SECTION 4

HAZARD IDENTIFICATION AND ANALYSIS

44 CFR Requirement
44 CFR Part 201.6(c)(2)(i): The risk assessment shall include a description of the type, location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

4.1 OVERVIEW

The City of Myrtle Beach is vulnerable to an array of natural hazards that threaten life and property. FEMA's current regulations and interim guidance under the Disaster Mitigation Act of 2000 (DMA 2000) require, at a minimum, an evaluation of a full range of natural hazards.

Upon a review of the full range of natural hazards suggested under FEMA planning guidance, the City of Myrtle Beach Floodplain Management and Hazard Mitigation Planning Committee (FMHMPC) identified a number of hazards that are to be addressed in the City's Floodplain Management and Hazard Mitigation Plan. The City has also decided to include several human-caused hazards in this analysis as well. All of the hazards included were identified through an extensive process that utilized input from FMHMPC members, research of past disaster declarations for the City, review of the City's previous hazard mitigation plan, and a review of the current South Carolina State Hazard Mitigation Plan. Readily available online information from reputable sources such as federal and state agencies was also evaluated to supplement information from these key sources.

This section of the Plan describes the hazards identified by the FMHMPC to pose a risk to people and property in the city. Further, an assessment of risk for each hazard includes background information, location and extent, notable historical occurrences and the probability of future occurrences. When possible, hazard profiles also include specific items noted by members of the FMHMPC as they relate to unique historical or anecdotal hazard information for Myrtle Beach.

The following hazards were identified:

- **Atmospheric**
  - Drought
  - Hailstorm
  - Ice Storm
  - Lightning
  - Northeaster

  - Wind Events
  - Tornado/Waterspout
  - Tropical Storm System/Hurricane

- **Geologic**
  - Earthquake
  - Tidal Wave/Tsunami

- **Hydrologic**
  - Erosion
  - Flood
  - Storm Surge
  - Sea Level Rise

- **Other**
  - Acts of Terror
  - Airplane Crash
  - Hazardous Materials Incident
  - Wildfire

For the 2015 update of this plan, the Floodplain Management and Hazard Mitigation Committee determined that all of the hazards identified in the previous plan were adequate and no additions or subtractions were made to the list of hazards addressed. However, the committee did recommend moving the Sea Level Rise hazard from the "Other" category to the Hydrologic category.

Some of these hazards are considered to be interrelated or cascading (i.e., hurricanes can cause flooding, storm surge and tornadoes), but for preliminary hazard identification purposes these distinct hazards are broken out separately. It should also be noted that some hazards, such as earthquakes or winter storms, may impact a large area yet cause little damage, while other hazards, such as a tornado, may impact a small area yet cause extensive damage. **Table 4.1** provides a brief description of the aforementioned hazards.

Table 4.1: Descriptions of Identified Hazards

Hazard	Description
ATMOSPHERIC	
Drought	A Drought occurs when a prolonged period of less than normal precipitation results in a serious hydrologic imbalance. Common effects of drought include crop failure, water supply shortages, and fish and wildlife mortality. High temperatures, high winds, and low humidity can worsen drought conditions and also make areas more susceptible to wildfire. Human demands and actions have the ability to hasten or mitigate drought-related impacts on local communities.
Hailstorm	Hail is formed when updrafts in thunderstorms carry raindrops into parts of the atmosphere where the temperatures are below freezing.
Ice Storm	An Ice Storm is a winter storm characterized by significant amounts of freezing rain. It is often associated with severe winter storms which may include snow, sleet, freezing rain, or a mix of these wintry forms of precipitation. Ice storms occur when moisture falls and freezes immediately upon impact on trees, power lines, communication towers, structures, roads and other hard surfaces. Winter storms and ice storms can cause widespread power outages, damage property, and result in fatalities and injuries.

Lightning	Lightning is a discharge of electrical energy resulting from the buildup of positive and negative charges within a thunderstorm, creating a “bolt” when the buildup of charges becomes strong enough. This flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit. Lightning rapidly heats the sky as it flashes, but the surrounding air cools following the bolt. (This rapid heating and cooling of the surrounding air causes thunder.) On average, 73 people are killed each year by lightning strikes in the United States.
Northeaster	The Northeaster is a particularly devastating type of coastal storm, named for the winds that blow in from the northeast and drive the storm up the U.S. East Coast alongside the Gulf Stream (a band of warm water that lies off the Atlantic coast). They are caused by the interaction of the jet stream with horizontal temperature gradients and generally occur during the fall and winter months when moisture and cold air are plentiful. Coastal storm events are notorious for producing heavy amounts of rain and snow, producing hurricane-force winds, and creating high surf that potentially causes severe beach erosion and coastal flooding.
Wind Events	Thunderstorms are caused by air masses of varying temperatures meeting in the atmosphere. Rapidly rising warm moist air fuels the formation of thunderstorms. Thunderstorms may occur singularly, in lines, or in clusters. They can move through an area very quickly or linger for several hours. Thunderstorms may result in hail, tornadoes, or wind. Windstorms pose a threat to lives, property, and vital utilities primarily due to the effects of flying debris and can down trees and power lines.
Tornado/Waterspout	A Tornado is a violently rotating column of air that has contact with the ground and is often visible as a funnel cloud. Its vortex rotates cyclonically with wind speeds ranging from as low as 40 mph to as high as 300 mph. Tornadoes are most often generated by thunderstorm activity when cool, dry air intersects and overrides a layer of warm, moist air forcing the warm air to rise rapidly. The destruction caused by tornadoes ranges from light to catastrophic depending on the intensity, size and duration of the storm.
Tropical Storm System/Hurricane	Hurricanes and tropical storms are classified as cyclones and defined as any closed circulation developing around a low-pressure center in which the winds rotate counter-clockwise in the Northern Hemisphere (or clockwise in the Southern Hemisphere) and with a diameter averaging 10 to 30 miles across. When maximum sustained winds reach or exceed 39 miles per hour, the system is designated a tropical storm, given a name, and is closely monitored by the National Hurricane Center. When sustained winds reach or exceed 74 miles per hour the storm is deemed a hurricane. The primary damaging forces associated with these storms are high-level sustained winds, heavy precipitation and tornadoes. Coastal areas are also vulnerable to the additional forces of storm surge, wind-driven waves and tidal flooding which can be more destructive than cyclone wind. The majority of hurricanes and tropical storms form in the Atlantic Ocean, Caribbean Sea and Gulf of Mexico during the official Atlantic hurricane season, which extends from June through November.
GEOLOGIC	
Earthquake	A sudden, rapid shaking of the Earth caused by the breaking and shifting of rock beneath the surface characterizes an Earthquake. This movement forces the gradual building and accumulation of energy. Eventually, strain becomes so great that the energy is abruptly released, causing the shaking at the earth’s surface which we know as an earthquake. Roughly 90 percent of all earthquakes occur at the boundaries where plates meet, although it is possible for earthquakes to occur entirely within plates. Earthquakes can affect hundreds of thousands of square miles; cause damage to property measured in the tens of billions of dollars; result in loss of life and injury to hundreds of thousands of persons; and disrupt the social and economic functioning of the affected area.

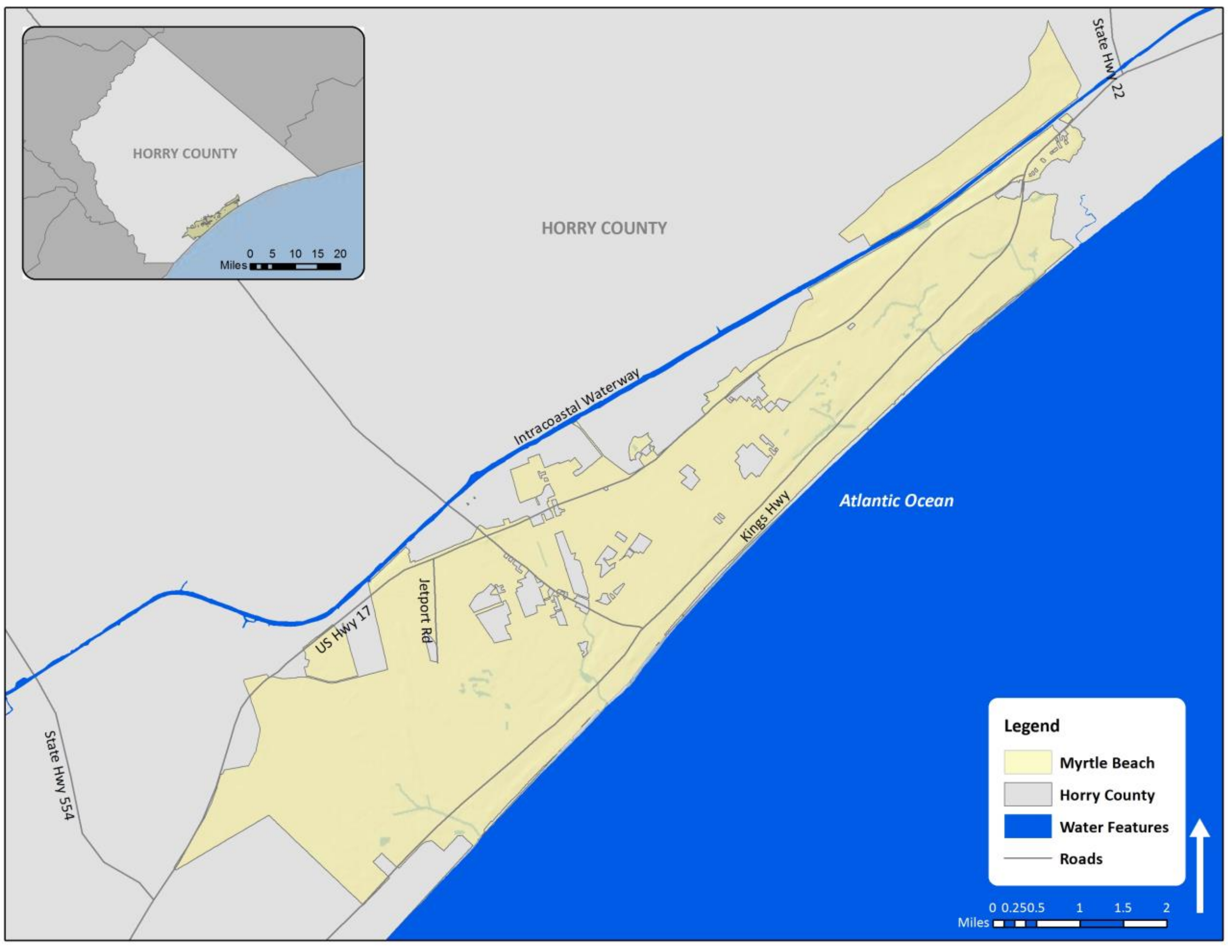
Tidal Wave/Tsunami	A Tsunami is a series of waves generated by an undersea disturbance such as an earthquake or moving plate tectonics. The speed of a tsunami traveling away from its source can range from up to 500 miles per hour in deep water to approximately 20 to 30 miles per hour in shallower areas near coastlines. Tsunamis differ from regular ocean waves in that their currents travel from the water surface all the way down to the sea floor. Wave amplitudes in deep water are typically less than one meter; they are often barely detectable to the human eye. However, as they approach shore, they slow in shallower water, basically causing the waves from behind to effectively "pile up", and wave heights to increase dramatically. As opposed to typical waves which crash at the shoreline, tsunamis bring with them a continuously flowing 'wall of water' with the potential to cause devastating damage in coastal areas located immediately along the shore.
HYDROLOGIC	
Erosion	Erosion is a landward displacement of a shoreline caused by the forces of waves and currents. Coastal erosion is measured as the rate of change in the position or horizontal displacement of a shoreline over a period of time. It is generally associated with episodic events such as hurricanes and tropical storms, nor'easters, storm surge and coastal flooding but may also be caused by human activities that alter sediment transport. Construction of shoreline protection structures can mitigate the hazard, but may also exacerbate it under some circumstances.
Flood	The accumulation of water within a water body which results in the overflow of excess water onto adjacent lands, usually floodplains. The floodplain is the land adjoining the channel of a river, stream ocean, lake or other watercourse or water body that is susceptible to flooding. Most floods fall into the following three categories: riverine flooding, coastal flooding, or shallow flooding (where shallow flooding refers to sheet flow, ponding and urban drainage). Coastal flooding is exacerbated during high tide events.
Storm Surge	Storm surge occurs when the water level of a tidally influenced body of water increases above the normal astronomical high tide, and are most common in conjunction with coastal storms with massive low-pressure systems with cyclonic flows such as hurricanes, tropical storms and nor'easters. The low barometric pressure associated with these storms cause the water surface to rise, and storms making landfall during peak tides have surge heights and more extensive flood inundation limits. Storm surges will inundate coastal floodplains by dune overwash, tidal elevation rise in inland bays and harbors, and backwater flooding through coastal river mouths. The duration of a storm is the most influential factor affecting the severity and impact of storm surges.
Sea Level Rise	According to NOAA, sea level rise is defined as a mean rise is sea level. As the ocean warms, sea water expands and continental ice sheets melt, thus inundating areas with sea water that were previously above sea level.
OTHER	
Acts of Terror	Terrorism is defined by FEMA as, "the use of force or violence against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion, or ransom." Terrorist acts may include assassinations, kidnappings, hijackings, bomb scares and bombings, cyber-attacks (computer-based), and the use of chemical, biological, nuclear and radiological weapons.
Airplane Crash	An airplane crash endangers the passengers onboard the craft as well as people and property at the crash site. The extent of an airplane crash risk is based on many factors including the size of the aircraft and location of crash site. For example, a large commuter jet crashing into a heavily populated urban area will likely have far greater damages than a personal aircraft crashing in a rural area.
Hazardous Materials Incident	Hazardous material (HAZMAT) incidents can apply to fixed facilities as well as mobile, transportation-related accidents in the air, by rail, on the nation's highways and on the water. HAZMAT incidents consist of solid, liquid and/or gaseous contaminants that are released from fixed or mobile containers, whether by accident or by design as with an intentional terrorist attack. A HAZMAT incident can last hours to days, while some chemicals can be corrosive or otherwise damaging over longer periods of time. In addition to the primary release, explosions and/or fires can result from a release, and contaminants can be extended beyond the initial area by persons, vehicles, water, wind and possibly wildlife as well.

Wildfire	An uncontrolled fire burning in an area of vegetative fuels such as grasslands, brush, or woodlands defines wildfire. Heavier fuels with high continuity, steep slopes, high temperatures, low humidity, low rainfall, and high winds all work to increase risk for people and property located within wildfire hazard areas or along the urban/wildland interface. Wildfires are part of the natural management of forest ecosystems, but most are caused by human factors. Over 80 percent of forest fires are started by negligent human behavior such as smoking in wooded areas or improperly extinguishing campfires. The second most common cause for wildfire is lightning.

4.2 STUDY AREA

Figure 4.1 provides a base map for the City of Myrtle Beach hazard risk assessment. The map depicts the Myrtle Beach boundary as of 2015.

Figure 4.1: Myrtle Beach Base Map



Atmospheric Hazards

4.3 DROUGHT

4.3.1 Background

Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of a natural reduction in the amount of precipitation expected over an extended period of time, usually a season or more in length. High temperatures, high winds, and low humidity can exacerbate drought conditions. In addition, human actions and demands for water resources can hasten drought-related impacts.

Droughts are typically classified into one of four types: 1) meteorological, 2) hydrologic, 3) agricultural, or 4) socioeconomic. **Table 4.2** presents definitions for these types of drought.

Table 4.2 Drought Classification Definitions

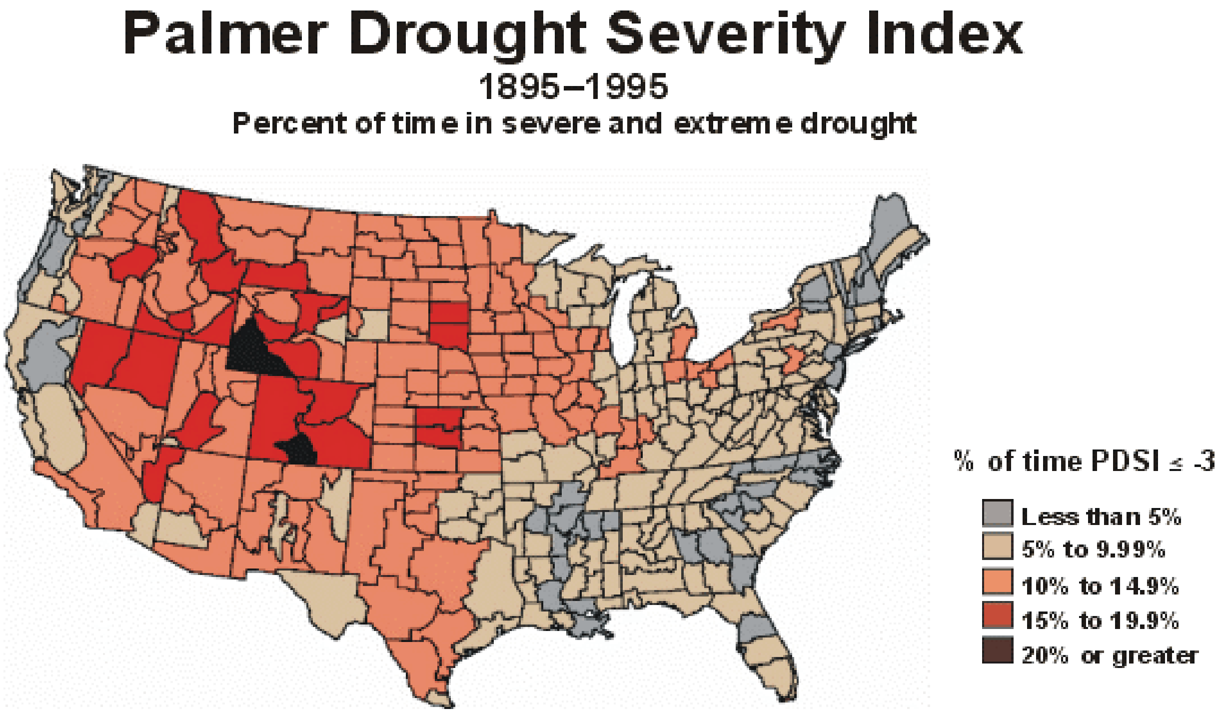
Meteorological Drought	The degree of dryness or departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales.
Hydrologic Drought	The effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels.
Agricultural Drought	Soil moisture deficiencies relative to water demands of plant life, usually crops.
Socioeconomic Drought	The effect of demands for water exceeding the supply as a result of a weather-related supply shortfall.

Source: Multi-Hazard Identification and Risk Assessment: A Cornerstone of the National Mitigation Strategy, FEMA

Droughts are slow-onset hazards, but, over time, can have very damaging affects to crops, municipal water supplies, recreational uses, and wildlife. If drought conditions extend over a number of years, the direct and indirect economic impact can be significant.

The Palmer Drought Severity Index (PDSI) is based on observed drought conditions and range from -0.5 (incipient dry spell) to -4.0 (extreme drought). Evident in **Figure 4.2**, the Palmer Drought Severity Index Summary Map for the United Stated, drought affects most areas of the United States, but is less severe in the Eastern United States.

Figure 4.2: Palmer Drought Severity Index Summary Map for the United States



Source: National Drought Mitigation Center

4.3.2 Location and Spatial Extent

Drought typically covers a large area and cannot be confined to any geographic or political boundaries. According to the Palmer Drought Severity Index (Figure 4.2), South Carolina has a relatively low risk for drought hazard. However, local areas may experience much more severe and/or frequent drought events than what is represented on the Palmer Drought Severity Index map. Further, it is assumed that the City of Myrtle Beach would be uniformly exposed to drought, making the spatial extent potentially widespread. It is also notable that drought conditions typically do not cause significant damage to the built environment.

4.3.3 Historical Occurrences

Data from the National Climate Data Center (NCDC) was used to ascertain historical drought events in Myrtle Beach. According to NCDC, five (5) drought events have affected the City of Myrtle Beach between 1993 and 2014, as shown in **Table 4.3**[1]:

[1] These drought events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional drought conditions have affected the City of Myrtle Beach. As additional local data becomes available, this hazard profile will be amended.

Table 4.3: Historical Drought Impacts

Location	Date	Deaths/ Injuries	Property Damage (2009 dollars)	Description
Across South Carolina	10/01/1993	0/0	$0	*Not Available*
Darlington, Dillon, Florence, Georgetown, Horry, Marion, Marlboro, and Williamsburg Counties	08/19/1999	0/0	$0	*Not Available*
Darlington, Dillon, Florence, Georgetown, Horry, Marion, Marlboro, and Williamsburg Counties	11/15/2001	0/0	$0	The South Carolina Drought Response Committee declared many parts of the state in a moderate drought. For the year, the state received well below the normal rainfall, averaging 9-12 inches below normal. The below normal rainfall actually began in 1999, and since that time the Pee Dee and the Grand Strand area are about 20 inches below normal.
Darlington, Dillon, Florence, Georgetown, Horry, Marion, Marlboro, and Williamsburg Counties	06/01/2002	0/0	$0	*Not Available*
Darlington, Dillon, Florence, Georgetown, Horry, Marion, Marlboro, and Williamsburg Counties	11/ 2007 - 01/2008	0/0	$0	*Not Available*
Coastal Horry (Zone)	07/01/2011	0/0	$0	*Not Available*

Source: NCDC

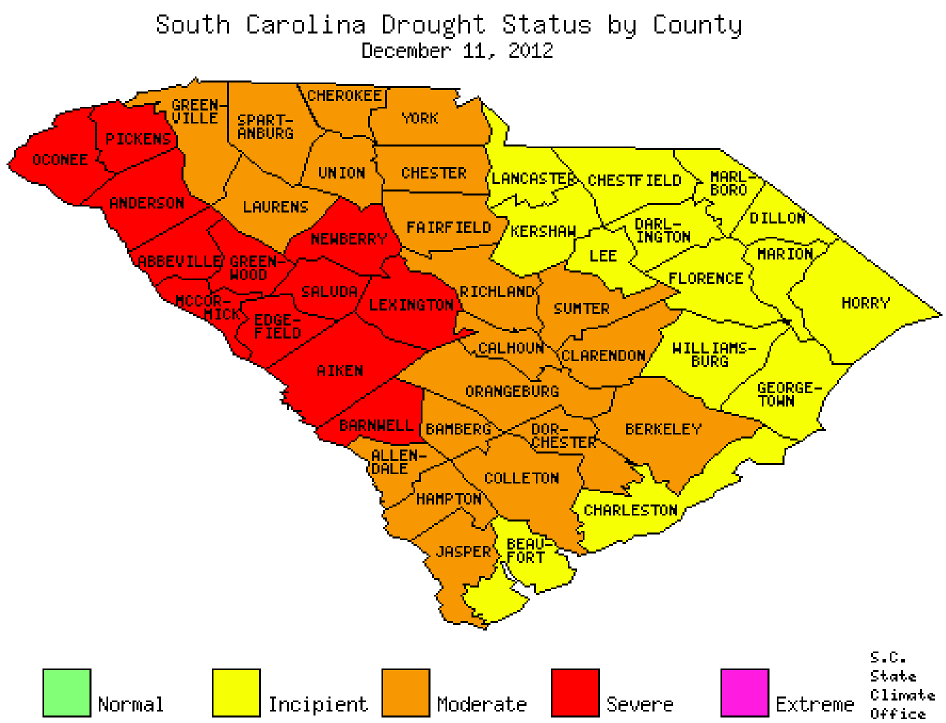
According to S.C. Climatology Office data from 2006-2015, the highest level of drought classification reached in Horry County was Severe in 2007, 2008, and 2011. **Table 4.4** shows the highest level of drought classification reached in each year for Horry County since 2006. **Figure 4.3** is also presented as an example of how the data is captured on a county by county level across the state.

Table 4.4: Highest Drought Levels Reached in Horry County Annually

Year	Horry County
2006	NORMAL
2007	**SEVERE**
2008	**SEVERE**
2009	**INCIPIENT**
2010	NORMAL
2011	**SEVERE**
2012	**MODERATE**
2013	**INCIPIENT**
2014	**INCIPIENT**
2015	**INCIPIENT**

Source: S.C. State Climatology Office

Figure 4.3: County by County Drought Level Example



Source: S.C. State Climatology Office

4.3.4 Probability of Future Occurrences

It is assumed that all of the City of Myrtle Beach has a high probability of a future drought event, so future occurrences are considered likely.

4.4 HAILSTORMS

4.4.1 Background

Hailstorms are a potentially damaging outgrowth of severe thunderstorms. Early in the developmental stages of a hailstorm, ice crystals form within a low-pressure front due to the rapid rising of warm air into the upper atmosphere and the subsequent cooling of the air mass. Frozen droplets gradually accumulate on the ice crystals until they develop to a sufficient weight and fall as precipitation. Hail typically takes the form of spheres or irregularly-shaped masses greater than 0.75 inches in diameter. The size of hailstones is a direct function of the size and severity of the storm. High velocity updraft winds are required to keep hail in suspension in thunderclouds. The strength of the updraft is a function of the intensity of heating at the Earth's surface. Higher temperature gradients relative to elevation above the surface result in increased suspension time and hailstone size.

4.4.2 Location and Spatial Extent

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. Thunderstorms are considered frequent occurrences throughout Myrtle Beach and coastal South Carolina. It is assumed that all of Myrtle Beach is uniformly exposed to severe thunderstorms; therefore, all areas of the city are equally exposed to hail which may be produced by such storms.

4.4.3 Historical Occurrences

According to the National Climatic Data Center, there have been 295 hail events in Horry County since 1956, 21 of which have affected the City of Myrtle Beach.[2] **Table 4.5** provides detailed information about these recorded events, which caused over $10,000 in reported property damages. Hail ranged in size from 0.75 inches to 1.75 inches in diameter during these events. It should be noted that hail is notorious for causing substantial damage to cars, roofs, and other areas of the built environment, so it is likely that damages are greater than the reported value. The planning team especially noted that they felt structural damage reported by NCDC was seemed very low and that historic dollar damages was much closer to millions of dollars of historic damage.

Table 4.5: Historical Hailstorm Impacts

Location	Date	Magnitude (inches)	Deaths/ Injuries	Property Damage (2014 dollars)	Description
Myrtle Beach	05/04/1975	1.75 in.	0/0	$0	*Not Available*
Myrtle Beach	6/10/1982	1.75 in.	0/0	$0	*Not Available*
Myrtle Beach	06/03/1988	0.75 in.	0/0	$0	*Not Available*
Myrtle Beach	05/29/1996	0.88 in.	0/0	$0	Nickel-size hail at Springmaid Pier.

[2] These hail events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional hail events have affected the City of Myrtle Beach. As additional local data becomes available, this hazard profile will be amended.

Location	Date	Magnitude (inches)	Deaths/ Injuries	Property Damage (2014 dollars)	Description
Myrtle Beach	05/25/2000	0.75 in.	0/0	$2,748	Horry Emergency Manager reported dime-size hail in Myrtle Beach. Storm moved to Socastee, blowing off shingles on a roof and downing several trees that were 6-8 inches in diameter.
Myrtle Beach	08/13/2000	0.88 in.	0/0	$0	The agricultural center reported nickel size hail. Severe thunderstorm winds were also suspected as a ham radio operator reported large tree limbs down across Kings Highway.
Myrtle Beach	08/29/2001	1.00 in.	0/0	$0	Public reported quarter size hail.
Myrtle Beach	04/03/2006	0.75 in.	0/0	$0	*Not Available*
Myrtle Beach	04/03/2006	1.00 in.	0/0	$0	*Not Available*
Myrtle Beach	05/14/2006	1.75 in.	0/0	$0	Golf ball size hail was reported.
Myrtle Beach	05/26/2006	0.75 in.	0/0	$0	Penny size hail near the intersection of US 17 Bypass and SR 544.
Myrtle Beach	6/1/2009	0.75 in.	0/0	$0	*Not Available*
Myrtle Beach	6/1/2009	0.88 in.	0/0	$0	*Not Available*
Myrtle Beach	6/26/2009	0.75 in.	0/0	$0	*Not Available*
Myrtle Beach	7/5/2012	1.00 in.	0/0	$1,289	*Not Available*
Myrtle Beach	5/23/2014	0.75 in.	0/0	$200	*Not Available*
Myrtle Beach	5/23/2014	1.75 in.	0/0	$2,000	*Not Available*
Myrtle Beach	5/23/2014	1.75 in.	0/0	$2,000	*Not Available*
Myrtle Beach	5/23/2014	1.75 in.	0/0	$2,000	*Not Available*
Myrtle Beach	5/23/2014	1.00 in.	0/0	$500	*Not Available*
Myrtle Beach	7/28/2014	1.00 in.	0/0	$250	*Not Available*

Source: NCDC

4.4.4 Probability of Future Occurrences

Because severe thunderstorm events will remain a very frequent occurrence for the City of Myrtle Beach, the probability of future occurrences of hail is highly likely. It can be expected that future hail events will continue to cause minor damages to property and vehicles throughout the city.

4.5 ICE STORM

4.5.1 Background

An ice storm is a type of winter storm that is characterized by significant amounts of freezing rain. Ice storms are a result of cold air damming (CAD). CAD is a shallow, surface-based layer of relatively cold, stably-stratified air entrenched against the eastern slopes of the Appalachian Mountains. With warmer air above, falling precipitation in the form of snow melts, then becomes either supercooled (liquid below the melting point of water) or re-freezes. In the former case, supercooled droplets can freeze on impact (freezing rain), while in the latter case, the re-frozen water particles are ice pellets (or sleet). When freezing rain falls onto a surface with a temperature below freezing, it forms a glaze of ice, creating very hazardous conditions. Sleet pellets usually bounce when hitting a surface and do not stick to objects; however, sleet can accumulate like snow.

Even small accumulations of ice can cause a significant hazard, especially on roadways, power lines and trees. An ice storm has an immediate impact on power lines, communication towers, roadways and other hard surfaces. Communications and power can be disrupted for days as a result of an ice storm event.

Winter storms are also discussed in this section because the two hazards are so closely related. A winter storm can range from a moderate snow over a period of a few hours to blizzard conditions with blinding wind-driven snow that lasts for several days. Many winter storms are accompanied by low temperatures and heavy and/or blowing snow, which can severely impair visibility and disrupt commerce and transportation. Occasionally heavy snow might also cause significant property damages, such as roof collapses on older buildings.

4.5.2 Location and Spatial Extent

Nearly the entire continental United States is susceptible to ice and winter storms. Some ice storms and winter storms might be large enough to affect several states, while others might affect only limited, localized areas. The degree of exposure typically depends on the normal expected severity of local winter weather. Myrtle Beach is not accustomed to severe winter weather conditions, and rarely receives winter weather. However, the entire city has uniform exposure to the event.

4.5.3 Historical Occurrences

According to the National Climatic Data Center, there have been a total of six (6) recorded winter storm events in Myrtle Beach since 2000 (**Table 4.6**).[3] Over $256,000 in property damages resulted from these winter storm events. Additionally, the planning team noted that the largest winter storm event to impact the city was in 1989 when a storm system dropped more than 15 inches of snow.

[3] These ice and winter storm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional winter storm conditions have affected the City of Myrtle Beach. As additional local data becomes available, this hazard profile will be amended.

Table 4.6: Historical Ice Storm Events

Location	Date	Type of Event	Deaths/ Injuries	Description
Countywide	01/18/2000	Freezing Rain	0/0	Although liquid accumulations were only around 0.10 inch, freezing rain and a bit of snow fell across the area during the early morning hours accumulating mostly on trees and grassy surfaces. Bridges and overpasses were slick and hazardous during the morning commute.
Countywide	01/24/2000	Winter Storm	0/0	As a winter low pressure system intensified along the coast, rain turned to snow inland on the night of the 24th and snow spread to the coast during the early morning of the 25th. Accumulations ranged from around 10 inches in parts of Marlboro County to 5 to 6 inches in the coastal counties. Schools and businesses were closed by this rare snow event.
Countywide	01/02/2002	Winter Storm	0/0	Low pressure formed in the Gulf of Mexico the morning of January 2nd and moved up the eastern seaboard. Moisture moved north, overrunning cold high pressure, setting up a wintery mix for North and South Carolina. The precipitation began as snow over South Carolina that afternoon, and expanded to include North Carolina later that afternoon. The precipitation changed to freezing rain and sleet, then to rain over coastal sections of North and South Carolina that evening and continued through the morning of January 3rd. As the the low pressure center continued to track north, cold air wrapped around the system, changing the precipitation back to all snow by midday on January 3rd, and continued until the snow tapered off by early morning on January 4th. The snowfall totals were heaviest over portions of Darlington, Marlboro, and Robeson counties, where between 6 to 8 inches fell, with some sleet mixed in. Along coastal counties, between 1 and 3 inches of snow occurred, with around a half inch of sleet and freezing rain. There were numerous traffic accidents reported, although there was no information on injuries. There were over 1500 traffic accidents reported in South Carolina alone. The freezing rain from the storm forced many trees and large branches to snap, causing numerous power outages around the area. More than 25,000 customers were without power in Horry, Georgetown, and Brunswick counties. Secondary roads in most areas proved treacherous, but road crews managed to keep highways and primary roads open. Many businesses and schools were closed on January 3rd and 4th, including 64,000 state workers.

Countywide	01/26/2004	Ice Storm	0/0	Another episode of frozen precipitation occurred on the heels of the storm of January 25th, bringing more freezing rain and sleet to areas that already had over a quarter inch of ice still in the trees. The total ice accumulations ranged from a trace near the coast to as much as three quarters of an inch over interior sections. The weight of the ice caused major power outages from falling limbs, as well as significant structural damage to many homes. The state declared a forest disaster for the first time in two years. There was some ice accumulation on the roads, especially on bridges and overpasses, with numerous traffic accidents reported. Many residences were without power for over a week. Monetary damages totaled into the millions per county in some parts of South Carolina, due to cleanup of debris, utility expenses, and home repair.
Countywide	1/28/2014	Winter Storm	0/0	*Not Available*
Countywide	2/11/2014	Winter Storm	0/0	*Not Available*

Source: NCDC

4.5.4 Probability of Future Occurrences

Winter storm events will remain a possible occurrence in Myrtle Beach, and the probability of future occurrences is certain though not necessarily annually. The impact of snow and ice storms may overwhelm city capabilities and cause major disruptions to transportation, commerce and electrical power. However, large scale property damages and/or threats to human life and safety are not expected.

4.6 LIGHTNING

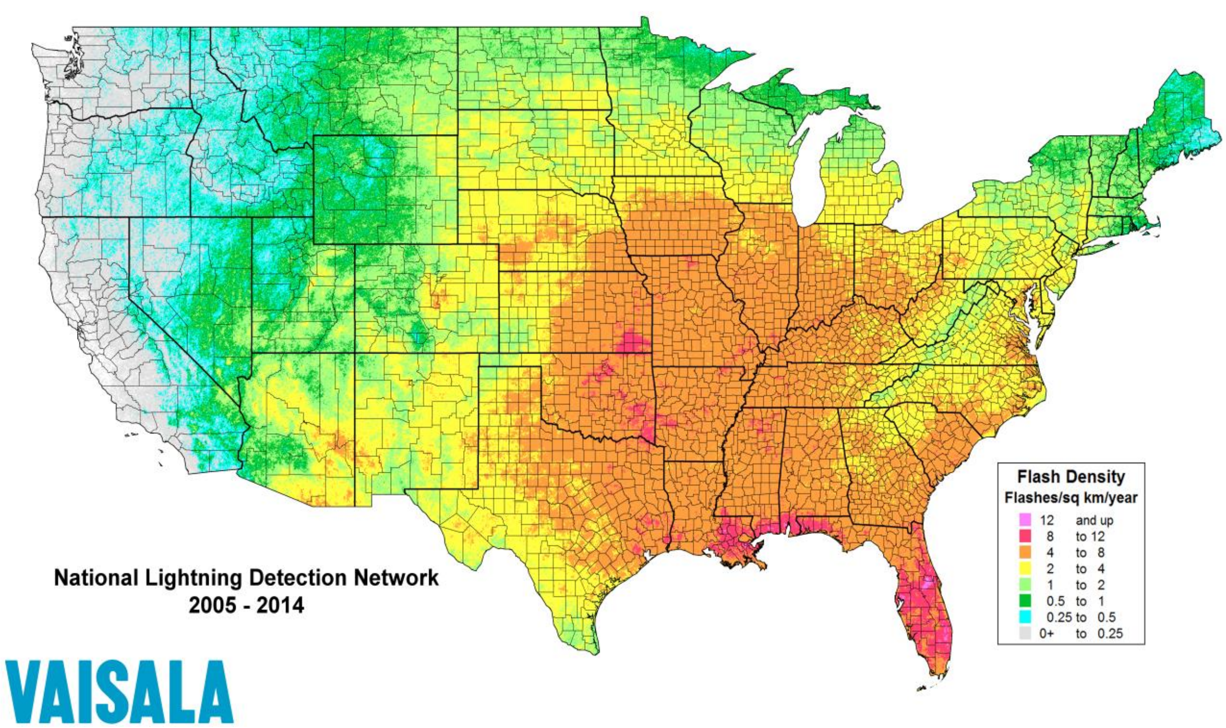
4.6.1 Background

Lightning is a discharge of electrical energy resulting from the buildup of positive and negative charges within a thunderstorm, creating a “bolt” when the buildup of charges becomes strong enough. This flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit. Lightning rapidly heats the sky as it flashes but the surrounding air cools following the bolt. This rapid heating and cooling of the surrounding air causes the thunder which often accompanies lightning strikes. While most often affiliated with severe thunderstorms, lightning may also strike outside of heavy rain and might occur as far as 10 miles away from any rainfall.

According to FEMA, lightning injures an average of 300 people and kills 80 people each year in the United States. Direct lightning strikes also have the ability to cause significant damage to buildings, critical facilities and infrastructure largely by igniting a fire. Lightning is also responsible for igniting wildfires that can result in widespread damages to property.

The City of Myrtle Beach is located in a region of the country that is particularly susceptible to lightning strike. **Figure 4.4** shows a lightning flash density map for the years 2005-2014 based upon data provided by Vaisala’s U.S. National Lightning Detection Network (NLDN®). This map demonstrates that Myrtle Beach is located in an area that generally experiences 4 to 8 flashes per square kilometer per year.

Figure 4.4: Lightning Flash Density in the United States



Source: Vaisala U.S. National Lightning Detection Network

4.6.2 Location and Spatial Extent

It is assumed that all of Myrtle Beach is uniformly exposed to lightning. Lightning occurs randomly, therefore it is impossible to predict where and with what frequency it will strike. It is assumed that all of Myrtle Beach is uniformly exposed to lightning which strikes in very small, specific geographic areas.

4.6.3 Historical Occurrences

According to the National Climatic Data Center, there have been a total of ten (10) recorded lightning events in the City of Myrtle Beach since 1995.[4] These events resulted in over $390,000 (2014 dollars) in damages, as listed in **Table 4.7**.

Table 4.7: Historical Lightning Impacts

Location	Date	Deaths/ Injuries	Property Damage (2014 dollars)	Description
Lakewood Camping Resort	06/25/1995	0/1	$0	Lifeguard at Lakewood Camping Resort south of Myrtle Beach was struck by lightning while clearing beach ahead of an approaching thunderstorm. He was revived due to prompt medical attention from a person nearby. Several people near the lifeguard reported tingling sensations when the lifeguard was hit.
Myrtle Beach	06/25/1995	0/1	$0	A lifeguard was injured by lightning.
Myrtle Beach	06/09/1996	0/0	$0	Lightning caused power outages affecting Santee Cooper Electric customers for up to an hour.
Myrtle Beach	06/03/2001	0/0	$26,729	Official reported that lightning struck a home on North Ocean Blvd, causing moderate fire and water damage.
Myrtle Beach	06/21/2001	0/0	$267,288	Lightning ignited a fire at an apartment complex. Residents in the building's 14 apartments were forced to relocate after an Horry County code enforcer deemed the building uninhabitable.
Myrtle Beach	07/20/2002	0/0	$39,462	Lightning caused a fire at the Chuck Wagon Restaurant on Kings Highway.
Myrtle Beach	07/06/2006	0/0	$5,866	Lightning struck an ambulance, disabling the vehicle.
Myrtle Beach	07/15/2006	0/0	$29,332	A barn was heavily damaged due to fire.
Myrtle Beach	07/10/2008	0/0	$21,991	Lightning started fires in two homes in Carolina Forest.
Myrtle Beach	7/29/2012	0/0	$0	A man was in an open garage on 4091 Coyledom Ct in Myrtle Beach. He was on an aluminum ladder and was struck in the hand by lightning. He was treated and released at a local hospital.

Source: NCDC

[4] These lightning events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional lightning events have occurred in the City of Myrtle Beach. As additional local data becomes available, this hazard profile will be amended.

4.6.4 Probability of Future Occurrences

According to Vaisala's National Lightning Detection Network, Myrtle Beach is located in an area of the country that experienced an average of 4-8 lightning flashes per square kilometer per year between 2005 and 2014. Given this regular frequency of occurrence, it can be expected that future lightning events will continue to threaten life and cause minor property damages throughout the city. Therefore, the probability of occurrence for future lightning events in the City of Myrtle Beach is highly likely.

4.7 NORTHEASTER

4.7.1 Background

The Northeaster is a particularly devastating type of coastal storm, named for the winds that blow in from the northeast and drive the storm up the U.S. East Coast alongside the Gulf Stream (a band of warm water that lies off the Atlantic coast). They are caused by the interaction of the jet stream with horizontal temperature gradients and generally occur during the fall and winter months when moisture and cold air are plentiful. Coastal storm events, such as Northeasters, are notorious for producing heavy amounts of rain and snow, hurricane-force winds, and high surf that causes severe beach erosion and coastal flooding.

The potential damage of a Northeaster is similar to a hurricane or tropical storm system with the added risk of hail and snow, thereby threatening property and life with severe winds and flooding.

4.7.2 Location and Spatial Extent

Northeasters affect the entire east coast of the United States and are thus a threat to the South Carolina coast. Therefore, the City of Myrtle Beach has uniform risk to the Northeaster hazard.

4.7.3 Historical Occurrences

December 1986:
This Northeaster reportedly had winds up to 40 miles per hour and waves 10 feet above sea level.

January 1 & 2, 1987
This Northeaster occurred less than a month after the previous storm, and caused $14.3 million in damages (2014 dollars) in Horry County. The National Weather Service reported it as the worst storm in over a decade.

March 1993:
This Northeaster occurred during the annual Can-Am fest so it had a definite impact on the local economy. The exact monetary losses were not documented at the time but there has since been a methodology developed that can determine such losses should another event such as this one occur.

It should also be noted that many of the repetitive loss properties that have been identified in the Flood section of this plan are considered repetitive loss properties because of flooding caused by recent northeaster events.

4.7.4 Probability of Future Occurrences

The probability of a Northeaster occurring in Myrtle Beach is possible.

4.8 WIND EVENTS

4.8.1 Background

Severe thunderstorms are common throughout South Carolina and occur throughout most of the year. Thunderstorms can produce a variety of accompanying hazards including wind (discussed here), hail, and lightning.[5] Although thunderstorms generally affect a small area, they are very dangerous may cause substantial property damage.

Three conditions need to occur for a thunderstorm to form. First, it needs moisture to form clouds and rain. Second, it needs unstable air, such as warm air that can rise rapidly (this often referred to as the "engine" of the storm). Third, thunderstorms need lift, which comes in the form of cold or warm fronts, sea breezes, mountains, or the sun's heat. When these conditions occur simultaneously, air masses of varying temperatures meet, and a thunderstorm is formed. These storm events can occur singularly, in lines, or in clusters. Further, they can move through an area very quickly or linger for several hours.

According to the National Weather Service, more than 100,000 thunderstorms occur each year, though only about 10 percent of these storms are classified as "severe." A severe thunderstorm occurs when the storm produces one of three elements: 1) Hail of three-quarters of an inch; 2) Tornado; 3) Winds of at least 58 miles per hour.

Thunderstorm events have the capability of producing straight-line winds that can cause severe destruction to communities and threaten the safety of a population.

4.8.2 Location and Spatial Extent

A thunderstorm event is an atmospheric hazard, and thus has no geographic boundaries. It is typically a widespread event that can occur in all regions of the United States. However, thunderstorms are most common in the central and southern states because atmospheric conditions in those regions are favorable for generating these powerful storms. Therefore, it is assumed that Myrtle Beach has uniform exposure to an event and the spatial extent of an impact would be potentially large.

4.8.3 Historical Occurrences

There have been seventeen (17) reported thunderstorm wind events in the City of Myrtle Beach since 1994.[6] These events caused over $1.8 million in damages (2014 dollars). In addition to property damage,

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[5] Lightning and Hail are discussed in detail as separate hazards in this section.

[6] These thunderstorm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional thunderstorm events have occurred in the City of Myrtle Beach. As additional local data becomes available, this hazard profile will be amended.

there were 4 injuries but no reports of fatalities. **Table 4.8** shows the historical occurrences of wind events for Myrtle Beach.

Table 4.8: Historical Thunderstorm Wind Events

Location	Date	Type	Mag (knots)	Deaths/ Injuries	Property Damage (2014 Dollars)	Description
Myrtle Beach	09/18/1994	Thunderstorm Winds	0 kts.	0/0	$798,937	Trees and limbs down near Waccamaw Pottery on U.S. 501. Several large signs (24'x 26') blown down, some shingles removed, and a mobile home heavily damaged. Five hundred power outages reported in Horry County.
Myrtle Beach	05/14/1995	Thunderstorm Winds	44 kts.	0/0	$0	*Not Available*
South Myrtle Beach	05/19/1995	Thunderstorm Winds	0 kts.	0/0	$8,128	Telephone pole down.
Myrtle Beach	07/24/1995	Thunderstorm Winds	0 kts.	0/0	$0	Trees down near Bucksport and Lakewood Campground.
Myrtle Beach	04/26/1996	Thunderstorm Winds	60 kts.	0/0	$0	Vents blown off roof of middle school.
Myrtle Beach	09/12/1997	Thunderstorm Winds	0 kts.	0/2	$737,280	A rain loaded thunderstorm microburst hit the beach berm and hotel area along a 4 block strip (from 26th Ave - 30th Ave). Two people were injured (cuts from flying glass and bruises).
Myrtle Beach	11/02/1997	Thunderstorm Winds	55 kts.	0/0		Strong winds downed power lines on south side of the city.
Myrtle Beach	03/09/1998	Thunderstorm Winds	55 kts.	0/0	$5,808	Roofs damaged and trees downed on Bush Drive, near Waccamaw Pottery.
Myrtle Beach	03/21/1999	Thunderstorm Winds	75 kts.	0/2	$248,600	Wind from a severe thunderstorm blew out windows at Wyndham Myrtle Beach Resort and overturned 4 trailers in a Briarcliffe RV park, injuring two people. At a car lot, 29 cars had windows blown out. Hail was marble size. Power outages extended from the Briarcliffe area to North Myrtle Beach.
Myrtle Beach	08/09/2000	Thunderstorm Winds	62 kts.	0/0	$0	A 62 knot wind gust was measured by an anemometer on Springmaid Pier.
Myrtle Beach	08/11/2000	Thunderstorm Winds	55 kts.	0/0	$0	Lifeguard stands were reported to be blown over.
Myrtle Beach	04/01/2001	Thunderstorm Winds	60 kts.	0/0	$20,047	The railing of a canopy was blown off at the cinema in Colonial Mall.
Myrtle Beach	04/17/2006	Thunderstorm Winds	65 kts.	0/0	$1,173	Power lines down on 13th and 14th Street South.

Myrtle Beach	07/11/2007	Thunderstorm Winds	70 kts.	0/0	$17,120	A pre-frontal trough, very unstable air, and an upper air disturbance moving east all combined to produce tornadoes and microbursts across a large portion of northeast South Carolina. Survey concluded straight line winds of around 80 mph caused spotty damage along a path 500 yards long and 60 yards wide in the Emerald Lakes subdivision, just off of US Highway 501. Tops of softwood trees were snapped. Damage to several homes included roofing, windows and siding.
Myrtle Beach	7/26/2010	Thunderstorm Winds	52 kts.	0/0	$16,299	*Not Available*
Myrtle Beach	7/26/2010	Thunderstorm Winds	52 kts.	0/0	$21,732	*Not Available*
Myrtle Beach	7/15/2014	Thunderstorm Winds	56 kts.	0/0	$1,500	*Not Available*

Source: NCDC

4.8.4 Probability of Future Occurrences

Given the high number of previous events and favorable atmospheric conditions of the area, it is certain that wind events, including straight-line winds, will occur in the future. Therefore, the probability of future occurrence is considered highly likely.

4.9 TORNADO/WATERSPOUT

4.9.1 Background

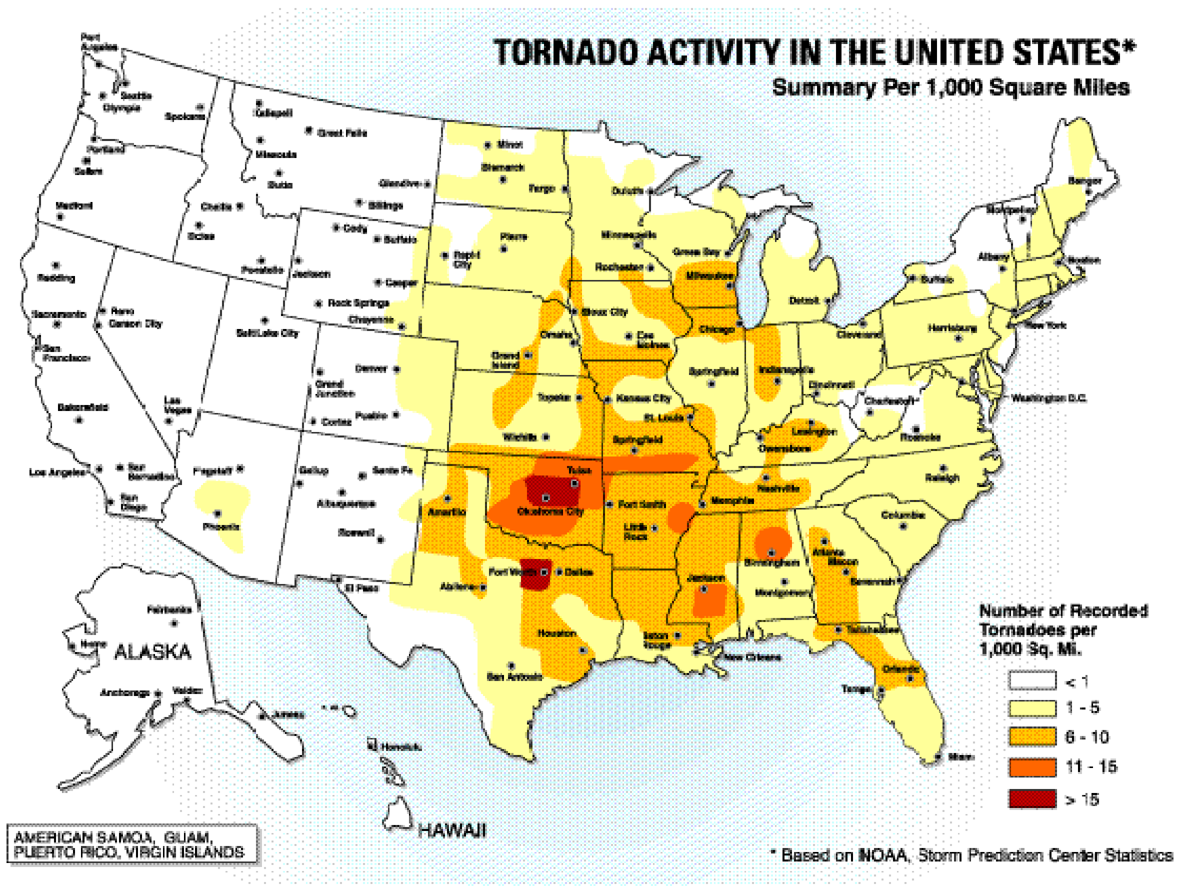
A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud extending to the ground. Tornadoes are most often generated by thunderstorm activity (but sometimes result from hurricanes and other tropical storms) when cool, dry air intersects and overrides a layer of warm, moist air forcing the warm air to rise rapidly. The damage caused by a tornado is a result of the high wind velocity and wind-blown debris, also accompanied by lightning or large hail. According to the National Weather Service, tornado wind speeds normally range from 40 miles per hour to more than 300 miles per hour. The most violent tornadoes have rotating winds of 250 miles per hour or more and are capable of causing extreme destruction and turning normally harmless objects into deadly missiles. Similar to tornadoes, waterspouts have most of the same characteristics of a tornado except that they occur over water instead of land. Indeed land-based tornadoes can turn into waterspouts as they move out over a water body and vice versa.

Each year, an average of over 800 tornadoes are reported nationwide, resulting in an average of 80 deaths and 1,500 injuries.[7] According to the NOAA Storm Prediction Center (SPC), the highest concentration of tornadoes in the United States has been in Oklahoma, Texas, Kansas and Florida

[7] NOAA, 2007.

respectively. Although the Great Plains region of the Central United States does favor the development of the largest and most dangerous tornadoes (earning the designation of “tornado alley”), Florida experiences the greatest number of tornadoes per square mile of all U.S. states (SPC, 2002). Comparatively, South Carolina ranks twenty-fourth in the nation for frequency. **Figure 4.5** shows tornado activity in the United States based on the number of recorded tornadoes per 1,000 square miles.

Figure 4.5: Tornado Activity in the United States



Source: Federal Emergency Management Agency

Tornadoes are more likely to occur during the months of March through May and are most likely to form in the late afternoon and early evening. Most tornadoes are a few dozen yards wide and touch down briefly, but even small short-lived tornadoes can inflict tremendous damage. Highly destructive tornadoes may carve out a path over a mile wide and several miles long.

The destruction caused by tornadoes ranges from light to inconceivable depending on the intensity, size and duration of the storm. Typically, tornadoes cause the greatest damage to structures of light construction, including residential dwellings (particularly mobile homes). Tornadic magnitude is reported according to the Fujita and Enhanced Fujita Scales. Tornado magnitudes prior to 2005 were determined using the traditional version of the Fujita Scale (**Table 4.9**). Tornado magnitudes that were determined in 2005 and later were determined using the Enhanced Fujita Scale (**Table 4.10**).

Table 4.9: The Fujita Scale (Effective Prior to 2005)

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

Source: National Weather Service

Table 4.10: The Enhanced Fujita Scale (Effective 2005 and Later)

EF-SCALE NUMBER	INTENSITY PHRASE	3 SECOND GUST (MPH)	TYPE OF DAMAGE DONE
F0	GALE	65–85	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages to sign boards.
F1	MODERATE	86–110	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	SIGNIFICANT	111–135	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	SEVERE	136–165	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.
F4	DEVASTATING	166–200	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	INCREDIBLE	Over 200	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel re-enforced concrete structures badly damaged.

Source: National Weather Service

4.9.2 Location and Spatial Extent

Tornadoes occur throughout the state of South Carolina and the state as a whole experienced an average of 29 tornadoes per year in the period from 1990 to 2013.[8] Tornadoes typically impact a relatively small area; however, events are completely random and it is not possible to predict specific areas that are more susceptible to tornado strikes over time. Therefore, it is assumed that Myrtle Beach is uniformly exposed to this hazard.

Historical evidence shows that all of Myrtle Beach is vulnerable to tornadic activity. This hazard can result from severe thunderstorm activity or may occur during a hurricane or major tropical storm. In fact, historical evidence shows more frequent tornado point locations on the Myrtle Beach coastline. However, it cannot be predicted where a tornado may touch down, so all buildings and facilities are considered to be exposed to this hazard and could potentially be impacted.

[8] South Carolina Department of Natural Resources, https://www.dnr.sc.gov/climate/sco/ClimateData/cli_table_tornado_stats.php

4.9.3 Historical Occurrences

According to the National Climatic Data Center, there have been a total of four (4) recorded tornado/waterspout events in Myrtle Beach since 1979, however it should be noted that two of these events were located far off the coast and did not come ashore or cause major damage (**Table 4.11**).[9] Thirty-nine injuries were reported as a result of a tornado event in 2001, and over $11 million in property damages resulted from all tornado events. The magnitude of these tornadoes ranges from F0 to F2 in intensity, with approximate touchdown locations for each major event where damage occurred shown in **Figure 4.6**. It is important to note that only tornadoes that have been reported are factored into this risk assessment. It is possible that a number of occurrences have gone unreported.

Table 4.11: Historical Tornado/Waterspout Impacts

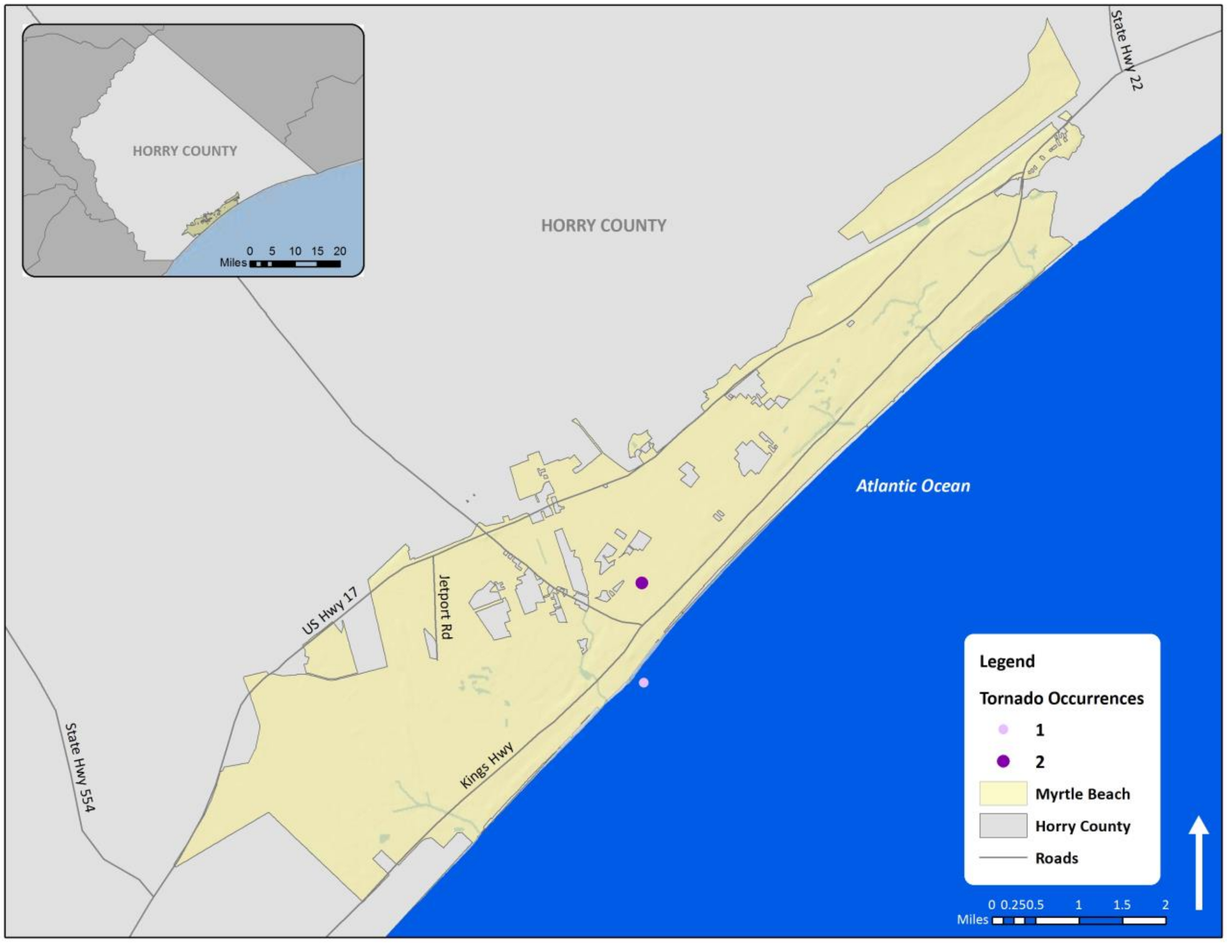
Location	Date	Magnitude	Deaths/ Injuries	Property Damage (2014 dollars)	Description
Myrtle Beach	09/04/1979	F1	0/0	$854,070	*Not Available*
Myrtle Beach	07/23/1996	*waterspout*	0/0	$0	Two waterspouts sighted off Myrtle Beach dissipated before coming ashore. No injuries or damage.
Myrtle Beach	07/24/1997	*waterspout*	0/0	$0	Waterspout reported over the ocean just off Myrtle Beach
Myrtle Beach	07/06/2001	F2	0/39	$10,691,502	An F0 tornado briefly touched down at 9th Ave N near the Myrtle Beach Pavilion, and soon after a waterspout formed just off the beach near 3rd Ave N. It slightly damaged the 2nd Ave N pier and then moved over the beach as it developed more strongly, causing F2 damage - overturned buses and extensive damage to vehicles and hotels along the beach to about 4th Ave S. Moving off the beach again, the waterspout continued south about 100 yards from the shore until it came ashore between 28th Ave S and Springmaid Pier, causing a 66 knot gust over water at the Springmaid Pier anemometer. As it moved through the Seagate RV park, it did F1 damage, destroyed 10 RVs and damaged 40 more. Weakening further, the tornado crossed US Hwy Business 17 onto Myrtle Beach International Airport, doing F0 damage to trees and structures.

Source: NCDC

** This event was reported by the City of Myrtle Beach.*

[9] These tornado events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is possible that additional tornadoes have occurred in the City of Myrtle Beach. As additional local data becomes available, this hazard profile will be amended.

Figure 4.6: Locations of Historical Tornado/Waterspout Events in Myrtle Beach



Source: NCDC

4.9.4 Probability of Future Occurrences

The probability of future tornado occurrences affecting Myrtle Beach is possible. According to historical records, Horry County experiences an average of nearly .85 confirmed tornado touchdown every year, while Myrtle Beach experiences a tornadic event roughly every 9 years, on average. While the majority of these events are small in terms of size, intensity and duration, they do pose a significant threat should the City of Myrtle Beach experience a direct tornado strike.

4.10 TROPICAL STORM SYSTEM/HURRICANE

4.10.1 Background

Hurricanes and tropical storms are classified as cyclones and defined as any closed circulation developing around a low-pressure center in which the winds rotate counter-clockwise in the Northern Hemisphere (or clockwise in the Southern Hemisphere) and whose diameter averages 10 to 30 miles across. A tropical cyclone refers to any such circulation that develops over tropical waters. Tropical cyclones act as a "safety-valve," limiting the continued build-up of heat and energy in tropical regions by maintaining the atmospheric heat and moisture balance between the tropics and the pole-ward latitudes. The primary damaging forces associated with these storms are high-level sustained winds, heavy precipitation and tornadoes. Coastal areas are also vulnerable to the additional forces of storm surge, wind-driven waves and tidal flooding which can be more destructive than cyclone wind.

The key energy source for a tropical cyclone is the release of latent heat from the condensation of warm water. Their formation requires a low-pressure disturbance, warm sea surface temperature, rotational force from the spinning of the earth and the absence of wind shear in the lowest 50,000 feet of the atmosphere. The majority of hurricanes and tropical storms form in the Atlantic Ocean, Caribbean Sea and Gulf of Mexico during the official Atlantic hurricane season, which encompasses the months of June through November. The peak of the Atlantic hurricane season is in early to mid-September and the average number of storms that reach hurricane intensity per year in this basin is about six (6).

As an incipient hurricane develops, barometric pressure (measured in millibars or inches) at its center falls and winds increase. If the atmospheric and oceanic conditions are favorable, it can intensify into a tropical depression. When maximum sustained winds reach or exceed 39 miles per hour, the system is designated a tropical storm, given a name, and is closely monitored by the National Hurricane Center in Miami, Florida. When sustained winds reach or exceed 74 miles per hour the storm is deemed a hurricane. Hurricane intensity is further classified by the Saffir-Simpson Scale (**Table 4.12**), which rates hurricane intensity on a scale of 1 to 5, with 5 being the most intense.

Table 4.12: Saffir-Simpson Scale

Category	Maximum Sustained Wind Speed (MPH)	Minimum Surface Pressure (Millibars)	Storm Surge (Feet)
1	74–95	Greater than 980	3–5
2	96–110	979–965	6–8
3	111–130	964–945	9–12
4	131–155	944–920	13–18
5	155 +	Less than 920	19+

Source: National Hurricane Center

The Saffir-Simpson Scale categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure and storm surge potential, which are combined to estimate potential damage. Categories 3, 4, and 5 are classified as "major" hurricanes, and while hurricanes within this range comprise only 20 percent of total tropical cyclone landfalls, they account for over 70 percent of the damage in the United States. **Table 4.13** describes the damage that could be expected for each category of hurricane. Damage during hurricanes may also result from spawned tornadoes, storm surge and inland flooding associated with heavy rainfall that usually accompanies these storms.

Table 4.13: Hurricane Damage Classifications

Storm Category	Damage Level	Description of Damages	Photo Example
1	MINIMAL	No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Also, some coastal flooding and minor pier damage.	
2	MODERATE	Some roofing material, door, and window damage. Considerable damage to vegetation, mobile homes, etc. Flooding damages piers and small craft in unprotected moorings may break their moorings.	
3	EXTENSIVE	Some structural damage to small residences and utility buildings, with a minor amount of curtainwall failures. Mobile homes are destroyed. Flooding near the coast destroys smaller structures, with larger structures damaged by floating debris. Terrain may be flooded well inland.	
4	EXTREME	More extensive curtainwall failures with some complete roof structure failure on small residences. Major erosion of beach areas. Terrain may be flooded well inland.	
5	CATASTROPHIC	Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Flooding causes major damage to lower floors of all structures near the shoreline. Massive evacuation of residential areas may be required.	

Sources: National Hurricane Center; Federal Emergency Management Agency

4.10.2 Location and Spatial Extent

Hurricanes and tropical storms threaten the entire Atlantic and Gulf seaboard of the United States, and while coastal areas are most directly exposed to the brunt of landfalling storms, their impact is often felt hundreds of miles inland. The City of Myrtle Beach is located in a region of the country that is susceptible to all of the hazards wrought by hurricanes and tropical storms. All areas throughout the City are susceptible to the accompanying hazard effects of extreme wind, flooding and tornadoes, and coastal areas are also extremely susceptible to the added effects of storm surge, wave action, coastal erosion and tidal flooding.[10]

4.10.3 Historical Occurrences

According to NOAA historical storm track records, seventy-six hurricane or tropical storm tracks have passed within 75 miles of the City of Myrtle Beach since 1850. This includes: zero (0) Category 5 hurricanes; four (4) Category 4 hurricanes; three (3) Category 3 hurricanes; eight (8) Category 2 hurricanes; twenty-four (24) Category 1 hurricanes; fifty-one (51) tropical storms; and twenty-eight (28) tropical depressions. Of the 118 recorded storm events, 6 had tracks that traversed directly through Myrtle Beach including one Category 2 hurricane and six tropical storms. **Table 4.14** provides for each event the date of occurrence, name (if applicable), maximum wind speed (as recorded within 75 miles of the City of Myrtle Beach) and Category of the storm based on the Saffir-

[10] Distinct hazard area locations for flooding, storm surge, wave action and coastal erosion are discussed elsewhere in this section.

Simpson Scale. **Figure 4.7** shows the track of each recorded storm in relation to the City of Myrtle Beach and South Carolina.

Table 4.14: Historical Storm Tracks within 75 Miles of Myrtle Beach (1850–2009)

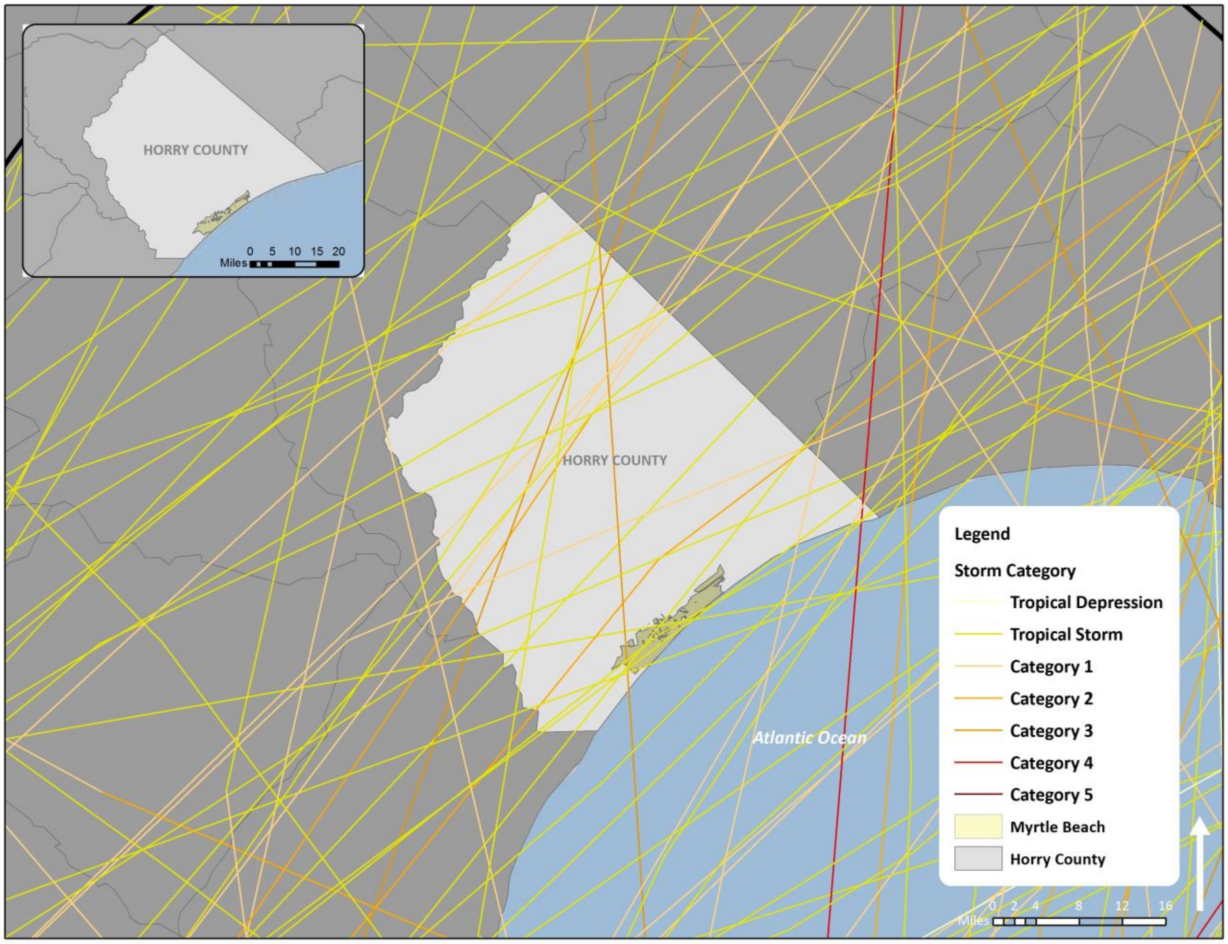
Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
08/24/1851	Not Named	60	Tropical Storm
8/28/1852	Not Named	45	Tropical Storm
10/10/1882	Not Named	60	Tropical Storm
9/1/1856	Not Named	60	Tropical Storm
9/12/1857	Not Named	90	Category 1
9/27/1861	Not Named	80	Category 1
9/18/1863	Not Named	70	Tropical Storm
6/22/1867	Not Named	80	Category 1
10/5/1868	Not Named	45	Tropical Storm
8/29/1871	Not Named	45	Tropical Storm
10/6/1871	Not Named	45	Tropical Storm
10/24/1872	Not Named	80	Category 1
9/20/1873	Not Named	70	Tropical Storm
9/28/1874	Not Named	90	Category 1
9/17/1876	Not Named	90	Category 1
9/12/1878	Not Named	90	Category 1
9/9/1881	Not Named	105	Category 2
10/12/1882	Not Named	80	Category 1
9/11/1883	Not Named	105	Category 2
8/25/1885	Not Named	105	Category 2
7/1/1886	Not Named	50	Tropical Storm
10/20/1887	Not Named	30	Tropical Depression
10/11/1888	Not Named	70	Tropical Storm
06/16/1893	Not Named	60	Tropical Storm
10/4/1893	Not Named	45	Tropical Storm
10/13/1893	Not Named	120	Category 3
9/27/1894	Not Named	80	Category 1
10/9/1894	Not Named	70	Tropical Storm
9/29/1896	Not Named	100	Category 2
9/22/1897	Not Named	65	Tropical Storm
10/31/1899	Not Named	110	Category 2
10/12/1900	Not Named	35	Tropical Depression
7/12/1901	Not Named	40	Tropical Storm
9/18/1901	Not Named	40	Tropical Storm
9/14/1904	Not Named	80	Category 1
11/4/1904	Not Named	35	Tropical Depression
9/17/1906	Not Named	90	Category 1
6/29/1907	Not Named	65	Tropical Storm
9/29/1907	Not Named	40	Tropical Storm

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
7/31/1908	Not Named	80	Category 1
10/23/1908	Not Named	35	Tropical Depression
8/28/1910	Not Named	40	Tropical Storm
10/20/1910	Not Named	70	Tropical Storm
10/8/1913	Not Named	75	Category 1
5/16/1916	Not Named	35	Tropical Depression
7/14/1916	Not Named	85	Category 1
9/5/1916	Not Named	40	Tropical Storm
9/22/1920	Not Named	80	Category 1
9/16/1924	Not Named	45	Tropical Storm
9/30/1924	Not Named	55	Tropical Storm
9/18/1928	Not Named	70	Tropical Storm
9/15/1932	Not Named	40	Tropical Storm
7/21/1934	Not Named	45	Tropical Storm
10/8/1941	Not Named	60	Tropical Storm
8/1/1944	Not Named	90	Category 1
10/20/1944	Not Named	50	Tropical Storm
6/25/1945	Not Named	70	Tropical Storm
9/17/1945	Not Named	45	Tropical Storm
7/5/1946	Not Named	45	Tropical Storm
11/3/1946	Not Named	20	Tropical Depression
9/24/1947	Not Named	30	Tropical Depression
9/27/1953	Florence	35	Tropical Depression
10/15/1954	Hazel	140	Category 4
8/17/1955	Diane	85	Category 1
9/26/1956	Flossy	35	Tropical Depression
6/9/1957	Not Named	50	Tropical Storm
9/27/1958	Helene	130	Category 4
7/9/1959	Cindy	75	Category 1
7/30/1960	Brenda	60	Tropical Storm
9/12/1960	Donna	110	Category 2
9/14/1961	Not Named	30	Tropical Depression
9/13/1964	Dora	50	Tropical Storm
6/11/1966	Alma	45	Tropical Storm
6/17/1967	Not Named	0	Tropical Depression
6/10/1968	Abby	25	Tropical Depression
10/20/1968	Gladys	85	Category 1
10/19/1968	Gladys	75	Category 1
8/17/1970	Not Named	30	Tropical Depression
9/10/1971	Not Named	25	Tropical Depression
6/21/1972	Agnes	30	Tropical Depression
7/12/1972	Not Named	25	Tropical Depression
9/14/1972	Dawn	30	Tropical Depression

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
6/28/1975	Amy	25	Tropical Depression
10/26/1975	Hallie	40	Tropical Storm
8/20/1976	Dottie	40	Tropical Storm
9/15/1976	Subtrop:Not Named	35	Tropical Depression
9/6/1977	Clara	25	Tropical Depression
7/3/1981	Not Named	25	Tropical Depression
8/20/1981	Dennis	60	Tropical Storm
6/19/1982	Subtrop:Not Named	60	Tropical Storm
9/12/1984	Diana	130	Category 4
11/22/1985	Kate	60	Tropical Storm
9/7/1987	Not Named	30	Tropical Depression
9/22/1989	Hugo	140	Category 4
7/20/1994	Not Named	30	Tropical Depression
11/21/1994	Gordon	20	Tropical Depression
6/6/1995	Allison	40	Tropical Storm
6/19/1996	Arthur	45	Tropical Storm
7/12/1996	Bertha	105	Category 2
9/5/1996	Fran	115	Category 3
10/8/1996	Josephine	45	Tropical Storm
8/26/1998	Bonnie	115	Category 3
9/4/1998	Earl	50	Tropical Storm
9/16/1999	Floyd	105	Category 2
10/17/1999	Irene	80	Category 1
9/19/2000	Gordon	25	Tropical Depression
9/23/2000	Helene	25	Tropical Depression
6/13/2001	Allison	25	Tropical Depression
10/11/2002	Kyle	40	Tropical Storm
8/13/2004	Bonnie	25	Tropical Depression
8/14/2004	Charley	75	Category 1
8/29/2004	Gaston	75	Category 1
9/14/2005	Ophelia	75	Category 1
9/1/2006	Ernesto	60	Tropical Storm
6/3/2007	Barry	40	Tropical Storm
7/19/2008	Cristobal	45	Tropical Storm
9/6/2008	Hanna	60	Tropical Storm
5/30/2012	Beryl	40	Tropical Storm

Source: National Oceanic and Atmospheric Administration

Figure 4.7: Historical Hurricane Storm Tracks within 75 Miles of the City of Myrtle Beach



Source: National Oceanic and Atmospheric Administration

Some of the more notable historical tropical cyclone events for the City of Myrtle Beach are described below (Information from National Climatic Data Center, National Weather Service and National Hurricane Center):

Hurricane Hazel, 1954

According to the National Hurricane Center, Hurricane Hazel, a Category 4 storm, was the last hurricane to directly hit the City of Myrtle Beach. Myrtle Beach, South Carolina reported a peak wind gust of 106 mph, and winds were estimated at 130 to 150 mph along the coast between Myrtle Beach and Cape Fear, North Carolina. The storm hit at the highest lunar tide of the year, resulting in increased storm surge and damage. It downed countless trees along the coast. (In fact, so many trees were downed that Hazel is said to have started Myrtle Beach as a tourist destination, clearing the land for golf course and condominium development.) Further, 80 percent of the buildings along the Myrtle Beach coast were destroyed. Hazel was responsible for 95 deaths and $2.3 billion in damages in the United States and $1.1 billion for the Carolinas. In South Carolina, 19 people were killed and over 200 were injured, in addition to the 15,000 homes being destroyed.

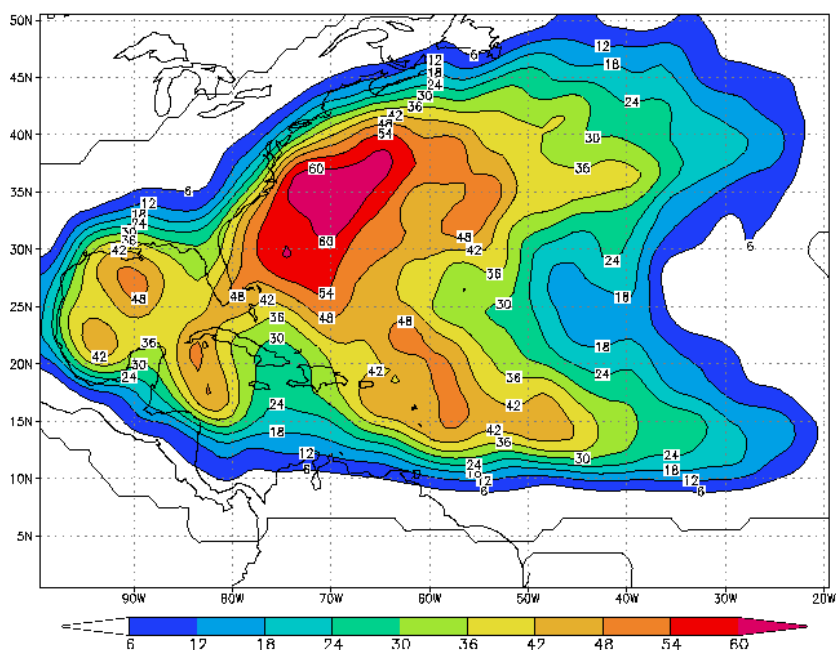
Hurricane Hugo 1989 (indirect hit)

Hurricane Hugo, a Category 4 storm, reached Myrtle Beach on September 22, 1989. It caused 57 deaths in the U.S. and over $7 billion in damages (1989 dollars) - $6 million in Myrtle Beach alone. Up to that time, it was the costliest storm in history (later surpassed by Andrew and Katrina).

4.10.4 Probability of Future Occurrences

The probability of future hurricane and tropical storm events for the City of Myrtle Beach is likely. According to NOAA statistical data, the city is located in an area with an annual probability of a named storm between 48 and 54 percent as presented in **Figure 4.8**. This illustration was created by the National Oceanic and Atmospheric Administration's Hurricane Research Division using data from 1944 to 1999 and counting hits when a storm or hurricane was within approximately 100 miles (165 km) of each location. As a reference point, the tip of Florida's outline can be found near the 25N, 80W intersection, and Myrtle Beach is near the 35N, 85W intersection. This empirical probability is fairly consistent with other scientific studies and observed historical data made available through a variety of federal, state and local sources.

Figure 4.8: Empirical Probability of a Named Hurricane or Tropical Storm



Source: National Oceanic and Atmospheric Administration

The probability of storm occurrences will vary significantly based on the return interval for different categories of magnitude. The probability of less intense storms (lower return periods) is higher than more intense storms (higher return periods). **Table 4.15** profiles the potential peak gust wind speeds that can be expected in the City of Myrtle Beach during a hurricane event for various return periods according to FEMA's HAZUS-MH®.

Table 4.15: Potential Peak Gust Wind Speeds per Return Period

10-Year	20-Year	50-Year	100-Year	200-Year	500-Year	1,000-Year
65.3 mph	81.1 mph	102.1 mph	114.2 mph	124.7 mph	136.8 mph	145.0

Source: Federal Emergency Management Agency (HAZUS-MH 2.2)

GEOLOGIC HAZARDS

4.11 EARTHQUAKE

4.11.1 Background

An earthquake is movement or trembling of the ground produced by sudden displacement of rock in the Earth's crust. Earthquakes result from crustal strain, volcanism, landslides or the collapse of caverns. Earthquakes can affect hundreds of thousands of square miles, cause damage to property measured in the tens of billions of dollars, result in loss of life and injury to hundreds of thousands of persons; and disrupt the social and economic functioning of the affected area.

Most property damage and earthquake-related deaths are caused by the failure and collapse of structures due to ground shaking. The level of damage depends upon the amplitude and duration of the shaking, which are directly related to the earthquake size, distance from the fault, site and regional geology. Other damaging earthquake effects include landslides, the down-slope movement of soil and rock (mountain regions and along hillsides), and liquefaction, in which ground soil loses the ability to resist shear and flows much like quick sand. In the case of liquefaction, anything relying on the substrata for support can shift, tilt, rupture or collapse.

Most earthquakes are caused by the release of stresses accumulated as a result of the rupture of rocks along opposing fault planes in the Earth's outer crust. These fault planes are typically found along borders of the Earth's 10 tectonic plates. The areas of greatest tectonic instability occur at the perimeters of the slowly moving plates, as these locations are subjected to the greatest strains from plates traveling in opposite directions and at different speeds. Deformation along plate boundaries causes strain in the rock and the consequent buildup of stored energy. When the built-up stress exceeds the rocks' strength, a rupture occurs. The rock on both sides of the fracture is snapped, releasing the stored energy and producing seismic waves, generating an earthquake.

Earthquakes are measured in terms of their magnitude and intensity. Magnitude is measured using the Richter Scale, an open-ended logarithmic scale that describes the energy release of an earthquake through a measure of shock wave amplitude (**Table 4.16**). Each unit increase in magnitude on the Richter Scale corresponds to a 10-fold increase in wave amplitude, or a 32-fold increase in energy. Intensity is most commonly measured using the Modified Mercalli Intensity (MMI) Scale based on direct and indirect measurements of seismic effects. The scale levels are typically described using roman numerals, with a I corresponding to imperceptible (instrumental) events, IV corresponding to moderate (felt by people awake), to XII for catastrophic (total destruction). A detailed description of the Modified Mercalli Intensity Scale of earthquake intensity and its correspondence to the Richter Scale is given in **Table 4.17**.

Table 4.16: Richter Scale

RICHTER MAGNITUDES	EARTHQUAKE EFFECTS
< 3.5	Generally not felt, but recorded.
3.5 - 5.4	Often felt, but rarely causes damage.
5.4 - 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1 - 6.9	Can be destructive in areas up to about 100 kilometers across where people live.
7.0 - 7.9	Major earthquake. Can cause serious damage over larger areas.
8 or >	Great earthquake. Can cause serious damage in areas several hundred kilometers across.

Source: Federal Emergency Management Agency

Table 4.17: Modified Mercalli Intensity Scale for Earthquakes

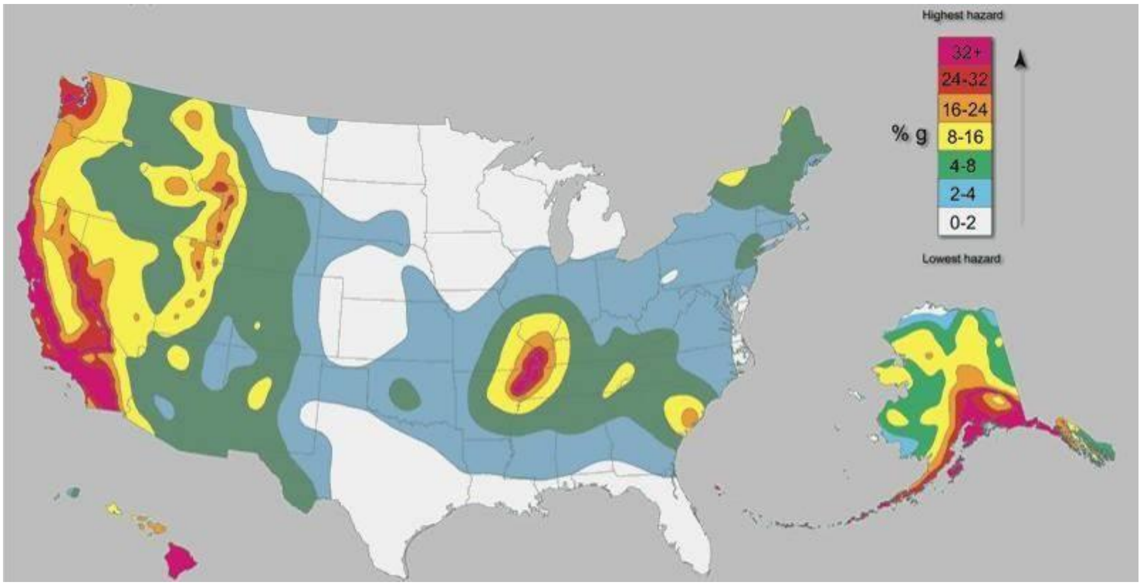
SCALE	INTENSITY	DESCRIPTION OF EFFECTS	CORRESPONDING RICHTER SCALE MAGNITUDE
I	INSTRUMENTAL	Detected only on seismographs.	
II	FEEBLE	Some people feel it.	< 4.2
III	SLIGHT	Felt by people resting; like a truck rumbling by.	
IV	MODERATE	Felt by people walking.	
V	SLIGHTLY STRONG	Sleepers awake; church bells ring.	< 4.8
VI	STRONG	Trees sway; suspended objects swing, objects fall off shelves.	< 5.4
VII	VERY STRONG	Mild alarm; walls crack; plaster falls.	< 6.1
VIII	DESTRUCTIVE	Moving cars uncontrollable; masonry fractures, poorly constructed buildings damaged.	
IX	RUINOUS	Some houses collapse; ground cracks; pipes break open.	< 6.9
X	DISASTROUS	Ground cracks profusely; many buildings destroyed; liquefaction and landslides widespread.	< 7.3
XI	VERY DISASTROUS	Most buildings and bridges collapse; roads, railways, pipes and cables destroyed; general triggering of other hazards.	< 8.1
XII	CATASTROPHIC	Total destruction; trees fall; ground rises and falls in waves.	> 8.1

Source: Federal Emergency Management Agency

4.11.2 Location and Spatial Extent

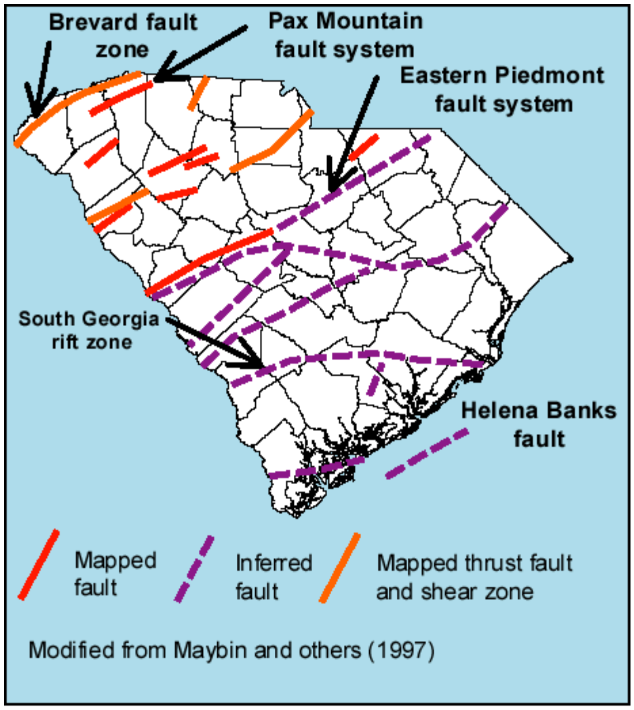
The greatest earthquake threat in the United States is along tectonic plate boundaries and seismic fault lines located in the central and western states; however, the East Coast does face moderate risk to less frequent, less intense earthquake events. **Figure 4.9** shows relative seismic risk for the United States and **Figure 4.10** shows the fault lines in South Carolina.

Figure 4.9: United States Earthquake Hazard Map



Source: United States Geological Survey

Figure 4.10: Fault Lines in South Carolina



Source: http://www.dnr.sc.gov/geology/earthquake.htm[11]

4.11.3 Historical Occurrences

According to the National Geophysical Data Center (NGDC), only one significant earthquake has occurred in South Carolina - the Charleston Earthquake of 1886. During this event, Horry County experienced a magnitude of VI (Strong) on the Modified Mercalli Intensity (MMI) Scale. There have also been three notable earthquakes as identified by the NGDC in **Table 4.18.** Although there have been more than two hundred minimal earthquakes reported in South Carolina since 2001, none of these events caused any significant damage and many were not even strong enough to be felt by people.

Table 4.18 Historical Earthquakes Experienced in Myrtle Beach

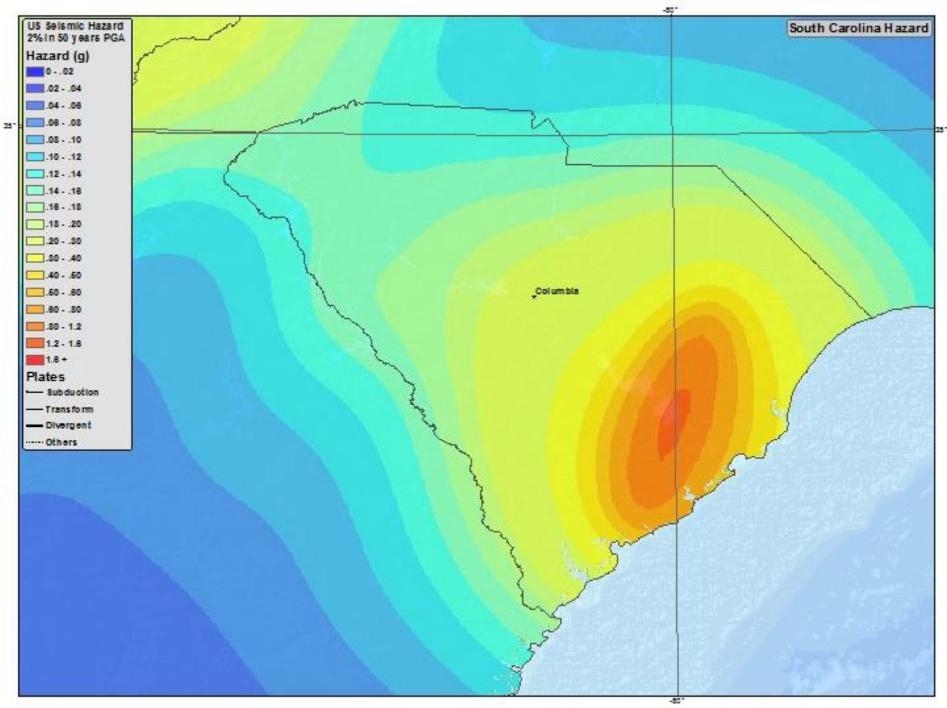
Location	Date	Magnitude (MMI)
Myrtle Beach	3/12/1960	4
Myrtle Beach AFB	2/3/1972	5
Myrtle Beach	11/22/1974	5

[11] Maybin, A.H., Clendenin, C.W., Jr., Assisted by Daniels, D.L., 1998, Structural features map of South Carolina: South Carolina Geological Survey General Geologic Map Series, 1p.

4.11.4 Probability of Future Occurrences

The probability of significant, damaging earthquake events affecting the City of Myrtle Beach is unlikely. According to the United States Geological Survey (USGS), Myrtle Beach resides in an area with a moderate seismic risk (**Figure 4.11**). This risk is for earthquakes resulting in light to moderate perceived shaking and damages ranging from very light to moderate. More destructive earthquakes are very rare, low probability events for Myrtle Beach.

Figure 4.11: Seismic Hazard Map for South Carolina



Source: USGS

4.12 TIDAL WAVE/TSUNAMI

4.12.1 Background

A tsunami is a series of great waves that are created by undersea disturbances such as earthquakes or volcanic eruptions. From the area of disturbance, tsunami waves will travel outward in all directions. Tsunamis can originate hundreds or even thousands of miles away from coastal areas.

The time between wave crests may be five to ninety minutes and the open ocean wave speed may average 450 miles per hour. As tsunami waves approach shallow coastal waters, they appear normal in size and the speed decreases until the waves near the shoreline, where it may grow to great height and crash into the shore. Areas at greatest risk are less than 50 feet above sea level and within one mile of the shoreline. Rapid changes in the ocean water level may indicate that a tsunami is approaching. Most deaths during a tsunami are the result of drowning. Associated risks include flooding, polluted water supplies, and damaged gas lines.

4.12.2 Location and Spatial Extent

In the United States, tsunamis have historically affected the West Coast, but the threat of tsunami inundation is also possible on the Atlantic Coast. Pacific Ocean tsunamis are classified as local, regional, or Pacific-wide. Regional tsunamis are most common. While Pacific-wide tsunamis are much less common, with the last one being recorded in 1964, they tend to generate larger waves, which can cause significant destruction.

Two offshore areas are currently under investigation according to a 2002 National Geophysical Data Center report. One area of interest consists of large cracks northeast of Cape Hatteras that could signal the early stages of an underwater landslide that could result in a tsunami. The other area of interest consists of submarine canyons approximately 150 kilometers from Atlantic City, New Jersey. A significant factor for consideration with regard to these areas is recent discoveries along the East Coast that demonstrate the existence of pressurized hydrates and pressurized water layers in the continental shelf. This has produced speculation among the scientific community on possible triggers that could cause sudden and perhaps violent releases of compressed material that may cause landslides and tsunami waves.

Figure 4.12 depicts a scenario presented in the Horry County Emergency Operations Plan that estimates what could happen if an earthquake of 9.0M were to occur in the Puerto Rico Trench. This model was developed by the NOAA Tsunami Warning Center. The areas affected by the tsunami are shown in blue. This includes many highways out to Highway 17/Kings Highway.

Figure 4.12: Tsunami Hazard Map for South Carolina

4.12.3 Historical Occurrences

There is only one historical tsunami event reported to have directly affected the state of South Carolina. This event occurred in Copper River, South Carolina as a result of the 1886 Charleston Earthquake. However, as many as 40 tsunamis and tsunami-like waves have been documented in the Eastern United States since 1600. Tsunami events along the East Coast are not the result of traditional sources of tsunami waves (i.e., subduction zones such as the Cascadia Subduction Zone), but rather are typically the result of slumping or landsliding associated with local earthquakes or with wave action associated with strong storms such as hurricanes. Other possible causes of tsunami-like activity along the East Coast could include explosive decompression of underwater methane deposits, the impact of a heavenly body (i.e., an asteroid, comet or oceanic meteor splashdown) or a large underwater explosion. One significant contributing factor to tsunami-related damage is the massive amount of moving debris possible during a tsunami event—including manmade debris such as boats and on-shore debris as the tsunami strikes land.

To cite one commonly referenced example in terms of Atlantic tsunamis, a severe earthquake registering 7.2 on the Richter Scale on November 18, 1929 in the Grand Banks of Newfoundland generated a tsunami that caused considerable damage and loss of life at Placentia Bay, Newfoundland and is also known to have impacted the New England and mid-east shoreline.

4.12.4 Probability of Future Occurrences

It is unlikely that a tidal wave or tsunami will occur in Myrtle Beach. There is no indication that this hazard is a significant enough threat to the City of Myrtle Beach to warrant further analysis or a detailed vulnerability assessment.

HYDROLOGIC HAZARDS

4.13 EROSION

4.13.1 Background

Erosion is a hydrologic hazard defined as the wearing away of land; loss of beach, shoreline, or dune material. It is measured as the rate of change in the position or horizontal (landward) displacement of a shoreline over a period of time. Short-term erosion typically results from episodic natural events such as hurricanes and storm surge, windstorms and flooding hazards, but may be exacerbated by human activities such as boat wakes, removal of dune and vegetative buffers, shoreline hardening and dredging. Long-term erosion is a function of multi-year impacts such as wave action, sea level rise, sediment loss, subsidence and climate change. Climatic trends can change a beach from naturally accreting to eroding due to increased episodic erosion events caused by waves from an above-average number of storms and high tides, or the long-term effects of fluctuations in sea level.

Natural recovery from erosion can take years to decades. If a beach and dune system does not recover quickly enough naturally, coastal and upland property may be exposed to further damage in subsequent coastal erosion and flooding events. Human actions to supplement natural coastal recovery, such as beach nourishment, dune stabilization and shoreline protection structures (e.g., sea walls, groins, jetties, etc.) can mitigate the hazard of coastal erosion.

Death and injury are not associated with coastal erosion; however, it can cause the destruction of buildings and infrastructure and represents a major threat to the local economies of coastal communities that rely on the financial benefits of recreational beaches.

4.13.2 Location and Spatial Extent

All of the coastal areas in Myrtle Beach are susceptible to the coastal erosion hazard. These areas are subject to repeated, episodic coastal erosion events that threaten public and private property. However, the City replenishes the sand lost to coastal erosion through renourishment projects.

4.13.3 Historical Occurrences

According to the National Climatic Data Center, there has been one event with reported coastal erosion impacts in Myrtle Beach since 1995, as shown in **Table 4.19**.[12] In addition, Hurricane Hazel (1954) reportedly caused 990,000 cubic yards of beach erosion. Because the erosion event was part of other hazard events (e.g., hurricanes), the monetary damage for the erosion alone is unknown.

Table 4.19: Historical Coastal Erosion Impacts

Location	Date	Deaths/ Injuries	Property Damage (2014 dollars)	Description
Myrtle Beach (surrounding areas presumed)	1989	0/0	$0	Hurricane Hugo caused extensive beach erosion.
Beaufort, Charleston, Georgetown, Horry, Jasper, and Colleton Counties	08/14/1995	0/0	$0	Minor coastal flooding and beach erosion associated with Hurricane Felix as it moved just off the Atlantic Coast.

Source: NCDC

The severity of coastal erosion is typically measured through a quantitative assessment of annual shoreline change for a given beach cross-section of profile (feet or meters per year) over a long period of time. Erosion rates vary as a function of shoreline type and are influenced primarily by episodic events, but can be used in land use and hazard management to define areas of critical concern. According to a study prepared by the Heinz Center, much of the Grand Strand, including Myrtle Beach, experiences an average of two to three feet of erosion per year.[13] However, more recent data from the Department of Health and Environmental Control suggests that the erosion rate at all survey monuments in Myrtle Beach (station 5300 to 5505) is -0.59 feet per year.[14]

Shortly after Hurricane Hugo, the City of Myrtle Beach began large scale beach renourishment projects to mitigate erosion.[15] Despite aforementioned rates of erosion, Myrtle Beach has made a commitment to beach renourishment. Sand is mined from offshore to replenish area beaches. It is projected that such projects will be necessary every 8 - 10 years in the city.

4.13.4 Probability of Future Occurrences

Coastal erosion remains a natural, dynamic and continuous process for the city's coastal areas and its probability of occurrence is highly likely. The damaging impacts of coastal erosion are lessened through continuous beach nourishment and structural shoreline protection measures; however, it is likely that the impacts of coastal erosion will increase in severity due to future episodic storm events as well as the anticipated slow onset, long-term effects of climate change and sea level rise (further discussed in the

[12] The reported erosion event is only inclusive of that reported by the National Climatic Data Center (NCDC). Additional erosion events have affected the City of Myrtle Beach. As additional local data becomes available, this hazard profile will be amended.
[13] "Evaluation of Erosion Hazards" prepared by The H. John Heinz III Center for Science, Economics and the Environment, April 2000. www.heinzctr.org/NEW_WEB/PDF/erosnrpt.pdf#pagemode=bookmarks&view=Fit
[14] South Carolina Department of Health and Environmental Control, 2010.
[15] Schwab, William, *et. al*. "Coastal Change Along the Shore of Northeastern South Carolina – The South Carolina Coastal Erosion Study." United State Geological Survey, Circular 1339: 2009. http://pubs.usgs.gov/circ/circ1339/pdf/circular1339.pdf

next section under *Flood*). Given the City's long-term commitment to beach nourishment to mitigate erosion, no further analysis is performed in Section 5: *Vulnerability Assessment.*

4.14 FLOOD

4.14.1 Background

Flooding is the most frequent and costly natural hazard in the United States; a hazard that has caused more than 10,000 deaths since 1900. Nearly 90 percent of presidential disaster declarations result from natural events where flooding was a major component.

Floods generally result from excessive precipitation, and can be classified under two categories: general floods, precipitation over a given river basin for a long period of time along with storm-induced wave or tidal action; and flash floods, the product of heavy localized precipitation in a short time period over a given location. The severity of a flooding event is typically determined by a combination of several major factors, including: stream and river basin topography and physiography; precipitation and weather patterns; recent soil moisture conditions; and the degree of vegetative clearing and impervious surface.

General floods are usually long-term events that may last for several days. The primary types of general flooding include riverine, coastal and urban flooding. Riverine flooding is a function of excessive precipitation levels and water runoff volumes within the watershed of a stream or river. Coastal flooding is typically a result of storm surge, wind-driven waves and heavy rainfall produced by hurricanes, tropical storms and other large coastal storms. [16] Urban flooding occurs where manmade development has obstructed the natural flow of water and decreased the ability of natural groundcover to absorb and retain surface water runoff.

Most flash flooding is caused by slow-moving thunderstorms in a local area or by heavy rains associated with hurricanes and tropical storms. However, flash flooding events may also occur from a dam or levee failure within minutes or hours of heavy amounts of rainfall, or from a sudden release of water held by a retention basin or other stormwater control facility. Although flash flooding occurs most often along mountain streams, it is also common in urbanized areas where much of the ground is covered by impervious surfaces.

The periodic flooding of lands adjacent to rivers, streams and shorelines (land known as floodplain) is a natural and inevitable occurrence that can be expected to take place based upon established recurrence intervals. The recurrence interval of a flood is defined as the average time interval, in years, expected between a flood event of a particular magnitude and an equal or larger flood. Flood magnitude increases with increasing recurrence interval.

Floodplains are designated by the frequency of the flood that is large enough to cover them. For example, the 10-year floodplain will be covered by the 10-year flood, and the 100-year floodplain by the 100-year flood. Flood frequencies such as the 100-year flood are determined by plotting a graph of the size of all known floods for an area and determining how often floods of a particular size occur. Another way of expressing the flood frequency is the chance of occurrence in a given year, which is the percentage of the probability of flooding each year. For example, the 100-year flood has a 1 percent

[16] While briefly mentioned here, coastal flooding is more thoroughly addressed under the "storm surge" hazard.

chance of occurring in any given year, and the 500-year flood has a 0.2 percent chance of occurring in any given year.

4.14.2 Location and Spatial Extent

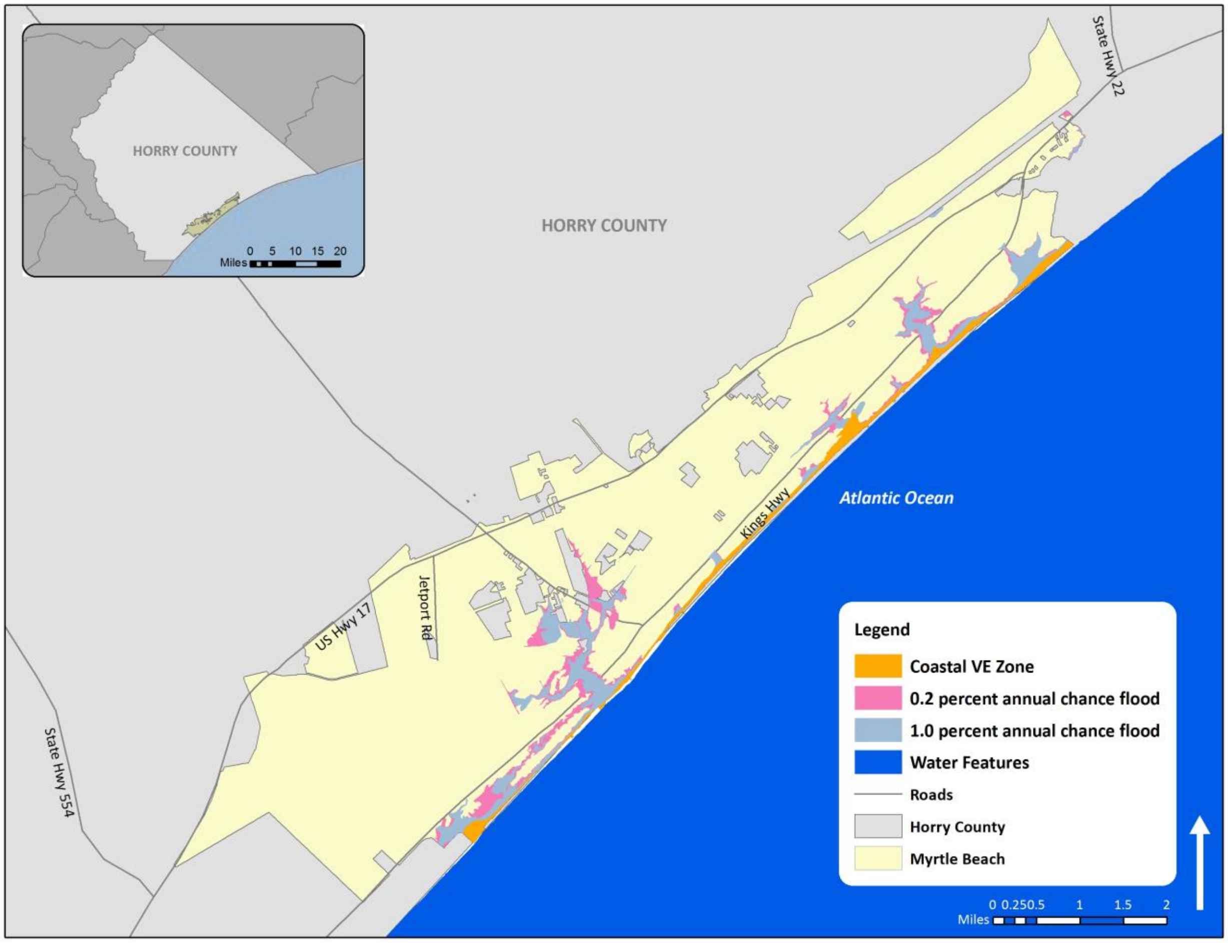
Many areas of the City of Myrtle Beach are susceptible to flooding, and its coastal areas are also very susceptible to tidal and coastal flooding due to coastal storm events including storm surge, hurricanes, tropical storms, and northeasters.[17] Flooding from rainfall occurs along all six swashes in Myrtle Beach—Midway, Withers, Deep Head, Canepatch, Bear Branch, and Singleton—and in other low-lying areas. Flooding is exacerbated in these areas by high tides. When the discharge points of these drainage systems are blocked by a high tide, then the precipitation that has occurred upstream has nowhere to flow. Instead, the water floods low areas along natural watercourses and within the man-made storm water system. This high tide effect is apparent throughout the city since the discharge points of all drainage systems—the ocean, the swashes, and the Atlantic Intracoastal Waterway—are affected by the tides. Of these discharge points, however, the Intracoastal Waterway near the City is the least affected by the tides.

Several other areas of the City have a history of flooding. The relatively flat topography and inadequately sized drainage facilities have combined to create ponding of storm water. Many of the frequently flooded areas that were identified in the last plan update have been mitigated through various stormwater projects. As a result, there are far fewer areas of concern during this update. The primary area of concern identified during the 2015 update of the plan is around the post office on 5th Avenue. The city is currently working on a plan to mitigate this area and is hoping to mitigate it in the next few years.

Flood areas can also be mapped using Geographic Information System (GIS) and FEMA Digital Flood Insurance Rate Maps (DFIRM). **Figure 4.13** illustrates the location and extent of currently mapped special flood hazard areas for the City of Myrtle Beach based on best available FEMA Digital Flood Insurance Rate Map (DFIRM) data.[18] This includes Zones A/AE (1-percent annual chance floodplain), Zone VE (coastal floodplain associated with wave action 1.5 feet to 3.5 feet) and Zone X500 (0.2-percent annual chance floodplain). According to GIS analysis, of the 23.39 square miles that make up Myrtle Beach, there are 1.01 square miles of land in the 1-percent annual chance floodplain, 0.45 square miles of land in the coastal floodplain, and 0.62 square miles of land in the 0.2-percent annual chance floodplain. It is important to note that while FEMA digital flood data is recognized as best available data for planning purposes, it does not always reflect the most accurate and up-to-date flood risk. Flooding and flood-related losses often do occur outside of delineated special flood hazard areas.

[17] Storm surge is addressed separately within this section.
[18] The DFIRM data used for the City of Myrtle Beach was last updated in 1999.

Figure 4.13: Special Flood Hazard Areas in Myrtle Beach



Source: Federal Emergency Management Agency

4.14.3 Historical Occurrences

Information from the City of Myrtle Beach and the National Climatic Data Center were used to ascertain historical flood occurrence events. According to the city, there have been thirty-seven (37) flood events in the City of Myrtle Beach since 1954.[19, 20] The National Climatic Data Center reported ten (10) additional events in the city for a total of 47. According to the events in **Table 4.20**, there was over $1.9 million (2014 dollars) in property damage due to flood events throughout the City.

[19] The reported flood events are only inclusive of that reported by the National Climatic Data Center (NCDC). It is likely that additional flood events have affected the City of Myrtle Beach. As additional local data becomes available, this hazard profile will be amended.

[20] Some of these events are from a single storm or hurricane event that lasted several days.

Table 4.20: Historical Flood Impacts

Location	Date	Type	Deaths/ Injuries	Property Damage (2014 dollars)	Description
Myrtle Beach	10/15/1954	Flooding	0/0	$0	Hurricane Hazel caused flooding in Myrtle Beach.
Myrtle Beach	10/02/1989	Flooding	0/0	$0	Kings Highway/ US 17 Bypass and Haskel Road were closed due to 4 inches of rain in 2 hours.
Myrtle Beach	8/10/1990	Flooding	0/0	$0	Kings Highway/ US 17 Bypass was closed due to 3.01 inches of rain in 2 hours.
Myrtle Beach	08/04/1992	Flooding	0/0	$0	Kings Highway/ US 17 Bypass was closed due to 3.1 inches of rain in 2 hours
Myrtle Beach	10/07/1992	Flooding	0/0	$0	Kings Highway/ US 17 Bypass was closed due to 3.3 inches of rain in 2 hours.
Myrtle Beach	10/14/1994	Flooding	0/0	$0	Kings Highway/ US 17 Bypass and Haskel Road were closed due to 4 inches of rain in 2 hours. In addition, backyards flooded.
Horry County*	12/22/1994	Heavy Rains/ Flooding	2/0	$217,354	Heavy rains caused considerable street flooding in Myrtle Beach. There were many traffic accidents and one apparent hit and run accident in Myrtle Beach caused a fatality. The Forest Acres Apartment Complex right on the beach was evacuated with up to 3 feet of water reported in some coastal homes. Some crop damage reported.
Myrtle Beach	12/23/1994	Flooding	0/0	$0	Rain began in the early evening and continued through the next dumping 3 inches of rain in 6 hours.
Myrtle Beach	12/24/1994	Flooding	0/0	$0	A project area was severely flooded due to 2.5 inches of rain in 6 hours.
Myrtle Beach*	06/05/1995	Flash Flood	0/0	$3,251	
Myrtle Beach*	08/24/1995	Urban Flood	0/0	$0	Heavy rains caused road closures.
Myrtle Beach	10/07/1995	Flooding	0/0	$0	A project area was severely flooded due to 2.5 inches of rain in 6 hours.
Myrtle Beach	07/11/1996	Flooding	0/0	$0	Hurricane Bertha caused 0.5 inches of rain in 24 hours.
Myrtle Beach	07/12/1996	Flooding	0/0	$0	Hurricane Bertha caused 0.1 inches of rain in 24 hours.
Myrtle Beach	09/04/1996	Flooding	0/0	$0	Hurricane Fran caused 0.46 inches of rain in 24 hours.
Myrtle Beach	09/05/1996	Flooding	0/0	$0	Hurricane Fran caused 0.05 inches of rain in 24 hours.
Myrtle Beach	09/06/1996	Flooding	0/0	$0	Hurricane Fran caused 0.2inches of rain in 24 hours.
Myrtle Beach	10/08/1996	Flooding	0/0	$0	2.25 inches of rain in 2 hours caused Kings Highway to close.
Myrtle Beach	07/30/1997	Flooding	0/0	$0	3.75 inches of rain in 2 hours closed Kings Highways and Haskel Road.

Myrtle Beach	01/23/1998	Flash Flood	0/0	$0	Heavy rains during the early morning caused some minor flooding on some secondary roads in Horry County. Jordanville Road was closed for a short time.
Myrtle Beach	02/05/1998	Flooding	0/0	$0	Kings Highway closed as result of 4.5 inches of rain in 2 hours.
Myrtle Beach**	02/17/1998	Flooding	0/0	$0	Nearly 7 inches of rain (including 4.2 inches in two hours) fell on parts of Myrtle Beach resulting in extensive flooding. (this entry was reported from NCDC and the city)
Myrtle Beach	07/31/1998	Flash Flood	0/0	$0	Thunderstorm rains measured 3 to 4 inches, flooding parts of the city. Water approximately 2 feet deep was reported on Kings Hwy between 9th and 11th Avenue.
Myrtle Beach	08/07/1998	Flooding	0/0	$0	Hurricane Bonnie caused 2.5 inches of rain in two hours.
Myrtle Beach	09/22/1998	Flooding	0/0	$0	Hurricane Hugo caused flooding throughout Myrtle Beach.
Myrtle Beach*	6/15/1999	Flash Flood	0/0	$35,514	A slow moving thunderstorm dropped about 4 inches of rain on Myrtle Beach during the afternoon. Drainage pipes were unable to accommodate the runoff at the corner of Ocean Blvd and Ave 55 N, where ponding reached a depth of 5 feet, necessitating the evacuation of 140 people. Between 30 and 40 rain-related car accidents occurred in the Myrtle Beach area.
Myrtle Beach*	09/05/2000	Flash Flood	0/0	$0	Flash flooding prompted Myrtle Beach city crews to barricade sections of Porcher, parts of Oak Street and side streets along 10th Avenue North.
Myrtle Beach	09/06/2000	Flooding	0/0	$0	Hurricane Dennis caused 0.13 inches of rain in 24 hours.
Myrtle Beach	09/07/2000	Flooding	0/0	$0	Hurricane Dennis caused 3.8 inches of rain in Myrtle Beach in 24 hours.
Myrtle Beach	09/15/1999	Flooding	0/0	$0	Hurricane Floyd caused 2 inches of rain in 24 hours. The city was evacuated.
Myrtle Beach	09/16/1999	Flooding	0/0	$575,585	Hurricane Floyd caused 14.8 inches of rain in 24 hours. The city was evacuated.
Myrtle Beach	07/24/2000	Flooding	0/0	$0	3.54 inches of rain in 2 hours caused Kings Highways and Haskel Road to close. In addition, backyards flooded.

Myrtle Beach	09/06/2000	Flooding	0/0	$0	4.52 inches of rain in 2 hours caused Kings Highways and Haskel Road to close. In addition, backyards flooded.
Myrtle Beach**	09/18/2000	Flash Flood	0/0	$13,739	Emergency management reported street flooding on 21st Street, with one home sustaining flood damage. In addition, Kings Highway and Haskel Roads closed and backyards flooded due to 3.55 inches of rain in 2 hours. (this was reported in NCDC and the city)
Myrtle Beach	09/19/2000	Flooding	0/0	$0	3.55 inches of rain in 2 hours caused Kings Highways and Haskel Road to close. In addition, backyards flooded.
Myrtle Beach*	07/02/2001	Flood	0/0	$0	Horry Skywarn reported rainwater flooding 1 foot deep at Ocean Blvd and 2nd Ave N, which was closed by police. Radar estimated 4-5 inches fell over a 2.5 hour period.
Myrtle Beach	08/31/2001	Flooding	0/0	$0	3.34 inches of rain in 2 hours caused Kings Highway to close.
Myrtle Beach*	07/18/2004	Flooding	0/0	$0	*Not Available*
Myrtle Beach	08/29/2004	Flooding	0/0	$18,827	0.43 inches of rain fell as a result of Gaston.
Myrtle Beach	09/16/2004	Flooding	0/0	$451,954	Flooding throughout Myrtle Beach resulted due to Hurricane Charley
Myrtle Beach**	09/14/2005	Flooding	0/0	$0	3.55 inches of rain in 2 hours caused Kings Highways and Haskel Road to close. In addition, backyards flooded. (This event was reported by NCDC and the city.)
Myrtle Beach	10/06/2005	Flooding	0/0	$605,422	7.6 inches of rain in 24 hours caused flooding and Kings Highway to close.
Myrtle Beach	09/01/2006	Flooding	0/0	$0	6.3 inches of rain fell in 24 hours as a result of Ernest.
Myrtle Beach	09/03/2006	Flooding	0/0	$0	Hurricane Fran caused 0.53 inches of rain in 24 hours.
Myrtle Beach*	12/2/2009	Heavy Rain	0/0	$0	*Not Available*
Myrtle Beach*	07/29/2010	Heavy Rain	0/0	$0	*Not Available*
Myrtle Beach*	07/1/2013	Heavy Rain	0/0	$0	*Not Available*

Source: NCDC
**These flood events were reported solely by the National Climatic Data Center.*
***These flood events were reported by both the National Climatic Data Center and the City of Myrtle Beach.*

4.14.4 Historical Summary of Insured Flood Losses

According to FEMA flood insurance policy records as of July 2015, there have been 1,229 flood losses reported in the City through the National Flood Insurance Program (NFIP) since 1978, totaling over $33.5 million in claims payments. These losses include both inland (freshwater) and coastal flooding events. It should be emphasized that these numbers include only those losses to structures that were insured through the NFIP policies, and for losses in which claims were sought and received. It is likely that many additional instances of flood losses in Myrtle Beach were either uninsured, denied claims payment, or not reported.

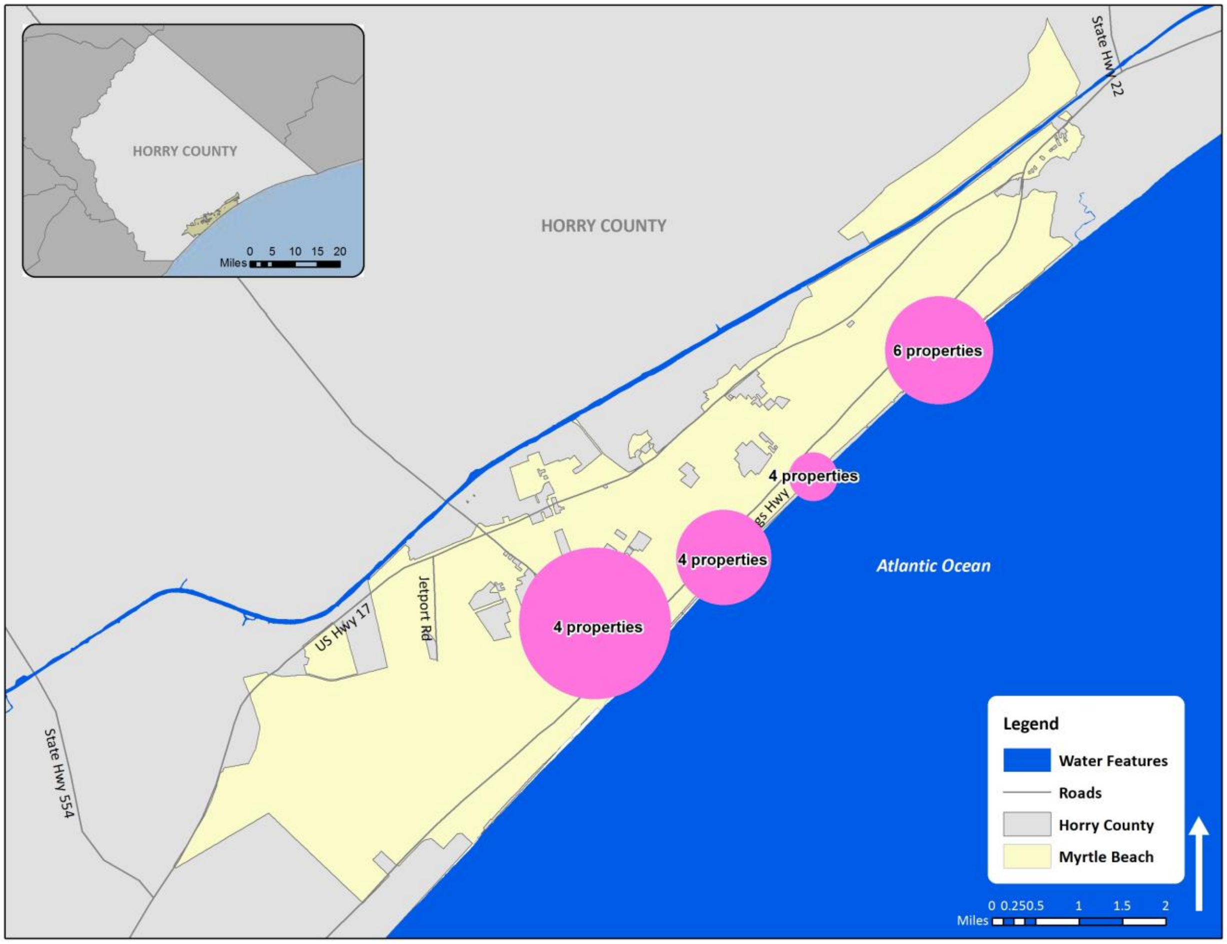
4.14.5 Repetitive Loss Properties

FEMA defines a repetitive loss property as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. A repetitive loss property may or may not be currently insured by the NFIP. Currently there are over 122,000 repetitive loss properties nationwide.

FEMA'S National Flood Insurance Program designated Myrtle Beach as a repetitive loss community in 1996 with 17 properties. In 2004, Myrtle Beach had 64 repetitive loss properties and in May 2009, there were 21 "non-mitigated" repetitive loss properties located in Myrtle Beach. As of July of 2015, there were 18 unmitigated repetitive loss properties including 13 residential properties and 5 non-residential properties (hotels). These properties have accounted for a total of 43 losses and more than $1.3 million in claims payments under the NFIP. The average claim amount for these properties is $35,491.04. Without mitigation, these properties will likely continue to experience flood losses.

As shown on the Repetitive Loss Properties map (**Figure 4.14**), the repetitive loss properties are generally located along the coast, with high concentrations in 4 primary areas throughout the city. Although exact locations for these properties cannot be identified in the body of this plan due to privacy concerns, local officials have access to address information for each of these properties.

Figure 4.14: Repetitive Loss Areas in Myrtle Beach



Source: City of Myrtle Beach

The oceanfront of Myrtle Beach stretches for the city's entire length, approximately ten miles. This area is exposed to flooding from storms that come in from the ocean, hurricanes, waterspouts, and northeasters. Most of the repetitive loss properties in this area are east of Ocean Boulevard, which generally corresponds to the VE zones on the FEMA Federal Insurance Rate Maps. The oceanfront in Myrtle Beach has relatively high elevations compared to the barrier islands along the coast to the north and south.

The remaining repetitive loss properties are located further inland. Only three of the repetitive loss properties in Myrtle Beach are located west of Kings Highway (Highway 17). The properties are located in various locations throughout the jurisdiction.

4.14.6 Probability of Future Occurrences

Flood events will remain a frequent occurrence in the City of Myrtle Beach, and the probability of future occurrences in is highly likely. The probability of future flood events based on magnitude and according to best available data is illustrated in Figure 4.13**,** which indicates those areas susceptible to the 1-

percent annual chance flood (100-year floodplain); the coastal flood zone with wave action; and the 0.2-percent annual chance flood (500-year floodplain). Further, as described in other hazard profiles, it is highly likely that Myrtle Beach will continue to experience inland and coastal flooding associated with large tropical storms, hurricanes and storm surge events.

It should also be noted that anticipated sea level rise will increase the probability and intensity of future tidal flooding events in years to come. Rising sea level over time will shorten the return period (increasing the frequency) of significant flood events. This hazard is discussed elsewhere in this section. For example; sea level rise of 1 foot over a typical project analysis period (50 years) may cause a flood event currently of annual probability 2-percent (50-year flood) to become an event of 10-percent annual probability (10-year flood).

4.15 STORM SURGE

4.15.1 Background

Storm surge occurs when the water level of a tidally influenced body of water increases above the normal astronomical high tide, and are most common in conjunction with coastal storms with massive low-pressure systems with cyclonic flows such as hurricanes, tropical storms and nor'easters. The low barometric pressure associated with these storms cause the water surface to rise, and storms landfalling during peak tides have surge heights and more extensive flood inundation limits. Storm surges will inundate coastal floodplains by dune overwash, tidal elevation rise in inland bays and harbors, and backwater flooding through coastal river mouths. The duration of a storm is the most influential factor affecting the severity and impact of storm surges.

A storm surge is often described as a wave that has outrun its generating source and become a long period swell. It is often recognized as a large dome of water that may be 50 to 100 miles wide and rising anywhere from four to five feet in a Category 1 hurricane up to 20 feet in a Category 5 storm. The storm surge arrives ahead of the storm center's actual landfall and the more intense the storm is, the sooner the surge arrives. Water rise can be very rapid, posing a serious threat to those who have not yet evacuated flood-prone areas. The surge is always highest in the right-front quadrant of the direction in which the storm is moving. As the storm approaches shore, the greatest storm surge will be to the north of the low-pressure system or hurricane eye. Such a surge of high water topped by waves driven by hurricane force winds can be devastating to coastal regions, causing severe beach erosion and property damage along the immediate shoreline.

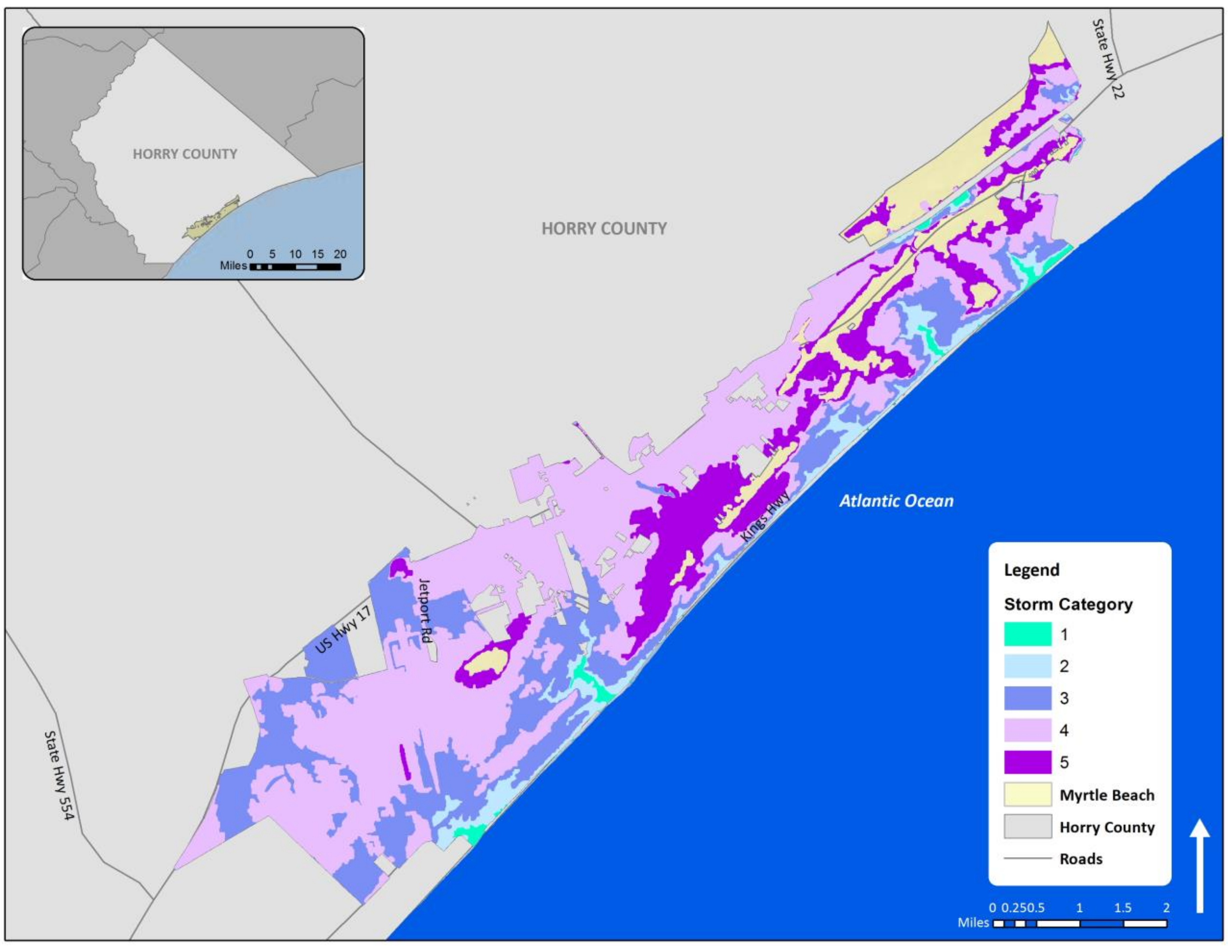
Storm surge heights and associated waves are dependent on not only the storm's intensity but also upon the shape of the offshore continental shelf (narrow or wide), the depth of the ocean bottom (bathymetry), and astronomical tides. A narrow shelf, or one that drops steeply from the shoreline and subsequently produces deep water close to the shoreline, tends to produce a lower surge but higher and more powerful storm waves. In addition, a storm surge event occurs during high tide will result in increased flooding and inundation of coastal areas. The storms that generate the largest coastal storm surges can develop year-round, but they are most frequent from late summer to early spring.

4.15.2 Location and Spatial Extent

There are many areas in the City of Myrtle Beach that are subject to potential storm surge inundation as modeled and mapped by the U.S. Army Corps of Engineers (USACE). **Figure 4.15** illustrates hurricane storm surge inundation zones different categories of storms in Myrtle Beach. The illustration is derived from geo-referenced SLOSH (Sea, Lake and Overland Surge from Hurricanes) data produced by the USACE in coordination with NOAA in 2011. SLOSH is a modeling tool used to estimate storm surge for coastal areas resulting from historical, hypothetical or predicted hurricanes taking into account maximum expected levels for pressure, size, forward speed, track and winds. Therefore, the SLOSH data is best used for defining the potential maximum surge associated with various storm intensities for any particular location.

As shown in the figures, the entire coast of the city is at high risk to storm surge inundation. Inland areas will also experience substantial flooding during a storm event. Based on the SLOSH model, 6.6 square miles of Myrtle Beach have been identified as being at risk to a Category 3 storm surge hazard and 21.2 square miles are at risk to a Category 5 event.

Figure 4.15: Storm Surge Risk Areas in Myrtle Beach



Source: United States Army Corp of Engineers, NOAA

4.15.3 Historical Occurrences

According to NCDC, two storm surge events have been reported for Horry County.[21]

October 15, 1954: Hurricane Hazel
Hurricane Hazel struck Myrtle Beach during the highest lunar tide of the year. As a result, storm surge was higher, rising to 15.5 feet during the storm. In addition, the surge downed countless trees along the coast.

September 6, 2008: Tropical Storm Hannah
Tropical Storm Hannah caused several road closures throughout Horry County as a result of flooding and minor storm surge.

While not reported in the NCDC database, **Hurricane Hugo** (September 1989) delivered a storm surge of an estimated 13ft to Myrtle Beach.

4.15.4 Probability of Future Occurrences

It is likely that the City of Myrtle Beach will continue to experience storm surge associated with large tropical storms, hurricanes and squalls combined with high tides. As noted in the preceding section (under *Flood*), anticipated sea level rise will increase the probability and intensity of future storm surge events in years to come.[22] This rise in sea level will not only increase the probability and intensity of tidal flooding events, but will also contribute to the loss of coastal wetlands and erosion of sand beaches that act as protective buffers against storm surge events.

4.16 SEA LEVEL RISE

4.16.1 Background

Sea Level Rise is defined as the mean rise in sea level. It is caused by two factors: 1) as the ocean warms, sea water expands in volume; 2) continental ice shelves melt, increasing the amount of water in the oceans. This leads to a greater area of land being inundated by sea water.

Rising sea level contributes to the loss of coastal wetlands (which provide protective buffers from flood events), beach erosion, population and property in low areas, coastal habitats and species. Further, flooding and hurricane events are more severe and effect a greater area.

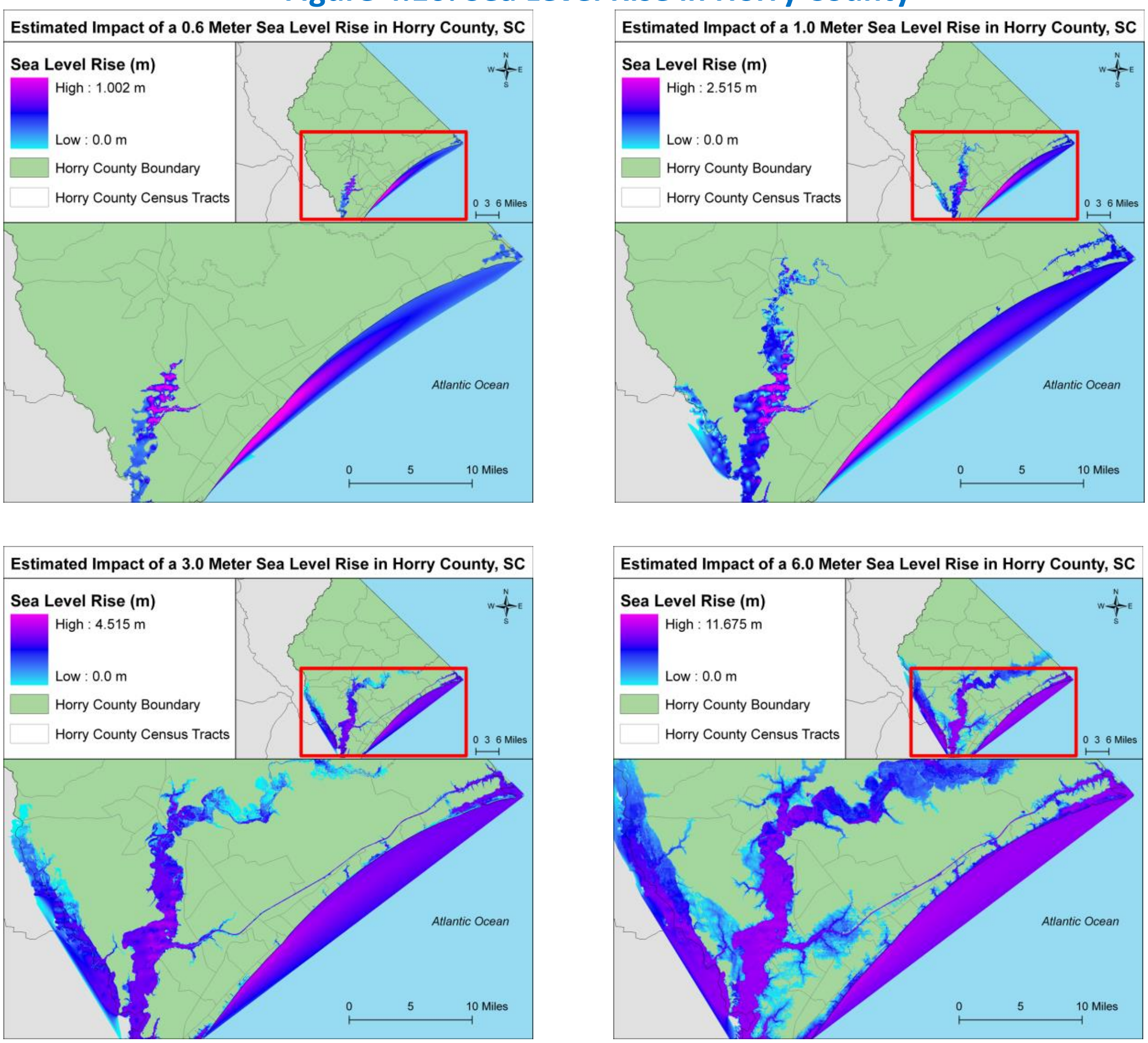
Given that 600 million people live in an area that is less than 10 meters or 33 feet above sea, level and the coastal population has doubled in the last 50 years, there is a great vulnerability to sea level rise.

[21] This is only the reported information from NCDC and does not include additional information from the public or local data sources. As more information becomes available, the plan will be amended.
[22] The Sea Level Rise hazard is assessed more extensively under Section 4.19.

4.16.2 Location and Spatial Extent

Sea level rise is occurring at a global scale. However, it does not affect areas uniformly and will be more severe in some places. **Figure 4.16** shows a hypothetical situation of sea level rise where the sea rises at 0.6 meters, 1.0 meters, 3 meters, and 6 meters. This research was conducted by the Hazards and Vulnerability Research Institute at the University of South Carolina and provided by the South Carolina Division of Emergency Management. The analysis used mosaicking LIDAR at a 4 meter grid (converted to match NOAA specifications) to determine elevation. Then ArcView GIS methodologies of bathtub/fill and nearest neighbor functionality were used to determine where flooding would occur at each interval. Myrtle Beach in impacted at each level as indicated in the scenarios.

Figure 4.16: Sea Level Rise in Horry County



Source: Emrich, Christopher. University of South Carolina Hazards and Vulnerability Research Institute; South Carolina Emergency Management Division

Additionally, **Figure 4.17** identifies areas in Myrtle Beach that would be inundated by water as a result of three feet in sea level rise as per projections by NOAA. The highest level of sea level rise projected by NOAA is shown in **Figure 4.18**. This figure shows the inundation areas in the case of six feet of sea level rise. This demonstrates the additional areas that would be impacted beyond the three feet scenario.

Figure 4.17: Three Feet Sea Level Rise in Horry County

Source: NOAA

Figure 4.18: Six Feet Sea Level Rise in Horry County

Source: NOAA

4.16.3 Historical Occurrences

Sea-level rise is a slow-onset hazard and specific events/occurrences are not possible to determine.

4.16.4 Probability of Future Occurrence

There is still much debate regarding the probability of future occurrence of sea level rise. This section will be updated as more reliable information becomes available. Future sea level rise is considered likely.

OTHER HAZARDS

4.17 ACTS OF TERROR

4.17.1 Background

Terrorism is defined by FEMA as, "the use of force or violence against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion, or ransom." Certain facilities are at greater risk than others to a terrorist attack. A high-risk target is defined by FEMA as military and civilian government facilities, international airports, large cities, and high-profile landmarks. Terrorists may also target large public gatherings, water and food supplies, and utilities.

Acts of terror may include assassinations and armed attacks, kidnappings, hijackings, bomb scares and bombings, cyber-attacks (computer-based), and the use of chemical, biological, nuclear and radiological weapons. Each act of terror is described below[23]:

Assassinations/Armed Attack:
Tactical assault or sniping from a remote location.

Kidnapping:
Capturing a person or persons against their will and holding them in false imprisonment, often for ransom.

Hijacking:
Robbing or seizing control or a vehicle by use of force.

Bomb Scares and Bombing:
A bombing is the result of a detonation of any material that will cause injury, death, or property damage. A bomb scare involves the verbal or written threat to detonate a bomb.

Cyber Attack:
Refers to the electronic attack using one computer system against another.

Chemical Agent:
Liquid/aerosol contaminants can be dispersed using sprayers or other aerosol generators; liquids vaporizing from puddles or containers; or munitions.

Biological Agent:
Liquid or solid toxic contaminants can be dispersed using sprayers/aerosol generators, or by point of line sources such as munitions, covert deposits and moving sprayers.

Nuclear Bomb:
A nuclear device may be detonated underground, at the surface, in the air or at high altitude.

[23] Much of this information comes from the FEMA State and Local Mitigation Planning How-to Guide: Integrating Manmade Hazards.

Radiological Agent:
Radioactive contaminants can be dispersed using sprayers/aerosol generators, or by point of line sources such as munitions, covert deposits and moving sprayers.

The United States Department of Homeland Security posts terror threat levels corresponding to a certain color. This warning system is shown in **Table 4.21.**

Table 4.21: Homeland Security Advisory System

Threat Level	Description	Federal Government Agency Response
SEVERE	Severe Risk of Terrorist Attacks	Under a Severe threat level, personnel will be increased or redirected to address emergency needs, specially trained teams will be pre-positioned as needed, transportations systems are to be monitored, redirected, and/or constrained, and public and government facilities may be closed.
HIGH	High Risk of Terrorist Attacks	A High threat level requires coordinating efforts between Federal, State, and local law enforcement agencies, taking additional precautions at public events (including alternate venues and cancellation), restricting threatened facilities to essential personnel only, and preparing to execute contingency procedures if necessary.
ELEVATED	Significant Risk of Terrorist Attacks	In Elevated situations, agencies should increase surveillance of critical places, coordinate emergency plans with neighboring jurisdictions, and implementing emergency response plans, where appropriate.
GUARDED	General Risk of Terrorist Attacks	This threat level requires that agencies check communications with designated emergency response and command locations, reviewing and updating emergency response plans, and providing the public with information to better manage a terrorist attack situation.
LOW	Low Risk of Terrorist Attacks	Requires “proactive measures” such as making sure as personnel is trained to deal with a terrorist attack, identifying vulnerabilities to a terrorist attack, and mitigating any vulnerabilities.

4.17.2 Location and Spatial Extent

While there are few high risk targets in the City of Myrtle Beach, the city is uniformly at risk to a terrorist attack since such events have no geographic boundaries. However, certain acts of terror, such as a bombing, will affect localized areas while others, such as chemical agents, may affect areas for miles if carried by persons, water, or wind. In addition, terrorists may instill fear in people that prevents travel and thus tourism dollars from entering the local economy.

The city noted that the entire grid system of utilities was a potential risk and that in many locations, there is not adequate protection of these facilities and the public has fairly open access to these facilities.

In addition to specific facilities, the planning team also recognized that there are a number of major events that occur in the city throughout the year that draw large crowds and which would be susceptible to a potential act of terror. Most of these events occur between March and October and include the Country Music Festival, Myrtle Beach Marathon, and Bike Week, among others.

Finally, the planning team noted that a growing concern when it comes to acts of terror is the threat of cyberterrorism which could be perpetrated from a distance and could cause major issues to the city's overall security. City officials noted that this is potentially the biggest threat going forward in terms of acts of terror, even though there have not been any major historic occurrences.

4.17.3 Historical Occurrences

There is no known history of a major act of terror occurring in Myrtle Beach. The planning team did note that there was a fire bomb thrown at City Hall at one point, but it was not considered a large-scale act of terror.

4.17.4 Probability of Future Occurrence

The probability of a future terrorist attack in Myrtle Beach is unlikely. However, a single event could have devastating effects on human lives, the economy, and future way of life.

4.18 AIRPLANE CRASH

4.18.1 Background

An airplane crash endangers the passengers onboard the craft as well as people and property at the crash site. The extent of an airplane crash risk is based on many factors including the size of the aircraft and location of crash site. For example, a large commuter jet crashing into a heavily populated urban area will likely have far greater damages than a personal aircraft crashing in a rural area.

4.18.2 Location and Spatial Extent

The existence of Myrtle Beach International Airport creates increased air traffic over the city. The airport caters to both commercial and cargo flights. However, the location of an airplane crash cannot be predicted. Therefore, the entire city of Myrtle Beach is at risk.

4.18.3 Historical Occurrences

There is no recent history of a major commercial airplane crash occurring in Myrtle Beach. The planning team noted that there have been occasional banner planes that have gone down, but those occur relatively infrequently (maybe every 5 years or so), and do not pose a major threat to safety.

4.18.4 Probability of Future Occurrence

The probability of an airplane crash in Myrtle Beach is unlikely. However, as the airport expands and runs more flights, the risk of a crash increases. Further, a single event could have serious consequences on the affected population and tourism.

4.19 HAZARDOUS MATERIALS INCIDENTS

4.19.1 Background

Hazardous materials can be found in many forms and quantities that can potentially cause death, serious injury, long-lasting health effects and damage to buildings, homes and other property in varying degrees. Such materials are routinely used and stored in many homes and businesses and are also shipped daily on the nation's highways, railroads, waterways and pipelines. This subsection on the hazardous material hazard is intended to provide a general overview of the hazard, and the threshold for identifying fixed and mobile sources of hazardous materials is limited to general information on rail, highway and FEMA-identified fixed HAZMAT sites determined to be of greatest significance as appropriate for the purposes of this plan.

Hazardous material (HAZMAT) incidents can apply to fixed facilities as well as mobile, transportation-related accidents in the air, by rail, on the nation's highways and on the water. Approximately 6,774 HAZMAT events occur each year, 5,517 of which are highway incidents, 991 are railroad incidents and 266 are due to other causes.[24] In essence, HAZMAT incidents consist of solid, liquid and/or gaseous contaminants that are released from fixed or mobile containers, whether by accident or by design as with an intentional terrorist attack. A HAZMAT incident can last hours to days, while some chemicals can be corrosive or otherwise damaging over longer periods of time. In addition to the primary release, explosions and/or fires can result from a release, and contaminants can be extended beyond the initial area by persons, vehicles, water, wind and possibly wildlife as well.

HAZMAT incidents can also occur as a result of or in tandem with natural hazard events, such as floods, hurricanes, tornadoes and earthquakes, which in addition to causing incidents can also hinder response efforts. In the case of Hurricane Floyd in September 1999, communities along the Eastern United States were faced with flooded junkyards, disturbed cemeteries, deceased livestock, floating propane tanks, uncontrolled fertilizer spills and a variety of other environmental pollutants that caused widespread toxological concern.

Hazardous material incidents can include the spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping or disposing into the environment of a hazardous material, but exclude: (1) any release which results in exposure to poisons solely within the workplace with respect to claims which such persons may assert against the employer of such persons; (2) emissions from the engine exhaust of a motor vehicle, rolling stock, aircraft, vessel or pipeline pumping

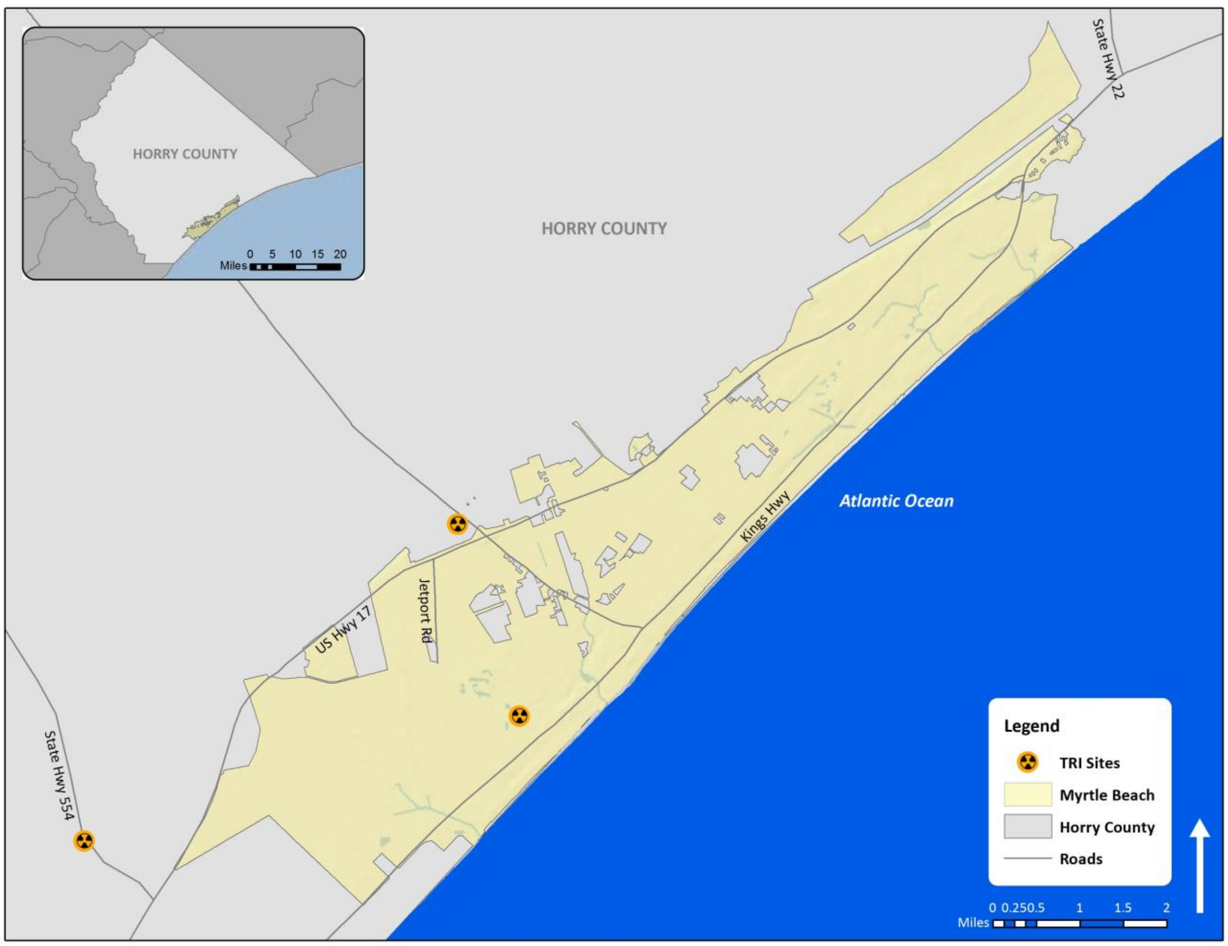
[24] FEMA, 1997.

station engine; (3) release of source, byproduct, or special nuclear material from a nuclear incident; and (4) the normal application of fertilizer.

4.19.2 Location and Spatial Extent

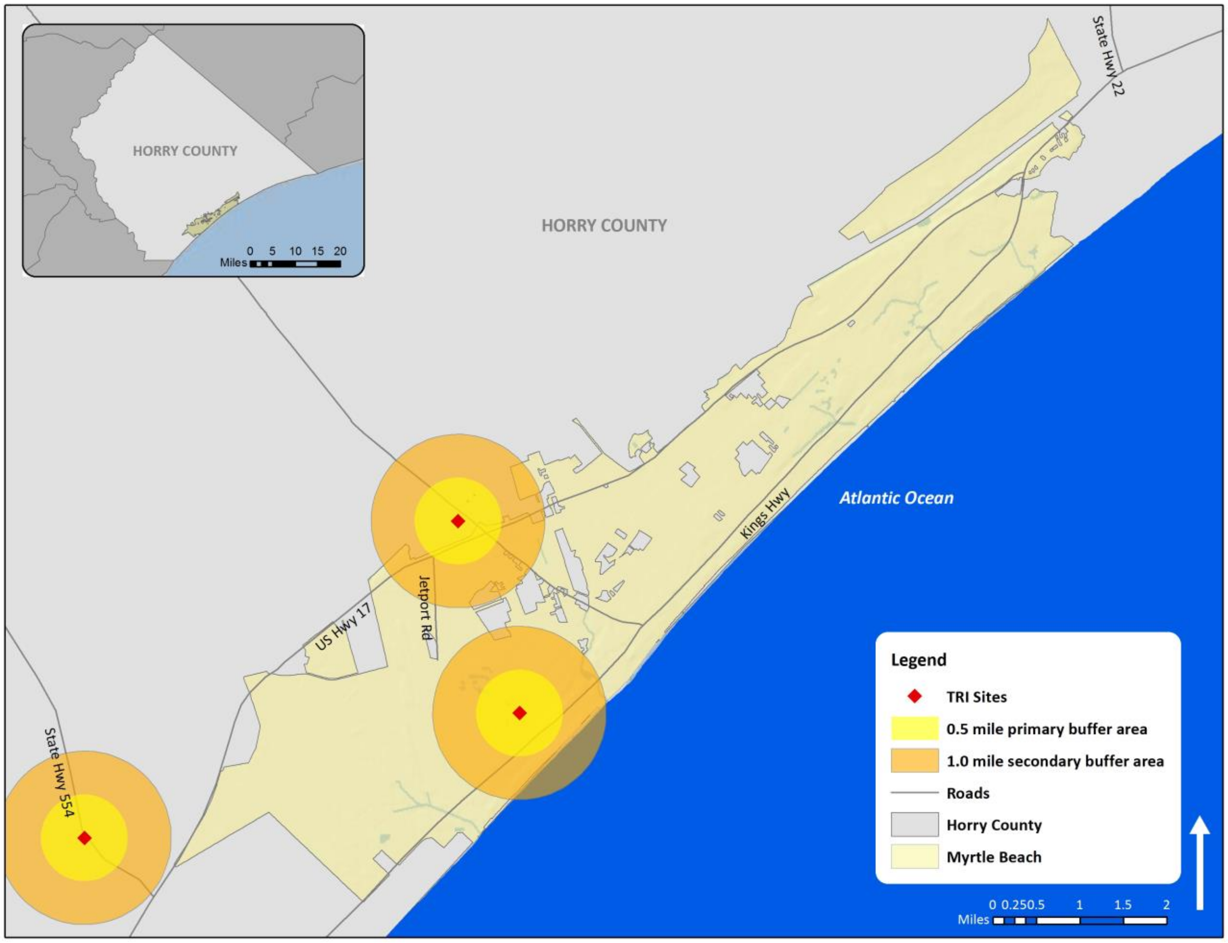
As a result of the 1986 Emergency Planning and Community Right to Know Act (EPCRA), the Environmental Protection Agency provides public information on hazardous materials. One facet of this program is to collect information from industrial facilities on the releases and transfers of certain toxic agents. This information is then reported in the Toxic Release Inventory (TRI). TRI sites indicate where such activity is occurring. Myrtle Beach has three TRI sites that are shown in **Figure 4.19.** Certain chemicals may travel through the air or water, affecting a much larger area than the point itself. Therefore, analysis is conducted using a 0.5 mile buffer and 1.0 mile buffer around the TRI sites to determine risk of people and property in the area. **Figure 4.20** shows the area affected when the buffers area applied.

Figure 4.19: Toxic Release Inventory (TRI) Sites in the City of Myrtle Beach



Source: EPA

Figure 4.20: Toxic Release Inventory (TRI) Sites with Buffers



Source: EPA

In addition to the identified hazardous materials sites above, the city noted that a hazardous material incident of pertinent concern is a chlorine spill, which is much more likely in Myrtle Beach than in other areas due to the prevalence of swimming pools in the city. A chlorine spill could cause a number of hazards if the chemical is released either into the water supply or natural environment and if it is spilled in the vicinity of large groups of people, it can pose a threat to health and well-being.

4.19.3 Historical Occurrences

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) lists historical occurrences throughout the nation. A “serious incident” is a hazardous materials incident that involves:

- a fatality or major injury caused by the release of a hazardous material,
- the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire,
- a release or exposure to fire which results in the closure of a major transportation artery,

- the alteration of an aircraft flight plan or operation,
- the release of radioactive materials from Type B packaging,
- the release of over 11.9 gallons or 88.2 pounds of a severe marine pollutant, or
- the release of a bulk quantity (over 199 gallons or 882 pounds) of a hazardous material.

However, prior to 2002, a hazardous materials "serious incident" was defined as follows:

- a fatality or major injury due to a hazardous material,
- closure of a major transportation artery or facility or evacuation of six or more person due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

There have been a total of 23 recorded HAZMAT incidents in Myrtle Beach since 1977. These events resulted in about $4,000 (2014 dollars) of property damage as well as 1 injury. **Table 4.22** presents detailed information on historical HAZMAT incidents in Myrtle Beach as reported by the U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA).

Report Number	Date	City	Mode	Serious Incident?	Fatalities / Injuries	Damages ($)*	Quantity Released
I-1977070277	6/3/1977	MYRTLE BEACH	Air	No	0/0	$0	0
I-1979040051	3/20/1979	MYRTLE BEACH	Highway	No	0/0	$0	10 LGA
I-1983090581	8/19/1983	MYRTLE BEACH	Highway	No	0/0	$0	0
I-1983090581	8/19/1983	MYRTLE BEACH	Highway	No	0/0	$0	15 LGA
I-1986010043	12/18/1985	MYRTLE BEACH	Highway	No	0/0	$0	40 LGA
I-1986060050	5/31/1986	MYRTLE BEACH	Highway	No	0/0	$0	50 LGA
I-1988080642	8/8/1988	MYRTLE BEACH	Highway	No	0/0	$0	4 SLB
I-1991030668	3/14/1991	MYRTLE BEACH	Highway	No	0/0	$61	35 LGA
I-1994010489	4/2/1993	MYRTLE BEACH	Highway	No	0/0	$41	0.007813 LGA
I-1994050417	4/1/1994	MYRTLE BEACH	Air	No	0/1	$0	1.056688 LGA
I-1997040395	3/17/1997	MYRTLE BEACH	Highway	No	0/0	$0	0
I-1998010362	12/15/1997	MYRTLE BEACH	Highway	No	0/0	$125	0.125 LGA
I-2001030659	2/1/2001	MYRTLE BEACH	Highway	No	0/0	$11	8 LGA
I-2003010706	12/18/2002	MYRTLE BEACH	Air	No	0/0	$0	0.792516 LGA
I-2004010994	7/4/2003	MYRTLE BEACH	Highway	Yes	0/0	$77	125 LGA
I-2003110413	11/2/2003	MYRTLE BEACH	Highway	Yes	0/0	$139,576	5,700 LGA
I-2004081552	8/5/2004	MYRTLE BEACH	Highway	No	0/0	$1,922	20 LGA
I-2004101004	10/16/2004	MYRTLE BEACH	Highway	No	0/0	$3,355	100 LGA
I-2010120284	12/8/2010	MYRTLE BEACH	Highway	No	0/0	$0	1 LGA
I-2014030121	2/28/2014	MYRTLE BEACH	Highway	No	0/0	$0	0.015625 LGA
I-2014090367	8/25/2014	MYRTLE BEACH	Highway	No	0/0	$0	0.023438 LGA
I-2014120158	11/3/2014	MYRTLE BEACH	Highway	No	0/0	$0	0
I-2015030249	2/25/2015	MYRTLE BEACH	Highway	No	0/0	$0	0.03125 LGA

*Property damage is reported in 2014 dollars.

Source: Untied States Department of Transportation Pipeline and Hazardous Materials Safety Administration

4.19.4 Probability of Future Occurrence

Given the location of two toxic release inventory sites in Myrtle Beach and several past incidents, it is likely that a hazardous material incident may occur.

4.20 WILDFIRE

4.20.1 Background

A wildfire is any outdoor fire (i.e. grassland, forest, brush land) that is not under control, supervised, or prescribed.[25] Wildfires are part of the natural management of forest ecosystems, but may also be caused by human factors.

Nationally, over 80 percent of forest fires are started by negligent human behavior such as smoking in wooded areas or improperly extinguishing campfires. The second most common cause for wildfire is lightning. In South Carolina, 98 percent of wildfires are human-caused. The number one cause is woods arson, followed by debris burning.

There are three classes of wildland fires: surface fire, ground fire and crown fire. A surface fire is the most common of these three classes and burns along the floor of a forest, moving slowly and killing or damaging trees. A ground fire (muck fire) is usually started by lightning or human carelessness and burns on or below the forest floor. Crown fires spread rapidly by wind and move quickly by jumping along the tops of trees. Wildfires are usually signaled by dense smoke that fills the area for miles around.

Wildfire probability depends on local weather conditions, outdoor activities such as camping, debris burning, and construction, and the degree of public cooperation with fire prevention measures. Drought conditions and other natural hazards (such as tornadoes, hurricanes, etc.) increase the probability of wildfires by producing fuel in both urban and rural settings. The South Carolina wildfire season runs from late winter to early spring with March being the most severe.

Many individual homes and cabins, subdivisions, resorts, recreational areas, organizational camps, businesses and industries are located within high wildfire hazard areas. Further, the increasing demand for outdoor recreation places more people in wildlands during holidays, weekends and vacation periods. Unfortunately, wildland residents and visitors are rarely educated or prepared for wildfire events that can sweep through the brush and timber and destroy property within minutes.

Wildfires can result in severe economic losses as well. Businesses that depend on timber, such as paper mills and lumber companies, experience losses that are often passed along to consumers through higher prices, and sometimes jobs are lost. The high cost of responding to and recovering from wildfires can deplete state resources and increase insurance rates. The economic impact of wildfires can also be felt in the tourism industry if roads and tourist attractions are closed due to health and safety concerns.

State and local governments can impose fire safety regulations on home sites and developments to help curb wildfire. Land treatment measures such as fire access roads, water storage, helipads, safety zones, buffers, firebreaks, fuel breaks and fuel management can be designed as part of an overall fire defense system to aid in fire control. Fuel management, prescribed burning and cooperative land management planning can also be encouraged to reduce fire hazards.

[25] Prescription burning, or "controlled burn," undertaken by land management agencies is the process of igniting fires under selected conditions, in accordance with strict parameters.

4.20.2 Location and Spatial Extent

Myrtle Beach is prone to wildfires. The entire city has uniform risk exposure to a wildfire occurrence. However, drought conditions may make a fire more likely in those locations.

4.20.3 Historical Occurrences

Based on data from the South Carolina Forestry Commission from 2004 to 2013, Horry County experienced an average of 97 wildfires annually which burn a combined average of 2,970 acres per year. The data indicates that some fires in the area can be quite large, averaging over 30 acres per fire. **Table 4.23** lists the number of reported wildfire occurrences in the county between the years 2004 and 2013.

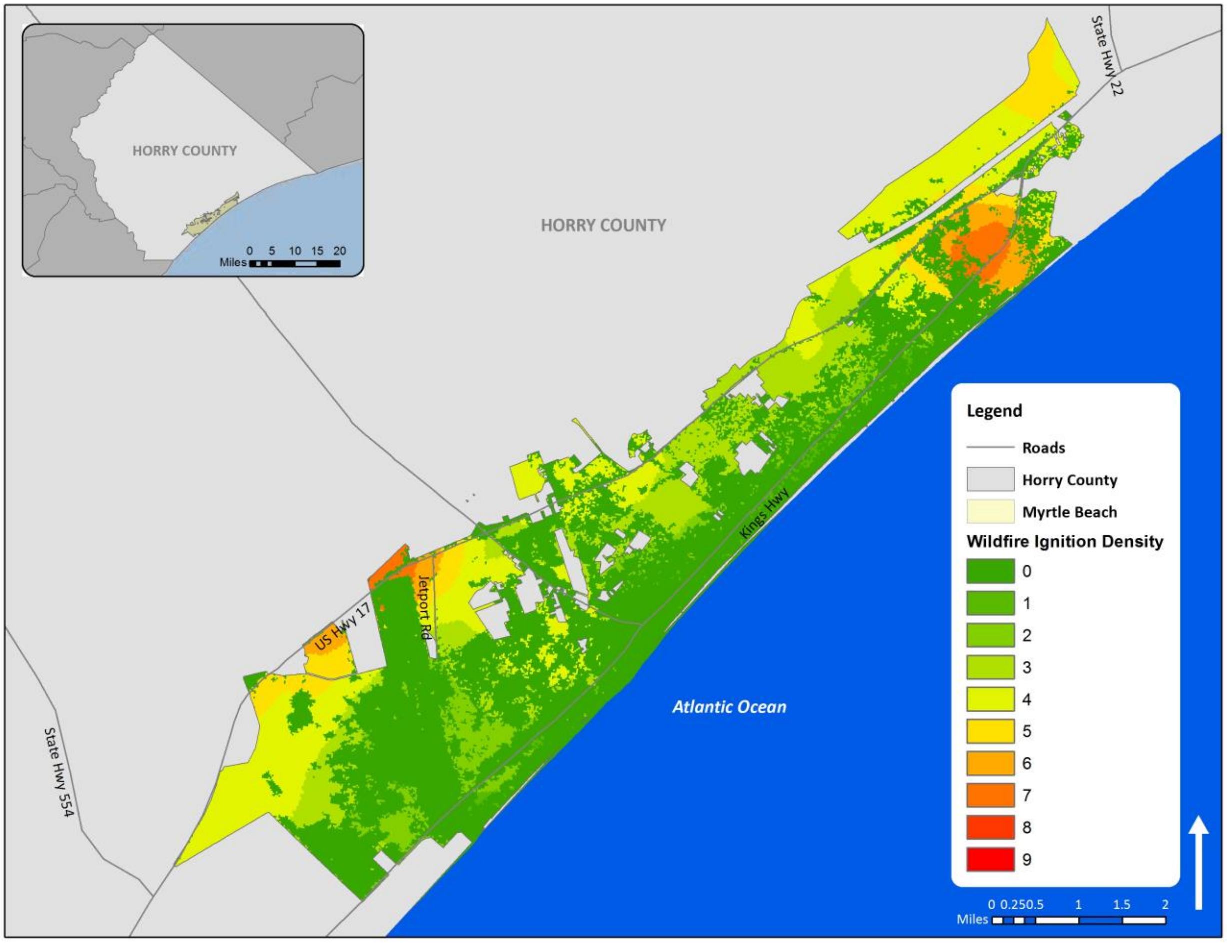
Table 4.22: Historical Wildfire Events in Horry County

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of Fires	147	97	73	131	185	72	46	*Not Available*	90	36
Number of Acres	1,014.5	898.5	321.7	1,631.0	1,126.7	19,357.1	401.5	*Not Available*	1,839.4	139.4

Figure 4.21 shows Wildfire Ignition Density in Myrtle Beach based on data from the Southern Wildfire Risk Assessment. This data is based on historical fire ignitions and the likelihood of a wildfire igniting in an area. Occurrence is derived by modeling historic wildfire ignition locations to create an average ignition rate map. This is measured in the number of fires per year per 1,000 acres.[26]

[26] Southern Wildfire Risk Assessment, 2014.

Figure 4.21: Historical Wildfire Ignition Density in the City of Myrtle Beach



Source: Southern Wildfire Risk Assessment Data, South Carolina Forestry Commission

4.20.4 Probability of Future Occurrences

There is a highly likely probability of future wildfire events in the City of Myrtle Beach, and particularly high during drought cycles and abnormally dry conditions. In addition, certain industrial operations/facilities and transport of flammable materials may also raise the threat of fire.

4.21 CONCLUSIONS ON HAZARD RISK

The hazard profiles presented in this section were developed using best available data and result in what may be considered principally a qualitative assessment as recommended by FEMA in its "How-to" guidance document titled *Understanding Your Risks: Identifying Hazards and Estimating Losses* (FEMA Publication 386-2). It relies heavily on historical and anecdotal data, stakeholder input, and professional and experienced judgment regarding observed and/or anticipated hazard impacts. It also carefully considers the findings in other relevant plans, studies and technical reports.

4.21.1 Hazard Extent

Table 4.24 describes the extent of each natural hazard identified for Myrtle Beach. The extent of a hazard is defined as its severity or magnitude, as it relates to the planning area.

Table 4.23: Extent of Myrtle Beach Hazards

Atmospheric Hazards	
Drought	Drought extent is defined by the South Carolina Climatology Office classifications (Normal, Incipient, Moderate, Severe, Extreme) (pages 4:6-4:9). Horry County and Myrtle Beach have received a Severe rating 3 times over the 10-year reporting period.
Hailstorm	Hail extent can be defined by the size of the hail stone. The largest hail stone reported in Myrtle Beach was 1.75 inches. This size hail has been recorded several times in the history of hail events in Myrtle Beach. It should be noted that future events may exceed this.
Tropical Storm System/Hurricane	Hurricane extent is defined by the Saffir-Simpson Scale which classifies hurricanes into Category 1 through Category 5 (Table 4.12). The greatest classification of hurricanes to traverse directly through Myrtle Beach was an unnamed storm in 1899 which reached a maximum wind speed of 95 knots in the city. The city is susceptible to many of the coastal impacts of a hurricane or tropical storm including high wind speeds and storm surge (addressed below).
Ice Storm	The extent of winter storms can be measured by the amount of snowfall or ice received (in inches). The greatest 24-hour snowfall reported in the city was around 15 in 1989 inches and ice accumulation has been over 1 inch in many cases. Due to unpredictable variations in snowfall, extent totals will vary and reliable data on snowfall totals is not abundantly available.
Lightning	According to the Vaisala flash density map (Figure 4.4), Myrtle Beach is located in an area that experiences 4 to 8 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.
Northeaster	The extent of northeasters can be measured by the amount of snowfall and ice received (in inches). As mentioned above, the greatest 24-hour snowfall reported in the city was over 5 inches and ice accumulation has been over 1 inch. In addition, extent for northeasters can be defined by wind speed and wave height. In Myrtle Beach, Northeasters have caused up to 40 mile per hour winds and waves that are 10 feet above sea level.
Wind Events (Thunderstorm/High Wind)	Wind Event/Thunderstorm extent is defined by the wind speeds reported. The strongest recorded wind event in Myrtle Beach was reported on March 21, 1999 (approximately 75 mph). It should be noted that future events may exceed these historical occurrences.
Tornado	Tornado hazard extent is measured by tornado occurrences in the US provided by FEMA (Figure 4.5) as well as the Fujita/Enhanced Fujita Scale (Tables 4.9 and 4.10). The greatest magnitude reported in Myrtle Beach was an F2 (reported on July 6, 2001). It should be noted that an F5 tornado is possible.
Geologic Hazards	
Earthquake	Earthquake extent can be measured by the Richter Scale (Table 4.17) and the Modified Mercalli Intensity (MMI) scale (Table 4.18). According to data provided by the National Geophysical Data Center, the greatest MMI to impact the county was V (moderate) with a correlating Richter Scale measurement of between 4 and 5 (reported on February 3, 1972 and November 22, 1974).
Tidal Waves/Tsunami	There is no history of tidal waves or tsunami in the Atlantic basin in recent years so an accurate extent measure is difficult to predict. However, it is possible that water depths similar to those experienced by storm surge would occur (in the range of 15-25 feet), with potentially even greater depths depending on the severity of the event that triggered the tidal wave/tsunami.

<table>
<tr><th colspan="2">Hydrologic Hazards</th></tr>
<tr><td>Erosion</td><td>The extent of erosion can be defined by the measurable rate of erosion that occurs or the number of cubic yards eroded. The SC Department of Health and Environmental Control estimates the rate of erosion in Myrtle Beach at around -0.59 feet per year. In addition, during Hurricane Hazel in 1954, almost 1 million cubic yards of sand were eroded in Myrtle Beach.</td></tr>
<tr><td>Flood</td><td>Flood extent can be measured by the amount of land and property in the floodplain as well as flood height and velocity. The amount of land in the floodplain accounts for 8.94 percent of the total land area in Myrtle Beach.

Flood depth and velocity are recorded via United States Geological Survey stream gages in the city. The greatest peak discharge recorded for the city was reported on April 22, 2003. Water reached a discharge of 7,200 cubic feet per second and the gage height was 18.50 feet. Additional peak discharge readings and gage heights are in the table below.

<table>
<tr><th>Location/Jurisdiction</th><th>Date</th><th>Peak Discharge (cfs)</th><th>Gage Height (ft)</th></tr>
<tr><td colspan="4">Horry County</td></tr>
<tr><td>Midway Swash at Myrtle Beach, SC</td><td>8/31/2001</td><td>413</td><td>7.46</td></tr>
<tr><td>AIW at Myrtlewood Golf Course at Myrtle Beach, SC</td><td>4/22/2003</td><td>7,200</td><td>18.50</td></tr>
</table>
</td></tr>
<tr><td>Storm Surge</td><td>Storm surge can be defined by the depth of inundation which is defined by the category of hurricane/tropical storm. Since Myrtle Beach could be impacted by a Category 5 storm, depth of inundation could be 23 to 35 feet.</td></tr>
<tr><td>Sea Level Rise</td><td>Sea level rise is defined by the areas impacted, but is more often associated with the amount of sea level rise that is expected to take place. Although it is difficult to predict an exact amount of rise, many projections call for somewhere in the range of 4-6 feet in the next 100 years.</td></tr>
<tr><th colspan="2">Other Hazards</th></tr>
<tr><td>Acts of Terror</td><td>There is no history of terror threats in Myrtle Beach; however; it is possible that one of these events could occur. If this were to take place, the magnitude of the event could range on the scale of critical damage with many fatalities and injuries to the population.</td></tr>
<tr><td>Airplane Crash</td><td>An airplane crash might cause death or injury to those involved in the accident as well as to bystanders near the site of the incident. The main effects of an airplane crash might be fire or explosions and a shutdown of transportation corridors.</td></tr>
<tr><td>Hazardous Materials Incident</td><td>According to USDOT PHMSA, the largest hazardous materials incident reported in the city was 5,700 LGA released on the highway on November 2, 2003. It should be noted that larger events are possible.</td></tr>
<tr><td>Wildfire</td><td>Wildfire data was provided by the South Carolina Forestry Commission and is reported annually by county from 2004-2013.

Analyzing the data indicates the following wildfire hazard extent for the county.

• The greatest number of fires to occur in any year was 185 in 2008.
• The greatest number of acres to burn in a single year occurred in 2010 when 19,357.1 acres were burned.

Although this data lists the extent that has occurred, larger and more frequent wildfires are possible throughout the county.</td></tr>
</table>

4.21.2 Priority Risk Index

In order to draw some meaningful planning conclusions on hazard risk for Myrtle Beach, the results of the hazard profiling process were used to generate countywide hazard classifications according to a

"Priority Risk Index" (PRI). The purpose of the PRI, described further below, is to categorize and prioritize all potential hazards for Myrtle Beach as high, moderate, or low risk. Combined with the asset inventory and quantitative vulnerability assessment provided in the next section, the summary hazard classifications generated through the use of the PRI allows for the prioritization of those high hazard risks for mitigation planning purposes, and more specifically, the identification of hazard mitigation opportunities for Myrtle Beach to consider as part of their proposed mitigation strategy.

The prioritization and categorization of identified hazards for Myrtle Beach is based principally on the PRI, a tool used to measure the degree of risk for identified hazards in a particular planning area. The PRI is used to assist the City of Myrtle Beach Floodplain Management and Hazard Mitigation Planning Committee (FMHMPC) in gaining consensus on the determination of those hazards that pose the most significant threat to Myrtle Beach based on a variety of factors. The PRI is not scientifically based, but is rather meant to be utilized as an objective planning tool for classifying and prioritizing hazard risks in Myrtle Beach based on standardized criteria.

The application of the PRI results in numerical values that allow identified hazards to be ranked against one another (the higher the PRI value, the greater the hazard risk). PRI values are obtained by assigning varying degrees of risk to five categories for each hazard (probability, impact, spatial extent, warning time and duration). Each degree of risk has been assigned a value (1 to 4) and an agreed upon weighting factor[27], as summarized in **Table 4.25**. To calculate the PRI value for a given hazard, the assigned risk value for each category is multiplied by the weighting factor. The sum of all five categories equals the final PRI value, as demonstrated in the example equation below:

PRI VALUE = [(PROBABILITY x .30) + (IMPACT x .30) + (SPATIAL EXTENT x .20) + (WARNING TIME x .10) + (DURATION x .10)]

According to the weighting scheme applied for Myrtle Beach, the highest possible PRI value is 3.4 (flood hazard). Prior to being finalized, PRI values for each identified hazard were reviewed and accepted by the members of the FMHMPC.

[27] The FMHMPC, based upon any unique concerns or factors for the planning area, may adjust the PRI weighting scheme during future plan updates.

Table 4.24: Priority Risk Index for Myrtle Beach

PRI Category	Degree of Risk			Assigned Weighting Factor
	Level	Criteria	Index Value	
Probability	Unlikely	Less than 1% annual probability	1	30%
	Possible	Between 1 and 10% annual probability	2	
	Likely	Between 10 and 100% annual probability	3	
	Highly Likely	100% annual probability	4	
Impact	Minor	Very few injuries, if any. Only minor property damage and minimal disruption on quality of life. Temporary shutdown of critical facilities.	1	30%
	Limited	Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.	2	
	Critical	Multiple deaths/injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one week.	3	
	Catastrophic	High number of deaths/injuries possible. More than 50% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for 30 days or more.	4	
Spatial Extent	Negligible	Less than 1% of area affected	1	20%
	Small	Between 1 and 10% of area affected	2	
	Moderate	Between 10 and 50% of area affected	3	
	Large	Between 50 and 100% of area affected	4	
Warning Time	More than 24 hours	Self explanatory	1	10%
	12 to 24 hours	Self explanatory	2	
	6 to 12 hours	Self explanatory	3	
	Less than 6 hours	Self explanatory	4	
Duration	Less than 6 hours	Self explanatory	1	10%
	Less than 24 hours	Self explanatory	2	
	Less than one week	Self explanatory	3	
	More than one week	Self explanatory	4	

4.21.3 PRI Results

Table 4.26 summarizes the degree of risk assigned to each category for all initially identified hazards based on the application of the PRI. Assigned risk levels were based on the detailed hazard profiles developed for this section, as well as input from the FMHMPC. The results were then used in calculating PRI values and making final determinations for the risk assessment.

Table 4.25: Summary of PRI Results for Myrtle Beach

Hazard	Category/Degree of Risk					
	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Atmospheric Hazards						
Drought	Likely	Minor	Small	Less than 6 hours	Less than 6 hours	**2.1**
Hailstorm	Highly Likely	Minor	Moderate	Less than 6 hours	Less than 6 hours	**2.6**
Tropical Storm System/Hurricane	Likely	Critical	Large	More than 24 hours	Less than 24 hours	**2.9**
Ice Storm	Possible	Critical	Large	More than 24 hours	Less than 1 week	**2.7**
Lightning	Highly Likely	Minor	Small	Less than 6 hours	Less than 6 hours	**2.4**
Northeaster	Possible	Critical	Large	More than 24 hours	Less than 1 week	**2.7**
Wind Events (Thunderstorm/High Wind)	Highly Likely	Limited	Large	Less than 6 hours	Less than 6 hours	**3.1**
Tornado	Possible	Critical	Small	6 to 12 hours	Less than 6 hours	**2.3**
Geologic Hazards						
Earthquakes	Possible	Minor	Moderate	Less than 6 hours	Less than 6 hours	**2.0**
Tidal Waves/Tsunami	Unlikely	Limited	Small	Less than 6 hours	More than 24 hours	**1.7**
Hydrologic Hazards						
Erosion	Highly Likely	Minor	Small	More than 24 hours	More than 1 week	**2.4**
Flood	Highly Likely	Critical	Moderate	6 to 12 hours	Less than 1 week	**3.3**
Storm Surge	Likely	Critical	Large	More than 24 hours	Less than 24 hours	**2.9**
Sea Level Rise	Likely	Limited	Small	More than 24 hours	More than 1 week	**2.4**
Other Natural Hazards						
Acts of Terror	Unlikely	Critical	Negligible	Less than 6 hours	Less than 6 hours	**1.9**
Airplane Crash	Unlikely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.1**
Hazardous Materials Incident	Likely	Limited	Small	Less than 6 hours	Less than 24 hours	**2.5**
Wildfire	Highly Likely	Minor	Moderate	Less than 6 hours	Less than 24 hours	**2.7**

4.22 FINAL DETERMINATIONS

The conclusions drawn from the hazard profiling process for Myrtle Beach, including the PRI results and input from the FMHMPC, resulted in the classification of risk for each identified hazard according to three categories: High Risk, Moderate Risk and Low Risk (**Table 4.27**). For purposes of these classifications, risk is expressed in relative terms according to the estimated impact that a hazard will have on human life and property throughout all of Myrtle Beach. A more quantitative analysis to estimate potential dollar losses for each hazard has been performed separately, and is described in the *Vulnerability Assessment* section. It should be noted that although some hazards are classified below as posing low risk, their occurrence of varying or unprecedented magnitudes is still possible in some cases and their assigned classification will continue to be evaluated during future plan updates.

Table 4.26: Conclusions on Hazard Risk for Myrtle Beach

HIGH RISK	Flood Wind Events (Thunderstorm/High Wind) Tropical Storm System/Hurricane Storm Surge
MODERATE RISK	Wildfire Ice Storm Northeaster Hail Storm Hazardous Materials Incident Sea Level Rise Erosion Lightning
LOW RISK	Tornado Drought Tidal Wave/Tsunami Airplane Crash Earthquake Acts of Terror