through a report entitled "The Flood Insurance Study for the Town of Warren, R.I." dated December 1982 with accompanying Flood Insurance Rates Maps (FIRM), effective date June 1, 1983, and any subsequent revisions thereto, and in addition, any regulatory floodway lines or maps designated through the process described in section 32-100 (B2) herein, are adopted by reference and declared to be part of this ordinance without the need to revise this ordinance.
B. *Base flood elevation:* The one hundred-year flood elevation or level as designated on a FIRM or a FHBM.
C. *Flood fringe land:* The continuous land adjacent to and higher than special flood hazard areas, the elevation of which is no greater than one (1) foot above the adjacent base flood elevation, and for the purposes of the flood provisions within this zoning ordinance, shall be subject only to provisions dealing with storage of bulk materials and anchoring of customary yard features in flood fringe lands.
D. *Development:* Any man-made change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavating or drilling operations.
E. *Regulatory floodway:* The channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation of that flood more than one (1) foot at any point.
F. *Substantial improvements:* As defined in Rhode Island State Building Code Rules and Regulations for Construction in Flood Hazard Areas, dated July 1, 1977, and any amendments thereto.
G. *Nonconforming structure:* For the purpose of this article, a nonconforming structure shall mean:

1. A residential structure with the lowest habitable floor (including basement) below the one hundred-year base flood elevation; or
2. A nonresidential structure which has not been flood proofed to that level.

H. *Recreational vehicle*: A vehicle, which is:
1. Built on a single chassis;
2. Four hundred (400) square feet when measured at the largest horizontal projections;
3. Designed to be self-propelled or permanently towable by a light duty truck; and
4. Designed primarily not for use as a permanent dwelling but as temporary living quarters for recreational, camping, travel or seasonal use.

Sec. 32-100. - Development standards.

All lands determined to be within special flood hazard areas and flood fringe lands shall be subject to the procedures and requirements established in this section. Additionally, development within two hundred (200) feet of any water course shown on a FIRM or FHBM shall also be governed. However, nothing contained herein shall prohibit the application of these requirements to lands which can be demonstrated by competent engineering survey to lie within any flood fringe lands; conversely, any lands which can be demonstrated by competent engineering survey to lie beyond the flood fringe lands shall not be subject to these requirements:

A. Nonconforming structures located with all special flood hazard areas shall not be enlarged or expanded.

B. No proposed construction or other development shall proceed prior to the issuance of a development permit from the building inspector. Such proposals shall be reviewed to assure that:
1. All such proposals are consistent with the need to minimize flood damage within the flood-prone area;
2. All public utilities and facilities such as sewer, gas, electrical and water systems are located and constructed to minimize or eliminate flood damage; and
3. Adequate drainage is provided to reduce exposure to flood hazards.

C. All proposed new developments shall include base flood elevation data within such proposals.

D. No water course may be altered or relocated without prior notification to the building inspector; the R. I. Statewide Planning Program; affected adjacent communities; and the Federal Emergency Management Agency (FEMA).

E. To insure that the flood carrying capacity within an altered or relocated water course is maintained, the following provisions shall be taken:
1. Until a regulatory floodway is designated, no new construction, substantial improvement or other development (including fill) shall be permitted unless it is demonstrated that the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than one (1) foot at any point within this community.
2. When a regulatory floodway is designated, based on flood data from any sources, including the developer:
   a. The regulatory floodway shall be selected and adopted on the principal that the area chosen for the regulatory floodway must be designed to carry the waters of the base flood without increasing the water surface elevation of that flood more than one (1) foot at any point;
   b. Encroachments shall be prohibited including fill, new construction, substantial improvements and other development within the adopted regulatory floodway that would result in any increase in flood levels within the community during the occurrences of the base flood discharge; and

c. The placement of any mobile homes shall be prohibited within the adopted regulatory floodway except in an existing mobile home park or mobile home subdivision.

d. Recreational vehicles placed on sites within zones A1-30, AH and AE shall either be on the site for fewer than one hundred eighty (180) consecutive days, be fully licensed and ready for highway use, or meet all standards of Section 60.3 (b)(1) of the NFIP Regulations and the elevations and anchoring requirements for "manufactured homes" in paragraph (c)(6) of Section 60.3.

3. All buildings shall be set back from a floodway at least the average of the setbacks existing on similar improvements on plots within two hundred (200) feet, or at least thirty (30) feet if there are no such improvements on plots within two hundred (200) feet. Accessory structures may, by special use permit, extend to the floodways; authorized public and semi-public bodies may be permitted to erect structures within a floodway only when the most extenuating circumstances warrant the issuance of a special use permit.
4. No principal building shall be located within the floodway set back lines established in accordance with subsection E.3 above. Principal buildings shall be located landward of mean high tide.

Sec. 32-101. - Standards for coastal velocity zones.

Within all special flood hazard areas designated as velocity zones and identified as zone VI-30 on the effective FIRM, the following requirements shall apply:

1. New construction shall be located landward of the reach of mean high tide;
2. The alteration of sand dunes shall not be permitted; and
3. The placement of any mobile homes shall be prohibited within zones V1-30 except within an existing mobile park.

Sec. 32-102. - Other requirements.

A. *Filling.* The filling of special flood hazard areas if otherwise authorized, may be permitted provided that the fill material:
   1. Obtained elsewhere is offset by the removal of an equivalent volume in the immediate vicinity of the area filled;
   2. Is obtained from the immediate vicinity of the area filled; and
   3. Shall not encroach upon, impede the flow of, or diminish the cross-sectional area of the floodway.

B. *Preliminary site work.* No preliminary site work may begin on any land below the base flood elevation until the building inspector has certified that the proposed use shall:
   1. Not cause the base flood elevation to rise more than one (1) foot when combined with all other similar existing and proposed uses;
   2. Not make more than twenty five (25) percent of the parcel below the base flood elevation along inland fresh water streams impervious to water, including but not limited to, roofs and paved areas;
   3. Not create hazards to water supplies or sewer systems; and
   4. Meet all other code provisions relating to flood hazards.

C. *Storage of bulk materials.* No material shall be stored in special flood hazard areas as well as in flood fringe lands which are likely to cause an obstruction, create a fire hazard, or pollute the water during flood periods. Such material includes but is not limited to substantial quantities of lumber and other floatable materials, volatile materials, acids, poisons, liquids other than water, and soluble materials.

D. *Customary yard features, anchoring.* Reasonable provisions shall be made for anchoring down those items customarily found out of doors, which are capable of floating in water for a prolonged period

of time and ordinarily not anchored. Such items shall include but not be limited to: movable structures and sheds; animal shelters, cages and feeders; fuel containers, tanks, cylinders and cans; picnic benches; railroad ties; flower boxes and planters; barrels and refuse containers; storage boxes; pallets; tires and tubes; freezers and refrigerators; lobster and eel traps; boat hulls; docking and float materials; signs; and stored vehicles.

E. *Other regulations to apply.* Except for the provisions of this article as they apply to the flood plain and the flood fringe land, the regulations for the zoning district in which such land is located shall continue in full force and effect.

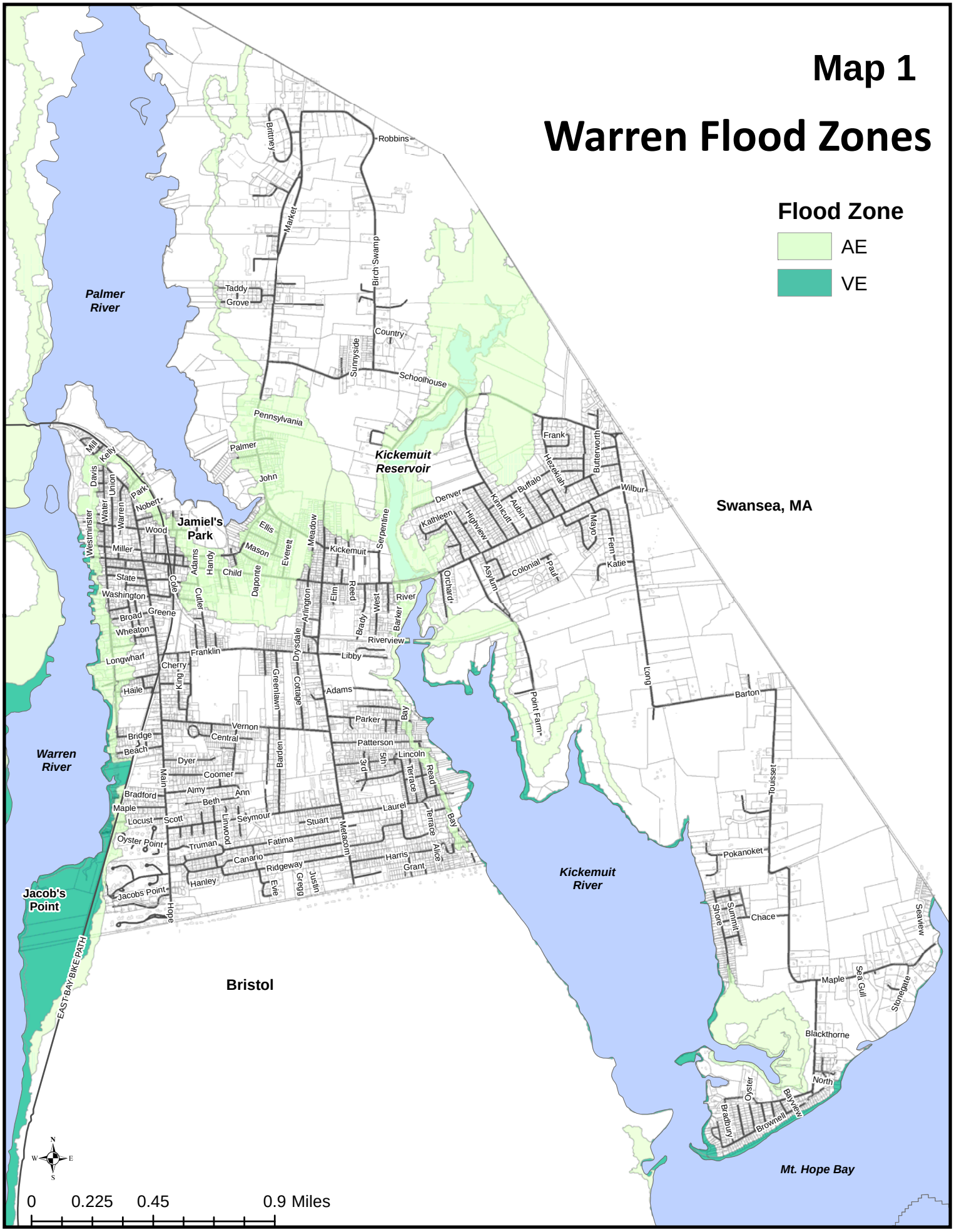
Sec. 32-103. - Variances in special flood hazard areas.

The zoning board of review may vary the provisions of this article in the case of a proven hardship. Variances granted under this section shall be noted on the property deed and shall contain the following information:

A. Flood hazard zone designation and date of flood map; and
B. Number in feet which the lowest habitable floor will be located in relation to the one hundred-year flood level.

Map 1

Warren Flood Zones

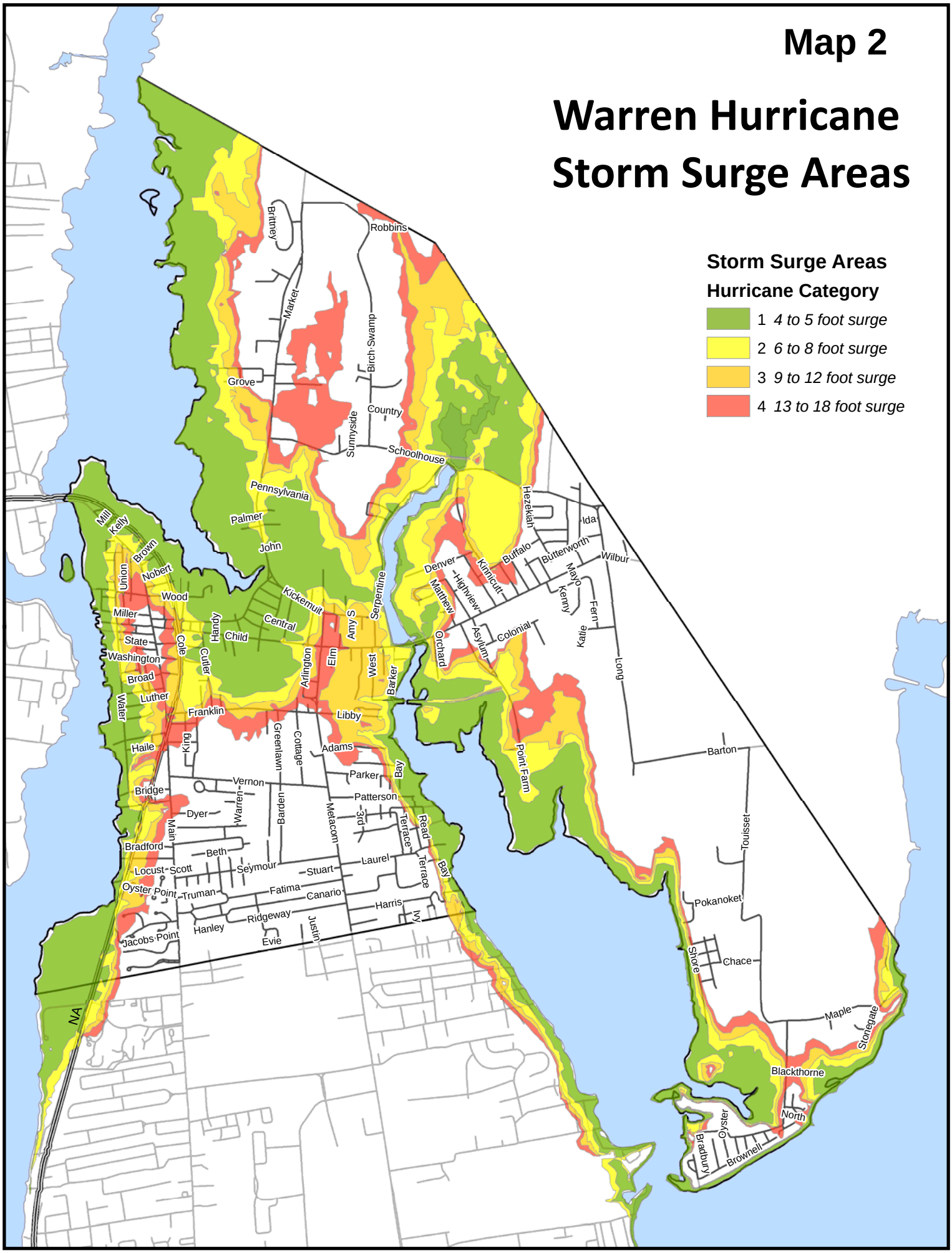


Warren Multi-Hazard Mitigation Plan, 2015
Warren Department of Planning & Community Development

Sources: Town GIS, RIGIS

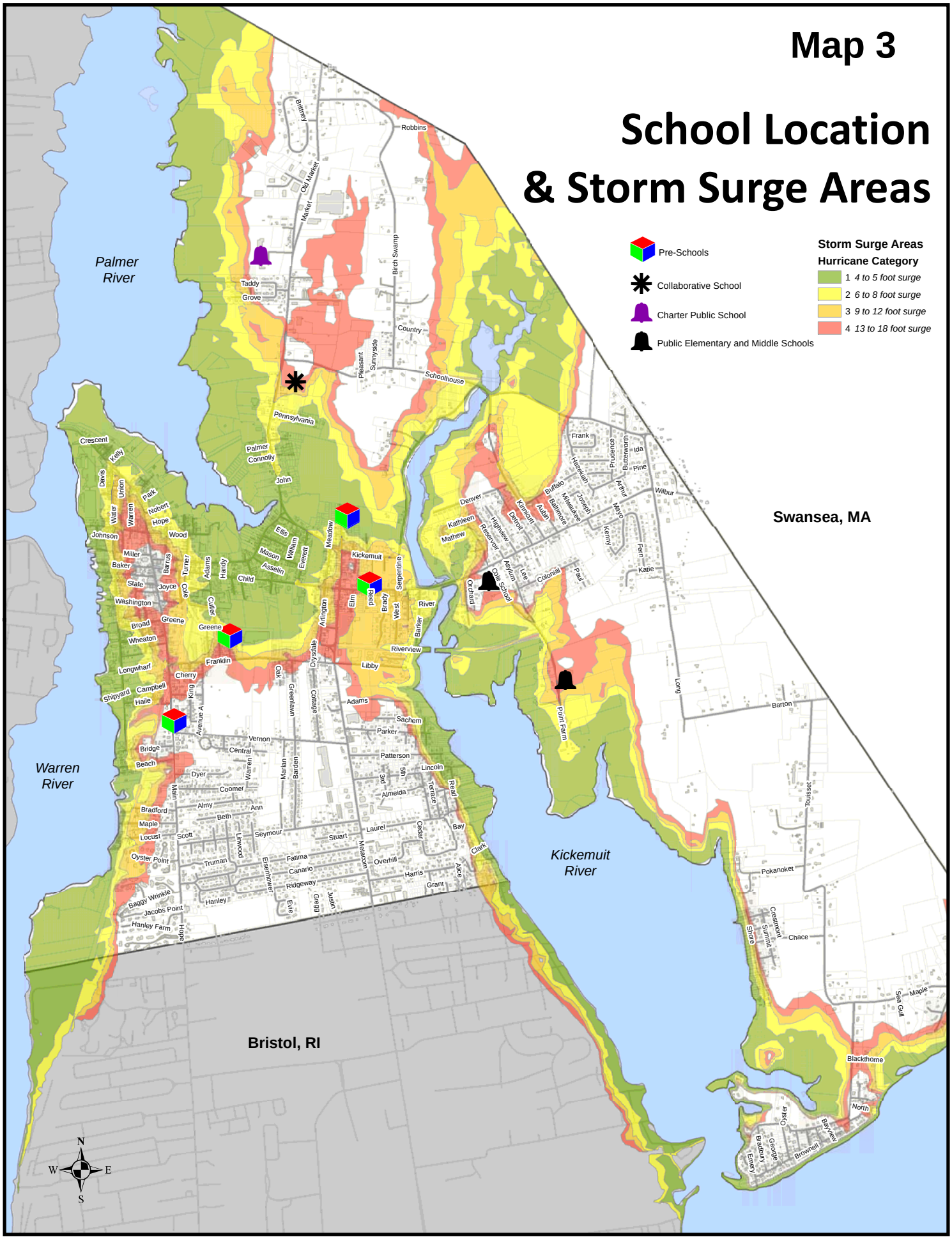
Map 2

Warren Hurricane Storm Surge Areas



Map 3

School Location & Storm Surge Areas

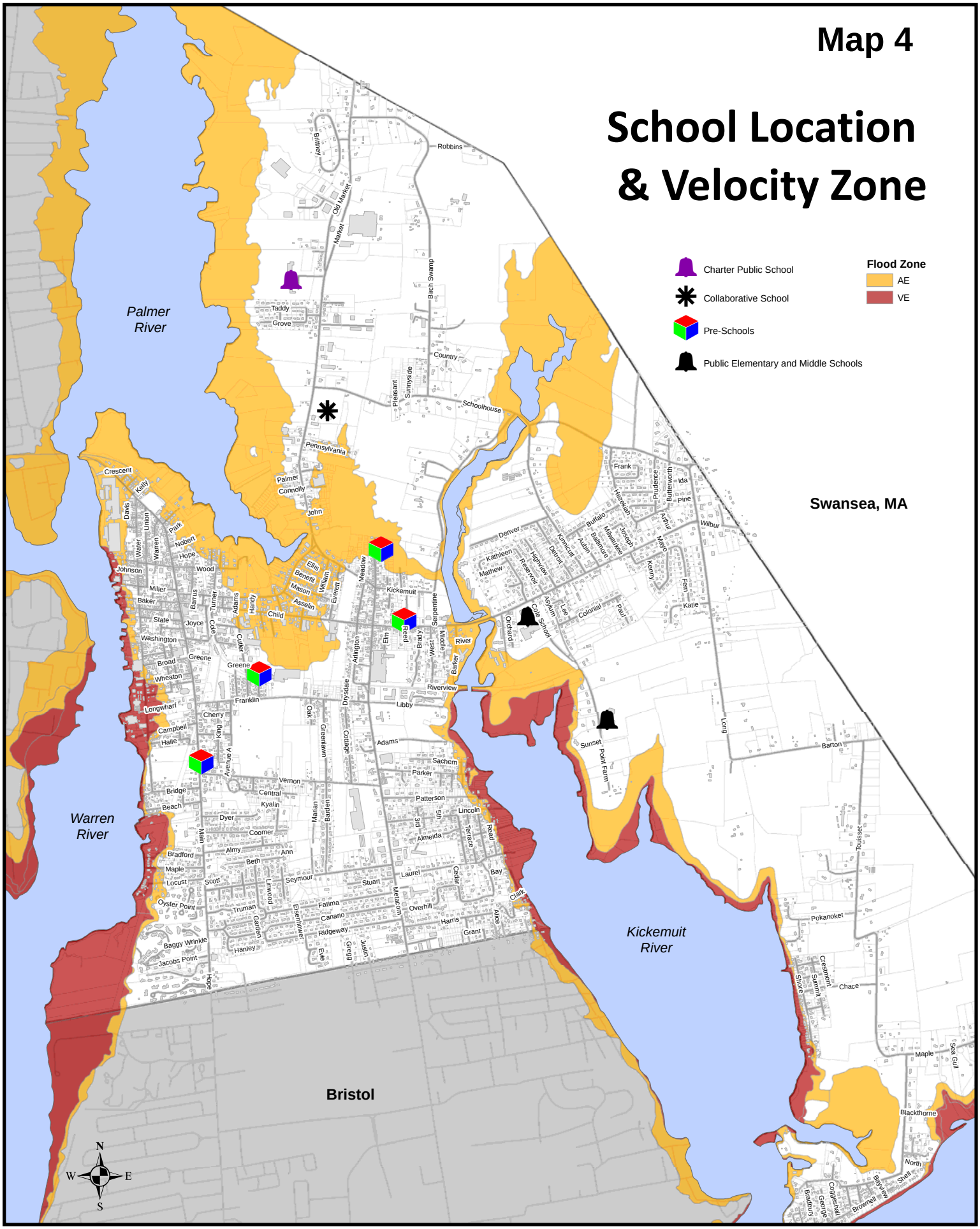


Warren Multi-Hazard Mitigation Plan, 2015
Department of Planning & Community Development

Sources, Town GIS, RIGIS

Map 4

School Location & Velocity Zone

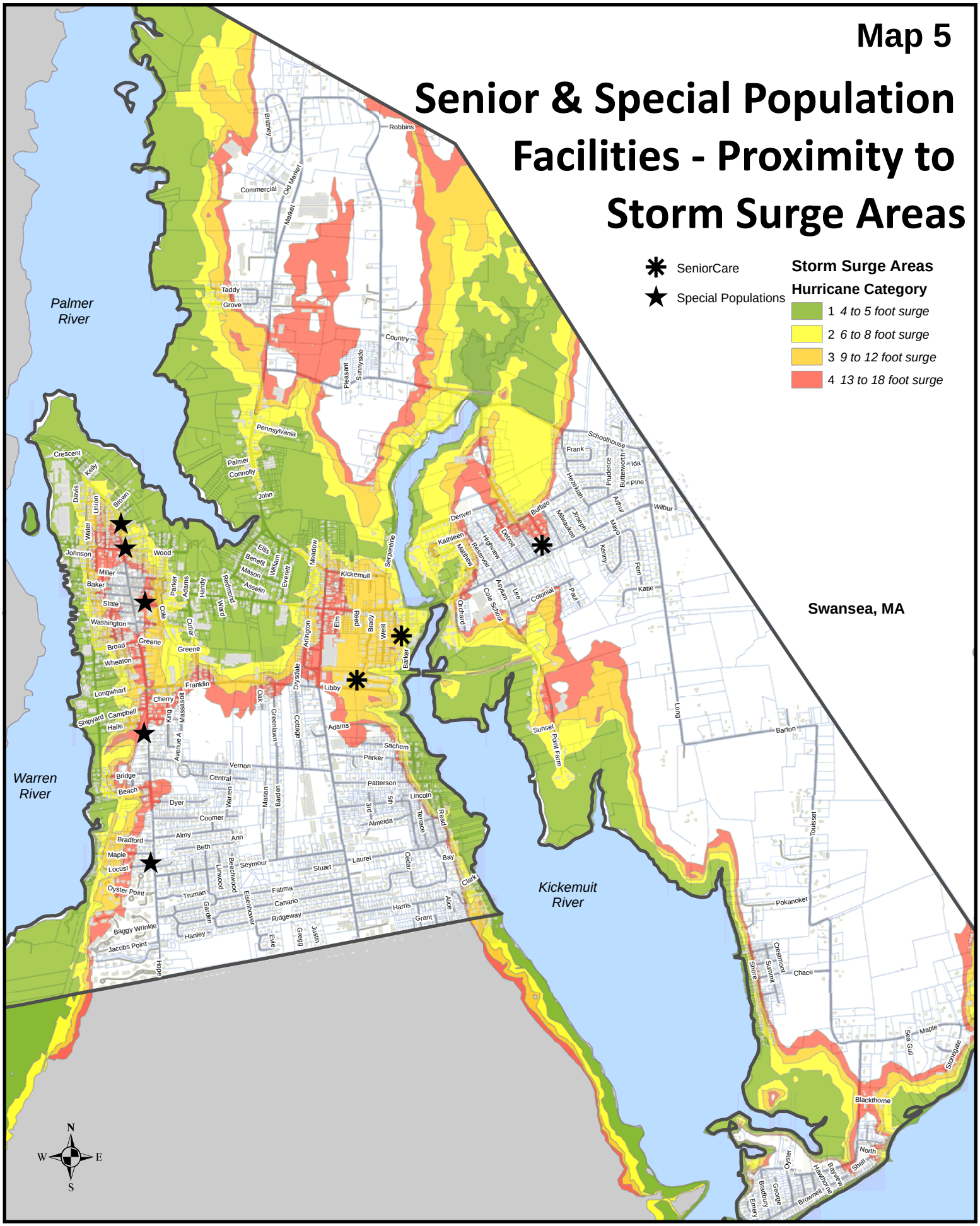


Warren Multi-Hazard Mitigation Plan, 2015
Department of Planning & Community Development

Sources, Town GIS, RIGIS

Map 5

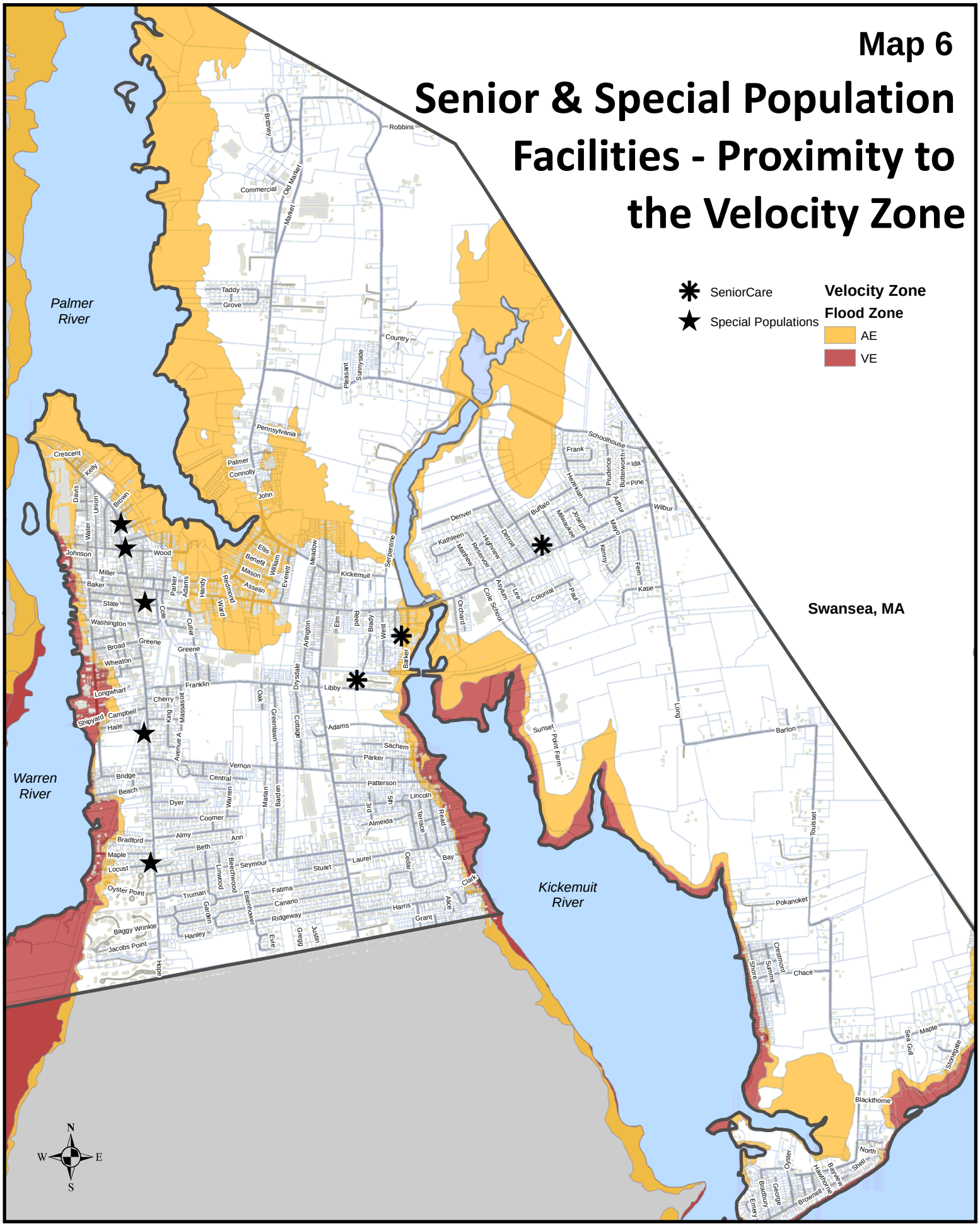
Senior & Special Population Facilities - Proximity to Storm Surge Areas



Sources, Town GIS, RIGIS

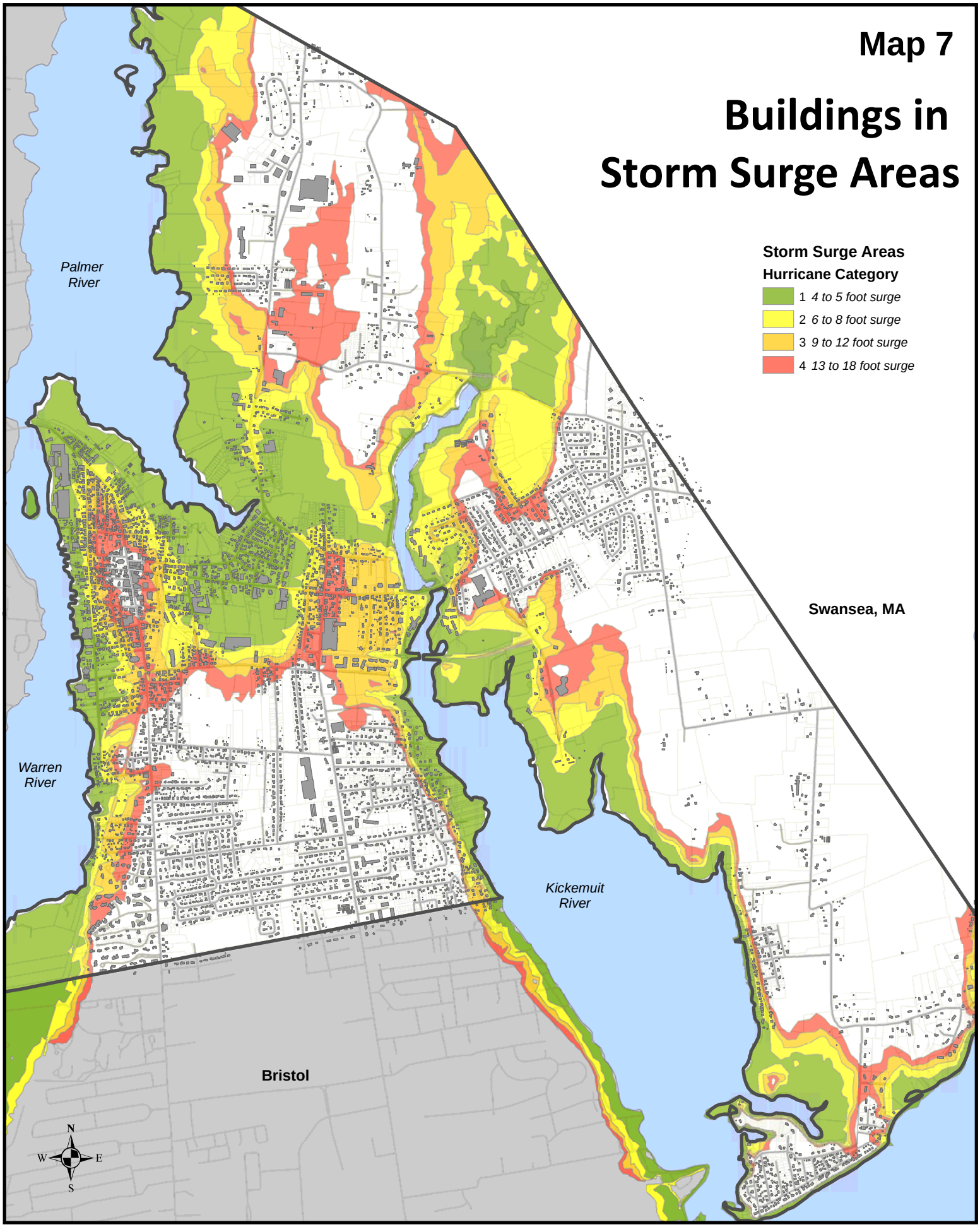
Map 6

Senior & Special Population Facilities - Proximity to the Velocity Zone



Warren Multi-Hazard Mitigation Plan, 2015
Department of Planning & Community Development

Sources, Town GIS, RIGIS

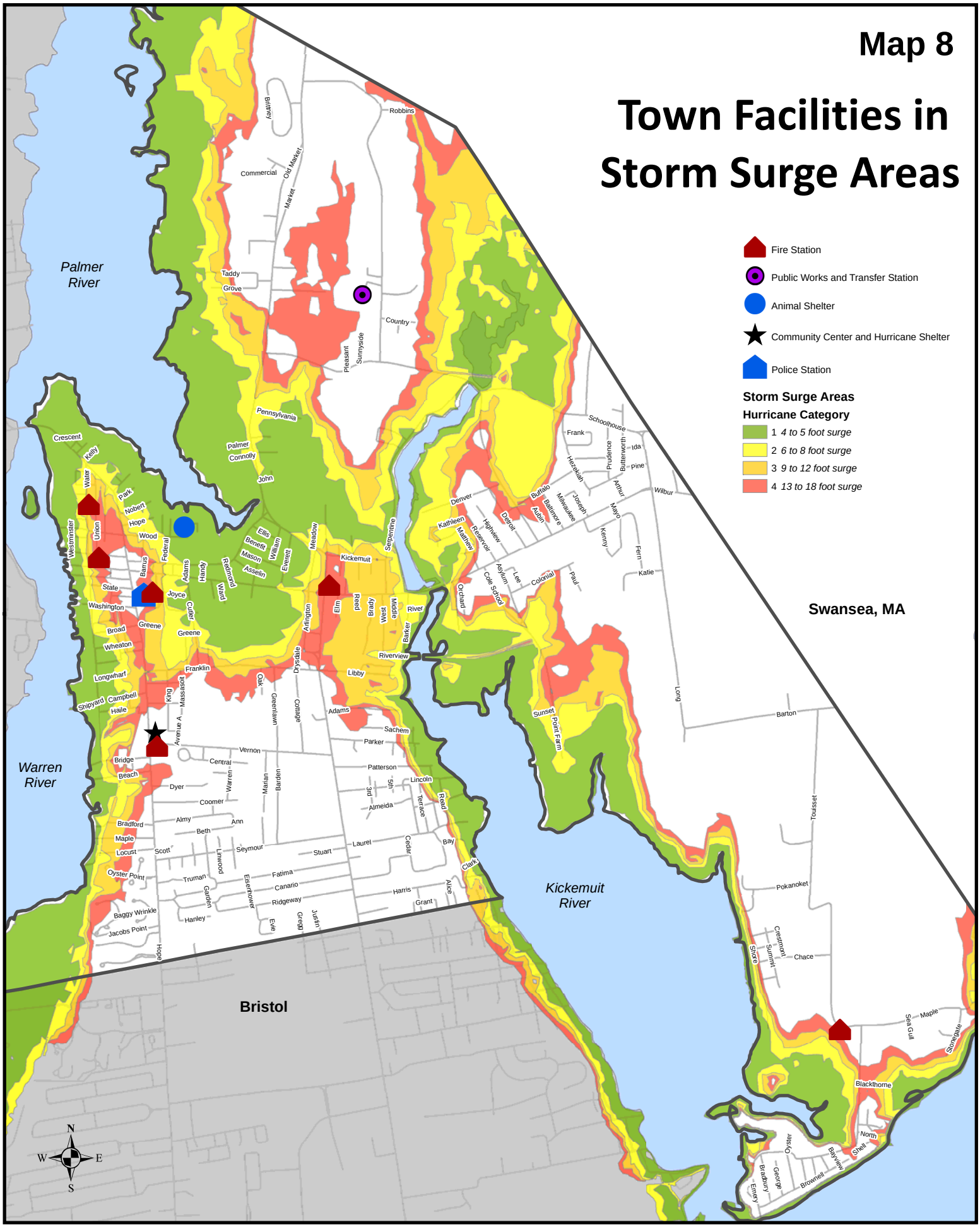


Warren Multi-Hazard Mitigation Plan, 2015
Department of Planning & Community Development

Sources, Town GIS, RIGIS

Map 8

Town Facilities in Storm Surge Areas

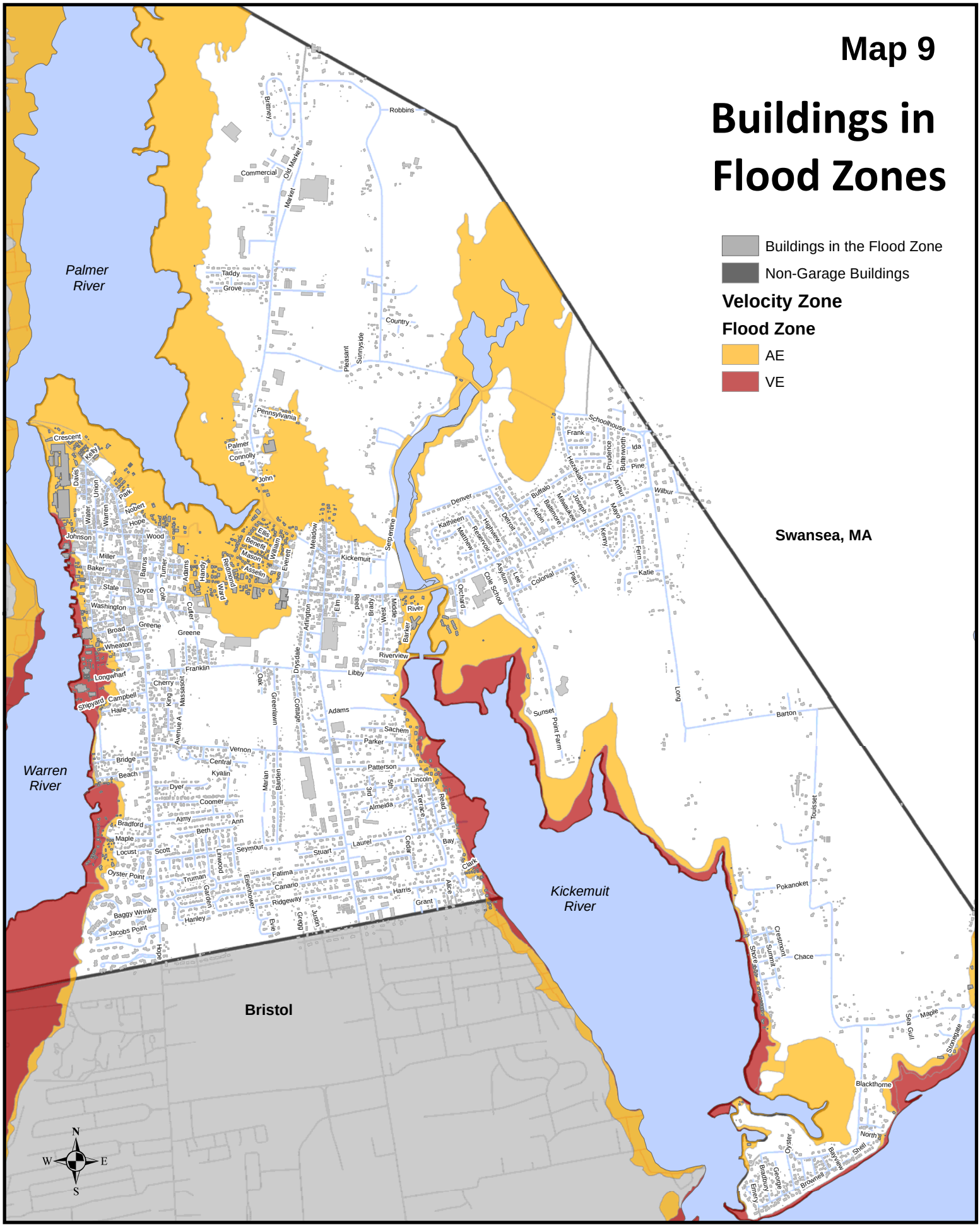


Warren Multi-Hazard Mitigation Plan, 2015
Department of Planning & Community Development

Sources, Town GIS, RIGIS

Map 9

Buildings in Flood Zones

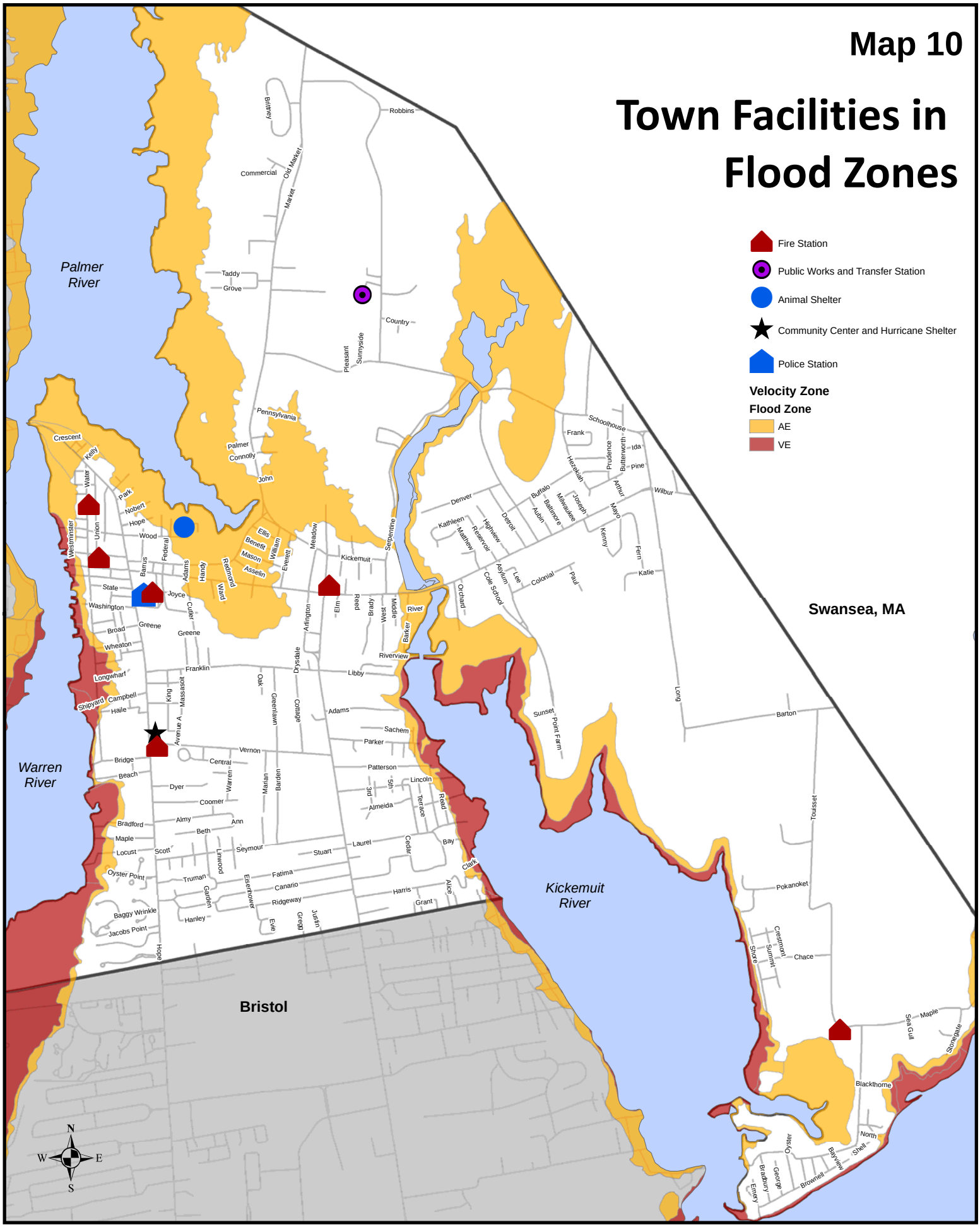


Warren Multi-Hazard Mitigation Plan, 2015
Department of Planning & Community Development

Sources, Town GIS, RIGIS

Map 10

Town Facilities in Flood Zones

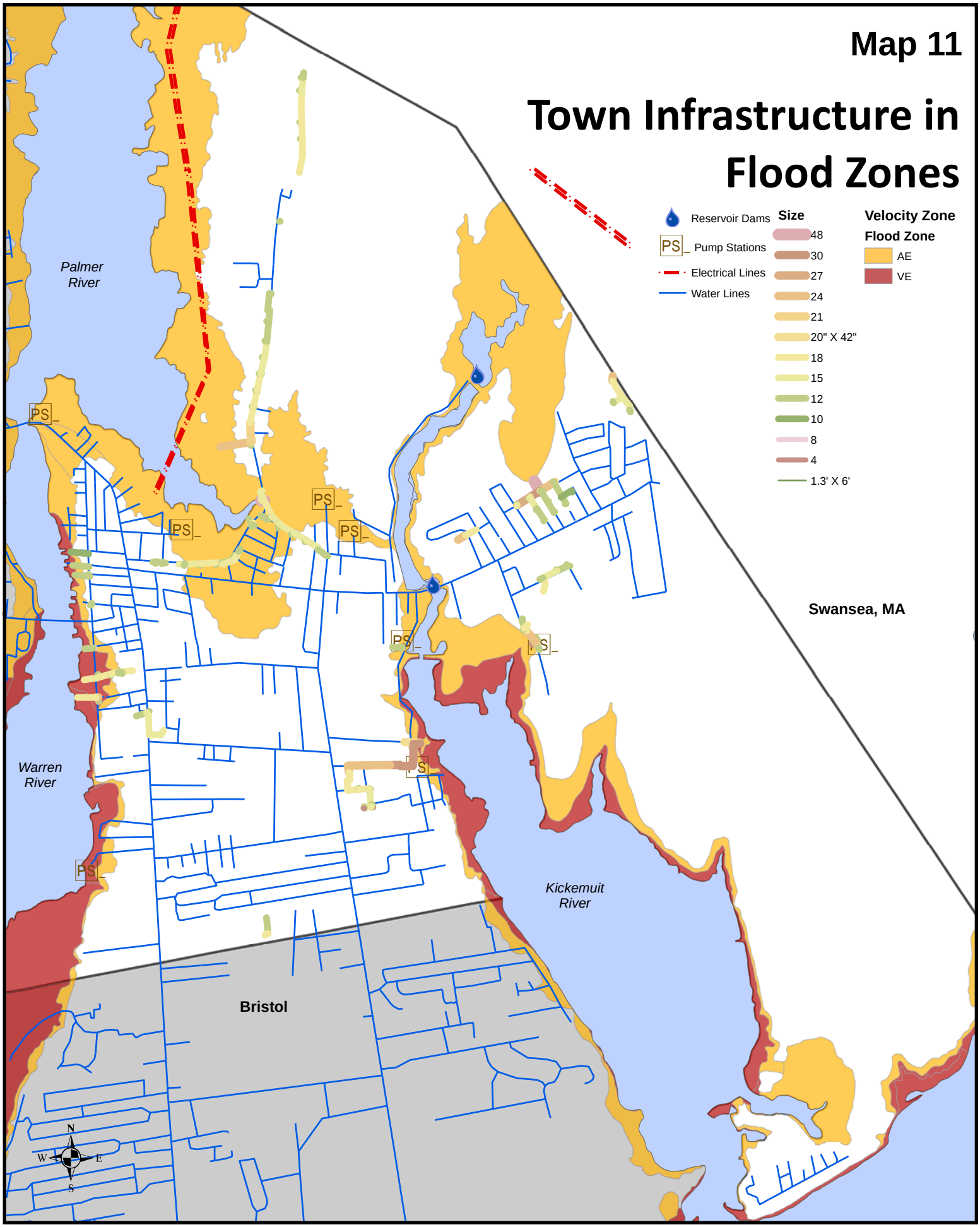


Warren Multi-Hazard Mitigation Plan, 2015
Department of Planning & Community Development

Sources, Town GIS, RIGIS

Map 11

Town Infrastructure in Flood Zones

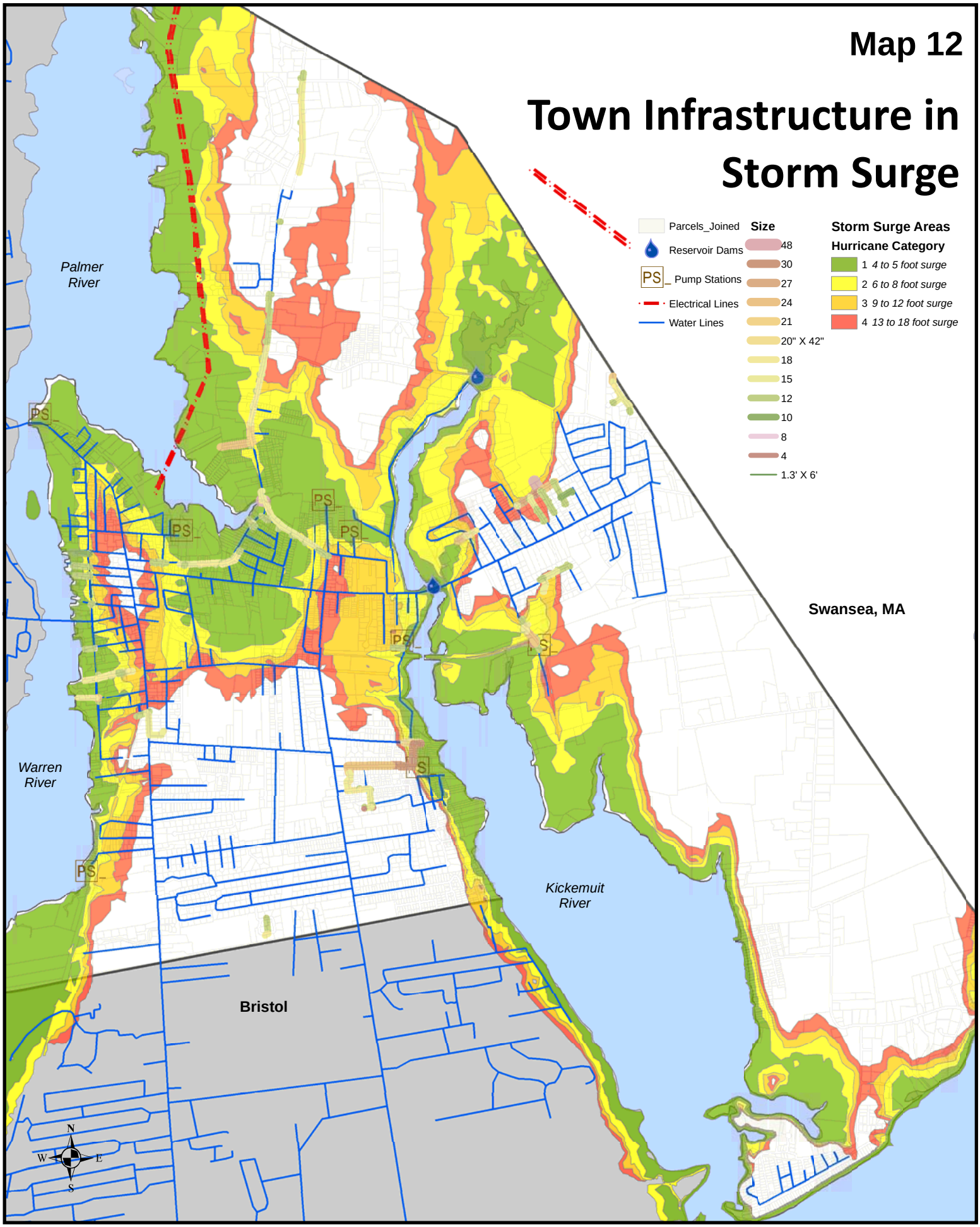


Warren Multi-Hazard Mitigation Plan, 2015
Department of Planning & Community Development

Sources, Town GIS, RIGIS

Map 12

Town Infrastructure in Storm Surge



Sources, Town GIS, RIGIS