5.4.6 Hurricane and Tropical Storm

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the hurricane and tropical storm hazard in Cape May County.

2021 HMP Update Changes

- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2016 and 2020.
- A vulnerability assessment section was completed for the hurricane and tropical storm hazard that provides a more accurate estimated exposure and potential losses to Cape May County. The potential loss analysis was conducted using a custom County-wide building inventory with an estimated replacement cost value (structure and contents) for each structure; the replacement cost value was calculated using RS Means 2019 data. Using this updated building inventory, it was possible to calculate potential losses at the structure level. A probabilistic assessment for the 100-year and 500-year Mean Return Periods (MRPs) was performed using the most current version of Hazus (v4.2) to estimate potential losses.

5.4.6.1 Profile

Hazard Description

A tropical cyclone is a rotating, organized system of clouds and thunderstorms that originates over tropical or sub-tropical waters and has a closed low-level circulation. Tropical depressions, tropical storms, and hurricanes are all considered tropical cyclones. These storms rotate counterclockwise around the center in the northern hemisphere and are accompanied by heavy rain and strong winds (NWS 2013a). Almost all tropical storms and hurricanes in the Atlantic basin (which includes the Gulf of Mexico and Caribbean Sea) form between June 1 and November 30 (hurricane season). August and September are peak months for hurricane development (NOAA 2013a).

Over a two-year period, the U.S. coastline is struck by an average of three hurricanes, one of which is classified as a major hurricane. Hurricanes, tropical storms, and tropical depressions pose a threat to life and property. These storms bring heavy rain, storm surge, and flooding (NOAA 2013b). The cooler waters off the coast of New Jersey can diminish the energy of storms that have traveled up the eastern seaboard. However, historical data show that a number of hurricanes/tropical storms have impacted New Jersey, often as the remnants of a larger storm hitting the Gulf or Atlantic Coast hundreds of miles south of New Jersey. These storms maintain sufficient wind and precipitation to cause substantial damage to the state.

For the purpose of this HMP update, this hazard profile will include hurricanes and tropical storms. Detailed information regarding these hazards in Cape May County are discussed further in this section.

Hurricanes and Tropical Storm

A tropical storm system is characterized by a low-pressure center and numerous thunderstorms that produce strong winds and heavy rain (winds are at a lower speed than hurricane-force winds, therefore categorized as a tropical storm instead of a hurricane). Tropical storms strengthen when water evaporated from the ocean is released as the saturated air rises, resulting in condensation of water vapor contained in the moist air. They are fueled by a different heat mechanism than other cyclonic windstorms such as Nor'Easters and polar lows. The characteristic that separates tropical cyclones from other cyclonic systems is that at any height in the atmosphere,

the center of a tropical cyclone will be warmer than its surroundings; a phenomenon called "warm core" storm systems (NOAA 2013c).

A hurricane is a tropical storm that attains hurricane status when its wind speed reaches 74 or more miles per hour (mph). Tropical systems may develop in the Atlantic between the Lesser Antilles and the African coast, or may develop in the warm tropical waters of the Caribbean and Gulf of Mexico. These storms may move up the Atlantic Coast of the United States and impact the Eastern Seaboard, or move into the United States through the states along the Gulf Coast, bringing wind and rain as far north as New England, before moving offshore and heading east.

NWS issues hurricane and tropical storm watches and warnings. These watches and warnings are issued or will remain in effect after a tropical cyclone becomes post-tropical, when such a storm poses a significant threat to life and property. The NWS allows the National Hurricane Center (NHC) to issue advisories during the post-tropical stage. The following are the definitions of the watches and warnings:

- *Hurricane/Typhoon Warning* is issued when sustained winds of 74 mph or higher are expected somewhere within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the warning is issued 36 hours in advance of the anticipated onset of tropical storm-force winds. The warning can remain in effect when dangerously high water or combination of dangerously high water and waves continue, even though winds may be less than hurricane force.
- *Hurricane Watch* is issued when sustained winds of 74 mph or higher are possible within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the hurricane watch is issued 48 hours prior to the anticipated onset of tropical storm-force winds.
- *Tropical Storm Warning* is issued when sustained winds of 39 to 73 mph are expected somewhere within the specified area within 36 hours in association with a tropical, subtropical, or post-tropical storm.
- *Tropical Storm Watch* is issued when sustained winds of 39 to 73 mph are possible within the specified area within 48 hours in association with a tropical, sub-tropical, or post-tropical storm.
(NWS 2013b).

Hurricanes and tropical storms often occur at the same time. Because of this, officials assign short, distinctive names to the storms to avoid confusion among weather stations, coastal bases, and ships at sea. Since 1953, Atlantic tropical storms have been named from lists originated by the National Hurricane Center. Currently, they are maintained and updated by the World Meteorological Organization. The list of names in the table below are used in rotation and recycled every 6 years. The only time there is a change in the list is if the named storm was so costly or deadly that the future use of it would be inappropriate. If that occurs, the World Meteorological Organization committee will select a new name to replace the one removed from the list. If all the names in a season's list have been used, later storms are named for Greek letters, in alphabetical order. A storm is given a name once its winds reach a speed of 40 mph. In addition to the Atlantic list of names, there are ten other lists corresponding to other storm-prone regions of the world (NOAA NHC 2020). Table 5.4.6-1 lists the tropical cyclone names for 2013 through 2018.

Table 5.4.6-1 Tropical Cyclone Names for the Atlantic

2020	2021	2022	2023	2024	2025
Arthur	Ana	Alex	Arlene	Alberto	Andrea
Bertha	Bill	Bonnie	Bret	Beryl	Barry

Table 5.4.6-1 Tropical Cyclone Names for the Atlantic

2020	2021	2022	2023	2024	2025
Cristobal	Claudette	Colin	Cindy	Chris	Chantal
Dolly	Danny	Danielle	Don	Debby	Dorian
Edouard	Elsa	Earl	Emily	Ernesto	Erin
Fay	Fred	Fiona	Franklin	Francine	Fernand
Gonzalo	Grace	Gaston	Gert	Gordon	Gabrielle
Hanna	Henri	Hermine	Harold	Helene	Humberto
Isaias	Ida	Ian	Idalia	Isaac	Imelda
Josephine	Julian	Julia	Jose	Joyce	Jerry
Kyle	Kate	Karl	Katia	Kirk	Karen
Laura	Larry	Lisa	Lee	Leslie	Lorenzo
Marco	Mindy	Martin	Margot	Milton	Melissa
Nana	Nicholas	Nicole	Nigel	Nadine	Nestor
Omar	Odette	Owen	Ophelia	Oscar	Olga
Paulette	Peter	Paula	Philippe	Patty	Pablo
Rene	Rose	Richard	Rina	Rafael	Rebekah
Sally	Sam	Shary	Sean	Sara	Sebastien
Teddy	Teresa	Tobias	Tammy	Tony	Tanya
Vicky	Victor	Virginie	Vince	Valerie	Van
Wilfred	Wanda	Walter	Whitney	William	Wendy

Source: NOAA 2020

Storm Surge

Storm surges inundate coastal floodplains by dune overwash, tidal elevation rise in inland bays and harbors, and backwater flooding through coastal river mouths. Strong winds can increase in tide levels and water-surface elevations. Storm systems generate large waves that run up and flood coastal beaches. The combined effects create storm surges that affect the beach, dunes, and adjacent low-lying floodplains. Shallow, offshore depths can cause storm-driven waves and tides to pile up against the shoreline and inside bays.

Based on an area's topography, a storm surge may inundate only a small area (along sections of the northeast or southeast coasts) or storm surge may inundate coastal lands for a mile or more inland from the shoreline. Storm surge is further discussed in Section 5.4.5 (Flood).

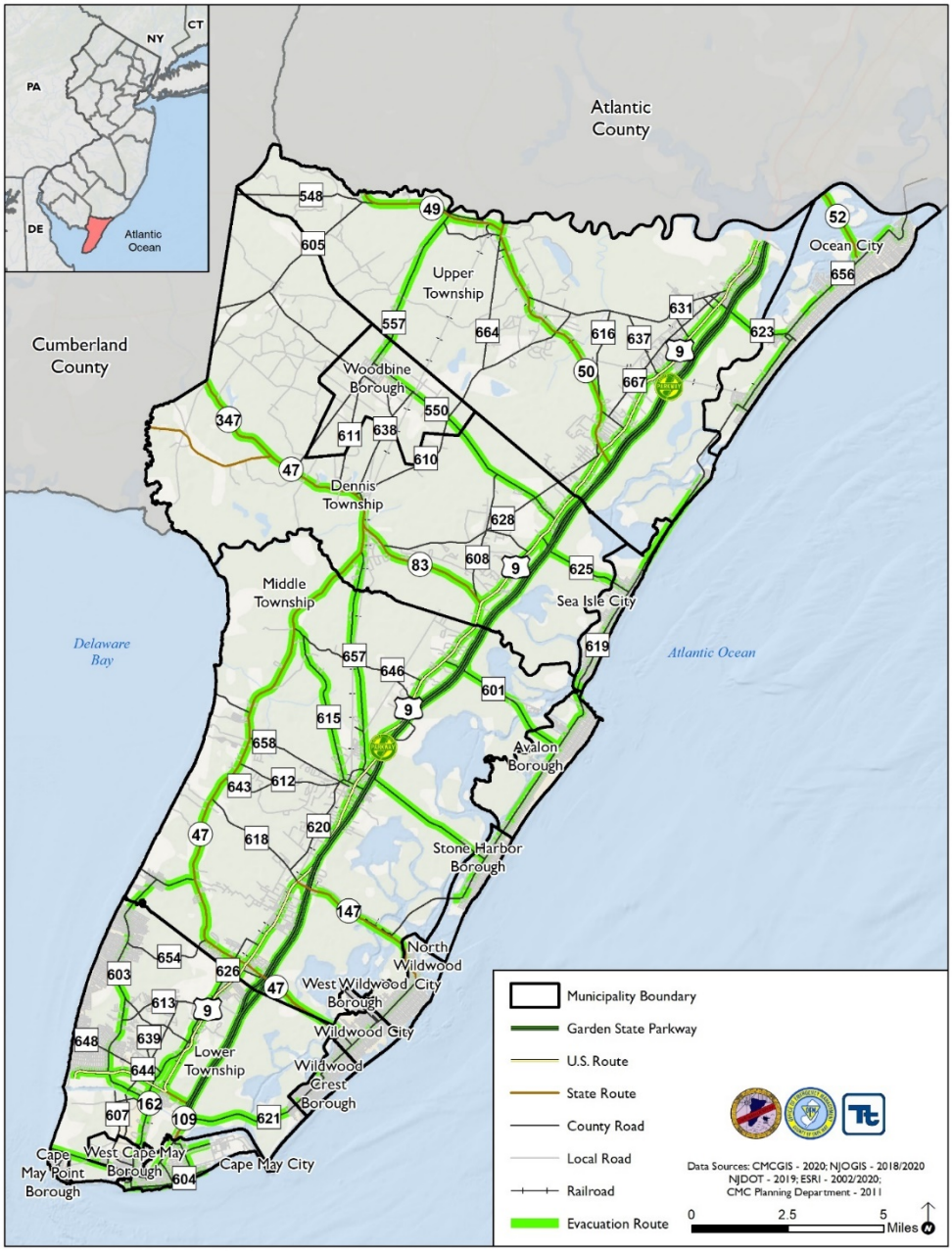
Location

The entire Cape May County Planning Area is vulnerable to coastal storms; however, where the storms impact depends on the storm's track. All of Cape May County is surrounded by coastal waters and susceptible to damage caused by the combination of both high winds and tidal surge. See Section 5.4.2 (Coastal Erosion) for detailed information regarding the coastline in Cape May County. Refer to Section 9 (Jurisdictional Annexes) for detailed maps that display the 1-percent annual chance event floodplains and Sea, Lake and Overland Surge from Hurricanes (SLOSH) inundation areas in each municipality.

The State of New Jersey has identified State roads as potential evacuation routes for coastal emergencies such as approaching tropical storms or hurricanes. When local, county or state officials order an evacuation, they will provide specific information about the roads that should be taken. Police and first responders will be posted in

the communities being evacuated to direct traffic and block unsafe roadways. Figure 5.4.6-1 illustrates the state road evacuation routes in Cape May County.

Figure 5.4.6-1. Coastal Evacuation Routes in Cape May County

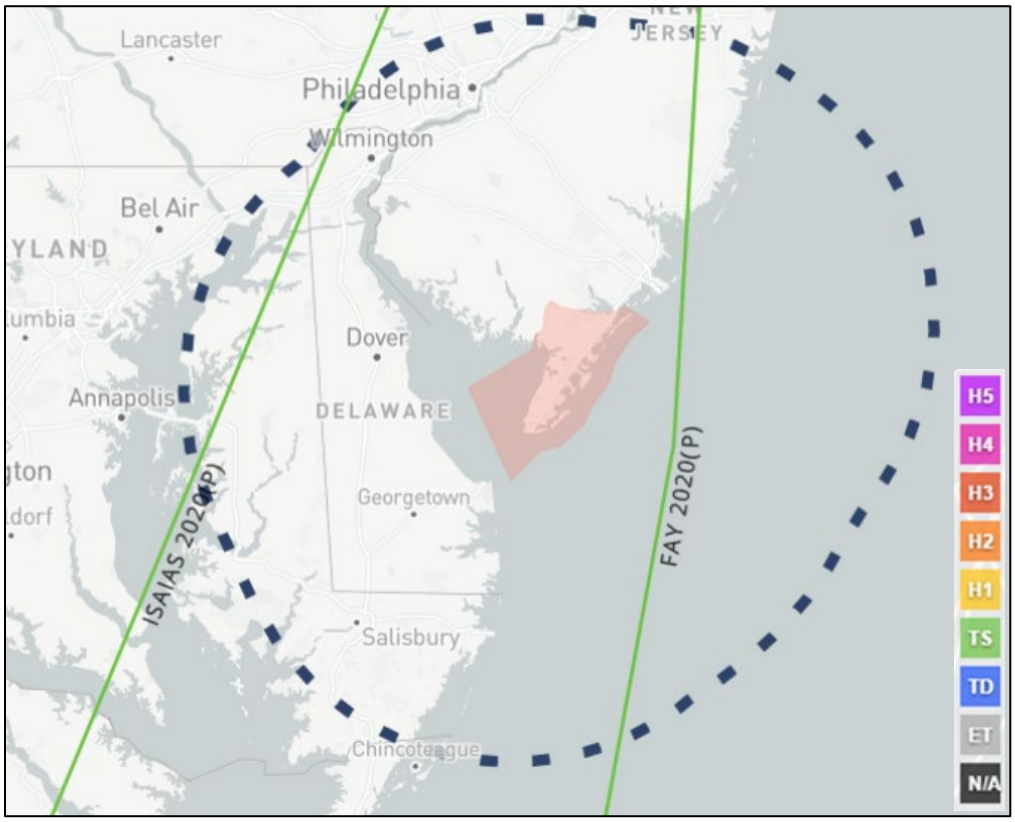


Tropical Storm and Hurricane Tracks

NOAA's Historical Hurricane Tracks tool is a public interactive mapping application that displays Atlantic Basin and East-Central Pacific Basin tropical cyclone data. This interactive tool catalogs tropical cyclones that have occurred from 1842 to 2020 (latest date available from data source). Between 1842 and 2020, 59 tropical cyclones tracked within 65 nautical miles of Cape May County. Figure 5.4.6-2 displays tropical cyclone tracks for Cape May County that tracked with 65 nautical miles between 2016 and 2020. Refer to the "Previous Events

and Losses" section for further information regarding hurricane and tropical storm events that impacted Cape May County.

Figure 5.4.6-2. Historical Tropical Storm and Hurricane Tracks 2016 to 2020

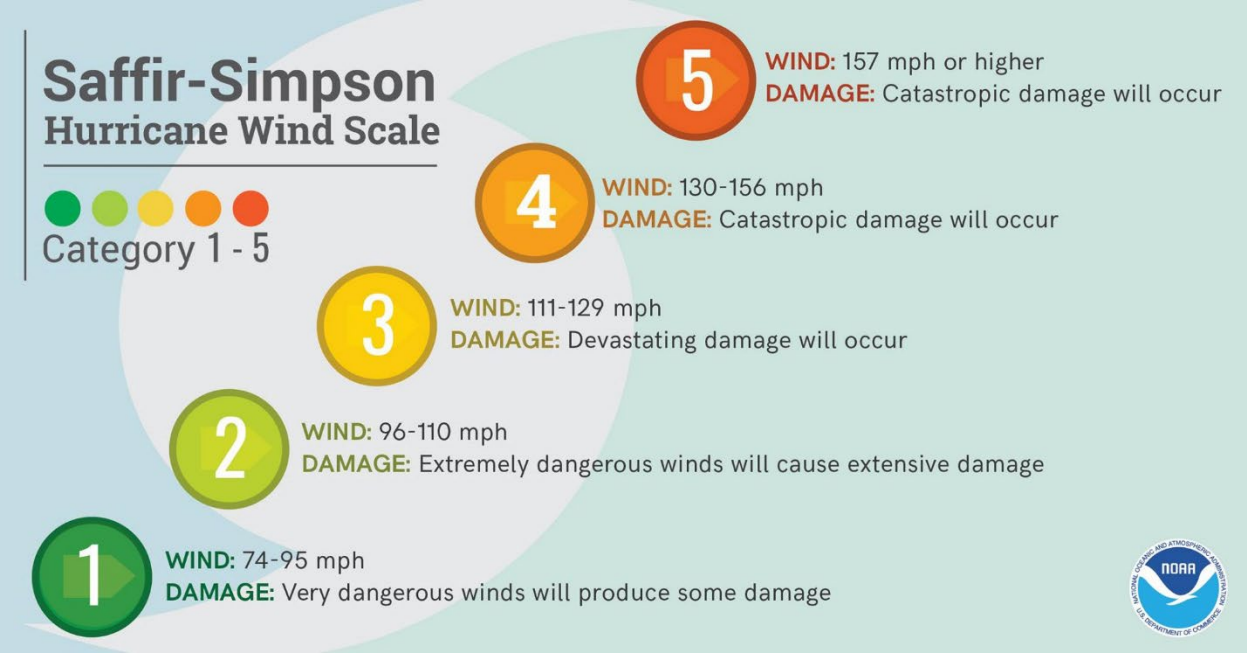


Source: NOAA 2020

Extent

The extent of a hurricane is categorized in accordance with the Saffir-Simpson Hurricane Scale. The Saffir-Simpson Hurricane Wind Scale is a 1-to-5 rating based on a hurricane's sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous and require preventative measures (NHC 2013).

Figure 5.4.6-3. Saffir-Simpson Scale



Source: NWS 2020

Mean Return Period

In evaluating the potential for hazard events of a given magnitude, a MRP is often used. The MRP provides an estimate of the magnitude of an event that may occur within any given year based on past recorded events. MRP is the average period of time, in years, between occurrences of a particular hazard event, equal to the inverse of the annual frequency of exceedance (Dinicola 2009).

Figure 5.4.6-4 and Figure 5.4.6-5 show the estimated maximum 3-second gust wind speeds that can be anticipated in the study area associated with the 100- and 500-year MRP events. These peak wind speed projections were generated using FEMA's Hazus wind model. The maximum 3-second gust wind speeds for Cape May County range from 81 mph to 95 mph for the 100-year MRP event (Category 1). The maximum 3-second gust wind speeds for Cape May County range from 87 mph to 123 mph for the 500-year MRP event (Category 1 to Category 3). The storm tracks for the 100- and 500-year event were not available in Hazus. The associated impacts and losses from these 100-year and 500-year MRP hurricane events are discussed later in the Vulnerability Assessment subsection.

Figure 5.4.6-4. Wind Speeds for the 100-Year Mean Return Period Event

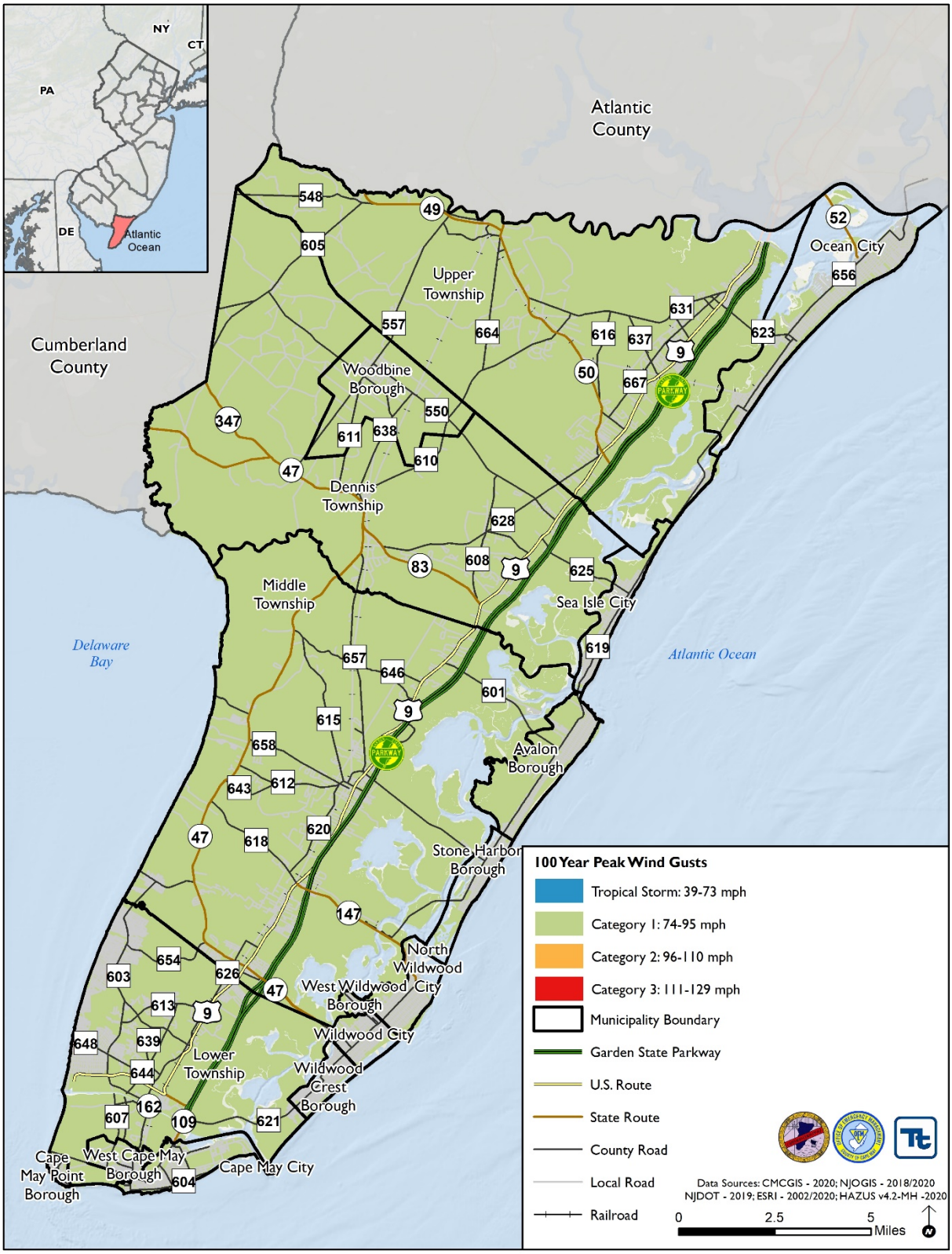
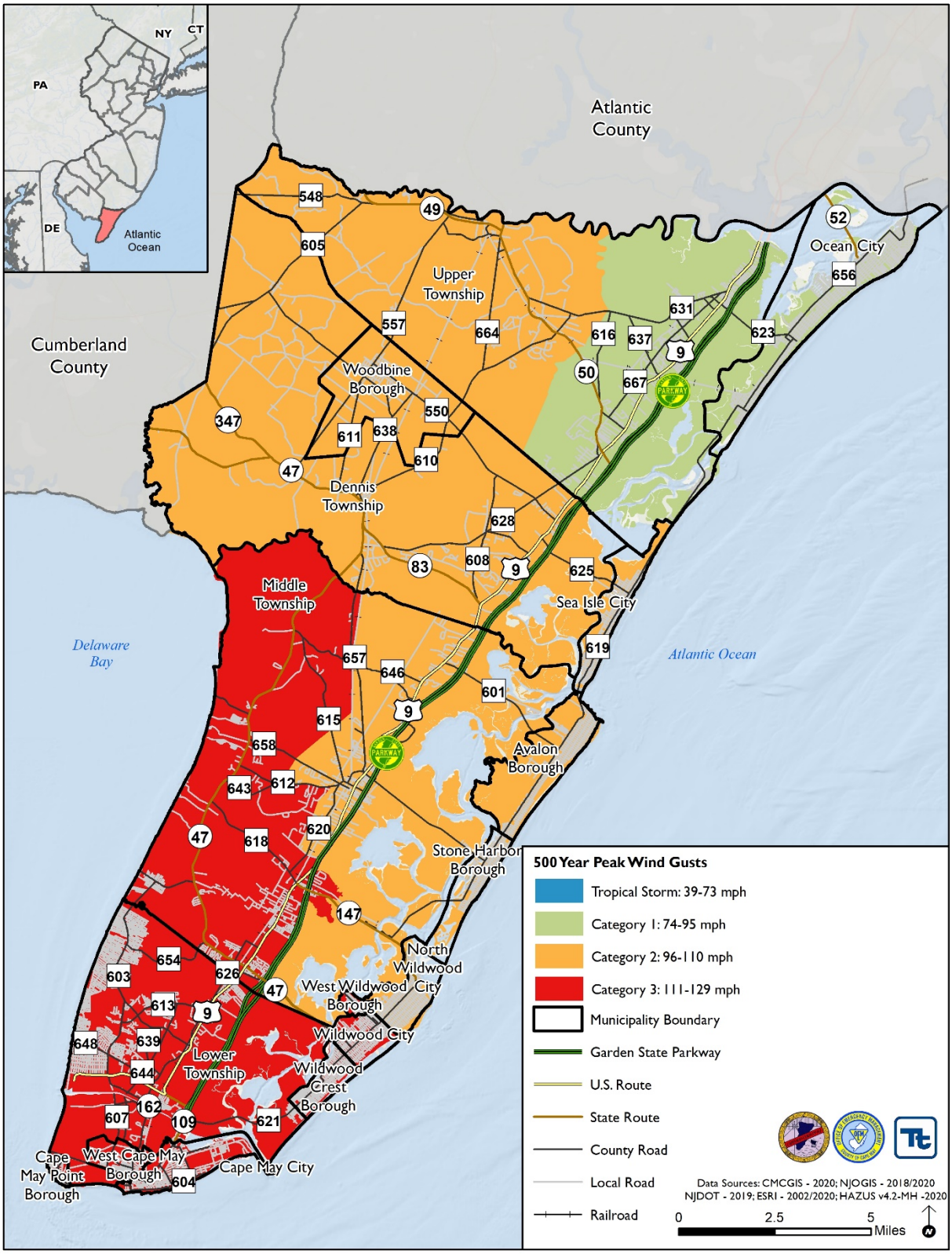


Figure 5.4.6-5. Wind Speeds for the 500-Year Mean Return Period Event



Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with hurricane and tropical storm throughout the State of New Jersey and Cape May County; therefore, the loss and impact information for many events varies depending on the source. The accuracy of monetary figures discussed is based only on the available information in cited sources.

FEMA Major Disasters and Emergency Declarations

Between 1954 and 2020, FEMA issued a disaster (DR) or emergency (EM) declaration for the State of New Jersey for eight tropical cyclone-related events, classified as one or a combination of the following disaster types: one or a combination of the following disaster types: hurricane, tropical storm, severe storms, flooding, and tropical depression. Of those events, Cape May County has been included in seven hurricane and tropical storm-related declarations (EM and DR) (FEMA 2020). Table 5.4.6-2 lists FEMA DR and EM declarations for the County.

Table 5.4.6-2. Hurricane and Tropical Storm-Related FEMA Declarations for Cape May County

FEMA Declaration Number	Date(s) of Event	Date of Declaration	Event Type
DR-749	September 27, 1985	October 15, 1985	Hurricane Gloria
EM-3148	September 16-18, 1999	September 17, 1999	Hurricane Floyd
DR-1867	November 11-19, 2009	December 22, 2009	Severe Storms and Flooding Associated with Tropical Depression Ida and a Nor'Easter
EM-3332	August 26 – September 5, 2011	August 27, 2011	Hurricane Irene
DR-4021	August 26 – September 5, 2011	August 31, 2011	Hurricane Irene
EM-3354	October 26 – November 8, 2012	October 28, 2012	Hurricane Sandy
DR-4086	October 26 – November 8, 2012	October 30, 2012	Hurricane Sandy

Source: FEMA 2020

U.S. Department of Agriculture Disaster Declarations

Between 2016 and 2020, the period for which data was available, Cape May County was not included in any USDA agricultural disasters relating to hurricanes or tropical storms.

Previous Events

For this 2021 Plan Update, known hurricane and tropical storm events that have impacted Cape May County between 2016 and 2020 are identified are identified in Table 5.4.6-3. With documentation of hurricanes and tropical storms for the State of New Jersey and Cape May County being extensive, not all sources have been identified or researched. Therefore, Table 5.4.6-3 may not include all events that occurred in the County. For events prior to 2016, refer to Appendix E (Supplementary Data). For detailed information on damages and impacts to each municipality, refer to Section 9 (Jurisdictional Annexes).

Table 5.4.6-3. Hurricane and Tropical Storm Cape May County, 2016-2020

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Location	Description
September 3-6, 2016	Tropical Storm Hermine, High Surf	N/A	N/A	Cape May County	Slow moving tropical cyclone Hermine caused several days of 8 to 12 feet of surf breaking on Atlantic Ocean shorelines. Cape May County beaches experienced moderate erosion.
September 19-20, 2017	Tropical Storm Jose, High Surf	N/A	N/A	Cape May County	Tropical cyclone Jose tracked north and east along the Mid Atlantic coast Tuesday September 19th, eventually passing well offshore of Cape May County. Tidal flooding and erosion occurred. According to eyewitnesses and video, storm surge pounded the seawall at Third Avenue and Kennedy Boulevard, pouring over the top of the seawall in North Wildwood. Heavy erosion was also witnessed in Ocean City.
October 20-21, 2019	Subtropical Storm Melissa	N/A	N/A	Cape May County	Subtropical Storm Melissa caused erosion on Cape May Beaches. Most of the towns that saw the worst were in Cape May and Atlantic counties, including parts of Atlantic City, Sea Isle City, North Wildwood and Ocean City. North Wildwood was one of the hardest hit. There, surveyors recorded 40 feet of erosion on the beach, up to four feet in height, between 2nd and 7th Avenues. Five blocks of beach had 12-foot high scarps, according to the survey from the NJ DEP's Division of Coastal Engineering. North Wildwood Mayor Patrick Rosenello estimated the city lost a total of 500,000 cubic yards of sand from the storm. In May, the city placed 200,000 cubic yards onto its beaches-- all of which was lost due to Melissa. In Ocean City, Subtropical Storm Melissa created scarps up to five feet high in the northern part of the island and wiped out dunes a few blocks from the Ocean City Music Pier, according to a DEP survey.
July 10, 2020	Tropical Storm Fay	N/A	N/A	Cape May County	Tropical Storm Fay made landfall near the border of Ocean and Atlantic County bringing heavy rain and flash flooding. Significant erosion occurred in portions of the County including Cape May City.
August 4, 2020	Tropical Storm Isaias	N/A	N/A	Cape May County	Tropical Storm Isaias tracked to the west of Cape May County, bringing tropical downpours, heavy winds, and spawning tornadoes across the region, including one that left a path of destruction in Upper Township. NWS reporting found up to an inch of rainfall. 1.3 million customers in NJ lose power with up to 30% of properties in the County experiencing power outages.

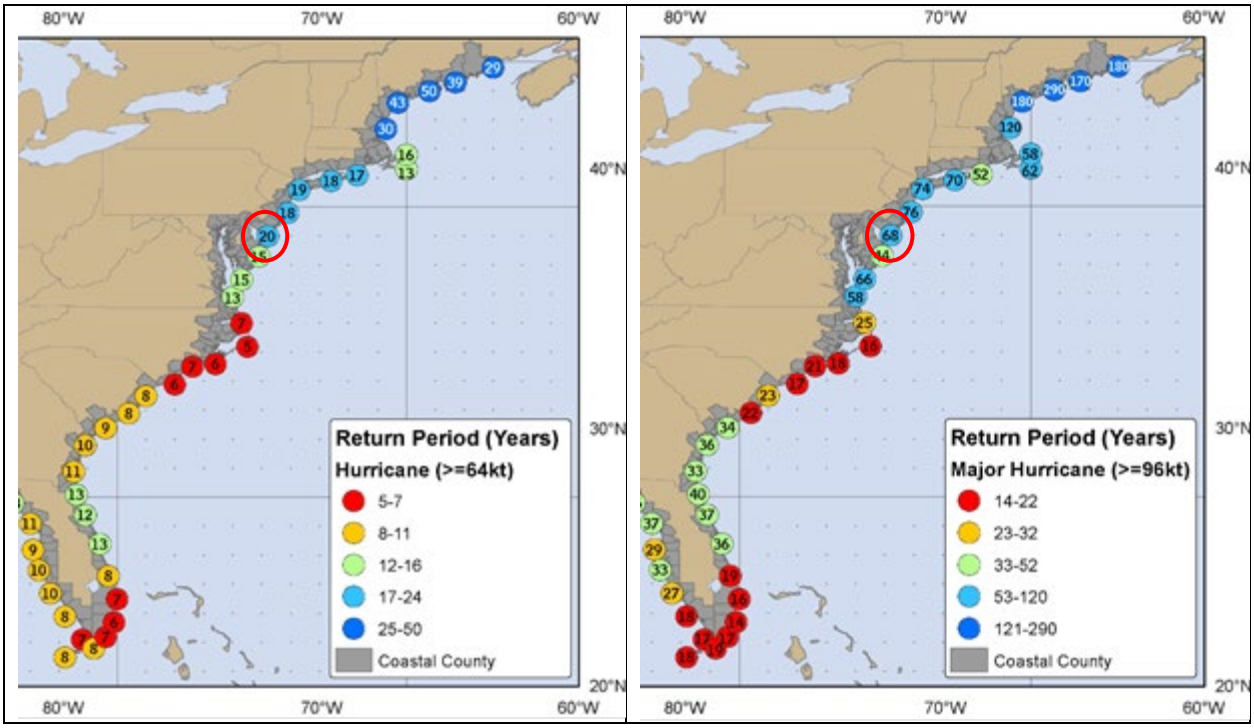
Sources: *NOAA-NCEI 2020, FEMA 2020, NHC 2020, Press of Atlantic City 2016, Cape May County Herald. 2017, Press of Atlantic City 2019, Press of Atlantic City 2020*
Note: *Many sources were consulted to provide an update of previous occurrences and losses; event details and loss/impact information may vary and has been summarized in the above table*

DR *Federal Major Disaster Declaration*
EM *Federal Emergency Declaration*
FEMA *Federal Emergency Management Agency*
HMP *Hazard Mitigation Plan*
K *Thousand ($)*
M *Million ($)*
Mph *Miles Per Hour*
NCEI *National Centers for Environmental Information*
NOAA *National Oceanic Atmospheric Administration*
NWS *National Weather Service*

Probability of Future Occurrences

It is estimated that Cape May County will continue to experience direct and indirect impacts of hurricane and tropical storms annually that may induce secondary hazards such as flooding, extreme wind, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents, and inconveniences. Figure 5.4.6-6 illustrates the return period for hurricanes and major hurricanes along the eastern seaboard. According to these maps, Cape May County can expect a hurricane ever 20 years and a major hurricane ever 68 years.

Figure 5.4.6-6. Return Period in Years for Hurricanes and Major Hurricanes



Source: NHC 2011
Note: The return period of hurricanes based on historical data. Cape May County circled in red. The information on return period is generated with the 1987 HURISK program, but uses data through 2010.

Historical records from the National Hurricane Center can also be used to calculate the probability of future occurrences of hurricane and tropical storm events. Table 5.4.6-4 summarizes data regarding the probability of occurrences of hurricane and tropical storm events in Cape May County based on these historical records.

Table 5.4.6-4. Probability of Future Occurrences of Hurricane/Tropical Storm Events

Hazard Type	Number of Occurrences Between 1950 and 2020	% Chance of Occurring in Any Given Year
Tropical Depression	5	7.04
Tropical Storm	19	26.76
Hurricane	8	11.27
Total	27	38.03

Source: NHC 2021
Note: Event totals include tropical cyclones paths that have traveled within 65 nautical miles of Cape May County. This distance represents a buffer of a distance where impacts would likely be felt even if direct landfall over the county did not occur. The total number of events is less than the total for all hazard types due to some individual storms transitioning from a higher category to a lower category within the buffer zone.

In Section 5.3, the identified hazards of concern for Cape May County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for hurricane and tropical storms in the county is considered "occasional" (between 10 and 100% annual chance of occurring).

Climate Change Impacts

Due to the increase in greenhouse gas concentrations since the end of the 1890s, New Jersey has experienced a 3.5° F (1.9° C) increase in the State's average temperature (Office of the New Jersey State Climatologist 2020), which is faster than the rest of the Northeast region (2° F [1.1° C]) (Melillo et al. 2014) and the world (1.5° F [0.8° C]) (IPCC 2014). This warming trend is expected to continue. By 2050, temperatures in New Jersey are expected to increase by 4.1 to 5.7° F (2.3° C to 3.2° C) (Horton et al. 2015).

Since the end of the twentieth century, New Jersey has experienced slight increases in the amount of precipitation it receives each year, and over the last 10 years there has been a 7.9% increase. By 2050, annual precipitation in New Jersey could increase by 4% to 11% (Horton et al. 2015). By the end of this century, heavy precipitation events are projected to occur two to five times more often (Walsh et al. 2014) and with more intensity (Huang et al. 2017) than in the last century. New Jersey will experience more intense rain events, less snow, and more rainfalls (Fan et al. 2014, Demaria et al. 2016, Runkle et al. 2017).

Climate change may result in changes to the frequency of coastal storms and the occurrence of storm surge. A warmer atmosphere means storms have the potential to be more intense (Guilbert et al. 2015) and occur more often (Coumou and Rahmstorf 2012, Marquardt Collow et al. 2016, Broccoli et al. 2020). In New Jersey, extreme storms typically include coastal nor'easters, snowstorms, spring and summer thunderstorms, tropical storms, and on rare occasions hurricanes. Most of these events occur in the warmer months between April and October, with nor'easters occurring between September and April. Over the last 50 years, in New Jersey, storms that resulted in extreme rain increased by 71% (Walsh et al. 2014) which is a faster rate than anywhere else in the United States (Huang et al. 2017). As temperatures increase so will the energy in a storm system, increasing the potential for more intense tropical storms (Huang et al. 2017), especially those of Category 4 and 5 (Melillo et al. 2014).

As oceans warm, the length of hurricane season may expand. The past five hurricane seasons have featured a tropical system occurring before the official start of the season. In 2016, a very rare winter hurricane named Alex developed in the middle of January (BBC 2019). According to NOAA's database, 39 storms formed in the Atlantic Basin before June 1 from 1851 through 2020, a long-term average of one such early storm every four to five years. The 2010s had the most such storms, and there has been a steady increase since the 1990s. However, the 1950s had six such storms, the 1930s had four and there was another four preseason storm streak from 1887 through 1890. It is possible there were other such storms in the era before satellites – before the mid-1960s – that were missed by ship observations or reports from areas impacted. It remains to be seen if expansion of the traditional hurricane season is a long-term trend or a common occurrence (Weather.com 2020).

In Atlantic City, Cape May, and Sandy Hook, sea-level has risen at a rate of approximately 0.2 to 0.5 inches per year since the beginning of the 20th century, and this rate will continue to increase (Kopp et al. 2019). The amount of greenhouse gases that are emitted is tied to rates of sea-level rise. By 2050, New Jersey will likely experience at least a 0.9 to 2.1-foot increase (above the levels in 2000; all emissions scenarios), 1.4 to 3.1-foot increase by 2070 (moderate emissions scenario), and potentially a 2.0 to 5.1-foot increase by 2100 (moderate emissions scenario). Rising sea levels will increase the severity of coastal flooding events caused by storm surge.

Impacts of climate change can lead to shoreline erosion, coastal flooding, and water pollution; affecting man-made coastal infrastructures and coastal ecosystems. Coastal areas may be impacted by climate change in different ways. These areas are sensitive to sea level rise, changes in the frequency and intensity of storms,

increase in precipitation, and warmer ocean temperatures (USEPA 2017). Temperatures are predicted to increase in Cape May County and ocean temperatures are forecast to continue to increase, which may lead to an increase in intensity and frequency of hurricanes. It remains to be seen if other factors such as steering currents, atmospheric sheer, and the presence of Saharan dust will be impacted in ways which increase or decrease the risk of hurricanes in Cape May County.

For details regarding climate change and sea level rise, refer to Section 5.4.1 (Climate Change and Sea Level Rise).

5.4.6.2 Vulnerability Assessment

A probabilistic assessment was conducted for the 100- and 500-year MRPs through a Level 2 analysis in Hazus-MH v4.2 to analyze the wind hazard associated with hurricanes and tropical storms and provide a range of loss estimates due to wind impacts. Storm surge was also assessed using 2014 SLOSH data from NOAA's National Hurricane Center. Refer to Section 4.2 (Methodology and Tools) for additional details on the methodology used to assess hurricane and tropical storm risk.

Impact on Life, Health, and Safety

The impact of a hurricanes and tropical storms on life, health, and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time was provided to residents. All Cape May County residents are exposed to a hurricane storm and tropical storm hazard; however 36.9-percent, 57.2-percent, 78.3-percent, and 90.8-percent of the population is exposed to the SLOSH Category 1, Category 2, Category 3, and Category 4 inundation areas, respectively (2018 American Community Survey 5-year Estimate). Refer to Table 5.4.6-5 and Table 5.4.6-6 for a summary of the number of persons exposed to the SLOSH Categories 1 through 4 by jurisdiction. Overall, Ocean City has the greatest number of persons exposed to the SLOSH Category 1 and Category 2 inundation areas. Lower Township has the greatest number of persons exposed to the SLOSH Category 3 and Category 4 inundation areas. One hundred percent of the population for three of the jurisdictions are exposed to the SLOSH Category 4 inundation area (i.e., Cape May Point Borough, West Cape May Borough, and Wildwood Crest Borough).

Research has shown that some populations, while they may not have more hazard exposure, may experience exacerbated impacts and prolonged recovery if/when impacted. This is due to many factors including their physical and financial ability to react or respond during a hazard. Economically disadvantaged populations are vulnerable because they are likely to evaluate their risk and make decisions based on the major economic impact to their family and may not have funds to evacuate. The population over the age of 65 is also vulnerable and, physically, they may have more difficulty evacuating. Additionally, the elderly are considered vulnerable because they require extra time or outside assistance during evacuations and are more likely to seek or need medical attention which may not be available due to isolation during a storm event. According to the 5-year population estimates from the American Community Survey, Cape May County has a total of 10,140 persons living in poverty and 23,572 over the age of 65 years old. Please refer to Section 4 (County Profile) for the statistics of these populations.

Residents may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings and debris carried by high winds can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Hazus estimates that 59 and 1,122 households will be displaced during the 100-year and 500-year MRP hurricane wind events, respectively. Hazus also estimates that 30 and 615 persons will be seeking short-term shelter during the 100-year and 500-year MRP hurricane wind events, respectively. Refer to Table 5.4.6-7 for a summary of the displaced households by

jurisdiction. Please note that estimates are only based on wind speed and do not account for sheltering needs associated with flooding and storm surge that may accompany hurricane and tropical storm events.

Table 5.4.6-5. Estimated Population Exposed to the Hurricane Storm Surge SLOSH Category 1 and Category 2 Hurricane Inundation Hazard Areas

Jurisdiction	American Community Survey (2014-2018) Population	Estimated Population Exposed to the Hurricane and Tropical Storm Hazard Areas			
		Number of Persons Exposed to Category 1 SLOSH	Percent of Total	Number of Persons Exposed to Category 2 SLOSH	Percent of Total
Avalon Borough	1,409	1,222	86.7%	1,401	99.4%
Cape May City	3,491	2,012	57.6%	3,362	96.3%
Cape May Point Borough	188	76	40.6%	187	99.6%
Dennis Township	6,244	82	1.3%	1,074	17.2%
Lower Township	21,838	3,035	13.9%	9,213	42.2%
Middle Township	18,492	2,934	15.9%	8,020	43.4%
North Wildwood City	3,849	3,841	99.8%	3,844	99.9%
Ocean City	11,202	9,359	83.5%	11,175	99.8%
Sea Isle City	1,955	1,765	90.3%	1,943	99.4%
Stone Harbor Borough	955	763	79.9%	950	99.5%
Upper Township	11,909	1,324	11.1%	2,820	23.7%
West Cape May Borough	1,103	512	46.4%	1,046	94.8%
West Wildwood Borough	376	373	99.2%	374	99.4%
Wildwood City	5,073	5,053	99.6%	5,055	99.6%
Wildwood Crest Borough	3,131	2,234	71.4%	3,131	100.0%
Woodbine Borough	2,490	0	0.0%	0	0.0%
Cape May County (Total)	**93,705**	**34,585**	**36.9%**	**53,595**	**57.2%**

Source: American Community Survey 5-year Estimate (2013-2017); NOAA 2014
Notes: SLOSH = Sea – Lake Overland Surge from Hurricanes

Table 5.4.6-6. Estimated Population Exposed to the Hurricane Storm Surge SLOSH Category 3 and Category 4 Hurricane Inundation Hazard Areas

Jurisdiction	American Community Survey (2014-2018) Population	Estimated Population Exposed to the Hurricane and Tropical Storm Hazard Areas			
		Number of Persons Exposed to Category 3 SLOSH	Percent of Total	Number of Persons Exposed to Category 4 SLOSH	Percent of Total
Avalon Borough	1,409	1,402	99.5%	1,403	99.6%
Cape May City	3,491	3,476	99.6%	3,478	99.6%
Cape May Point Borough	188	188	100.0%	188	100.0%
Dennis Township	6,244	2,833	45.4%	4,819	77.2%
Lower Township	21,838	16,271	74.5%	20,816	95.3%
Middle Township	18,492	15,983	86.4%	18,393	99.5%
North Wildwood City	3,849	3,843	99.8%	3,841	99.8%

Table 5.4.6-6. Estimated Population Exposed to the Hurricane Storm Surge SLOSH Category 3 and Category 4 Hurricane Inundation Hazard Areas

Jurisdiction	American Community Survey (2014-2018) Population	Estimated Population Exposed to the Hurricane and Tropical Storm Hazard Areas			
		Number of Persons Exposed to Category 3 SLOSH	Percent of Total	Number of Persons Exposed to Category 4 SLOSH	Percent of Total
Ocean City	11,202	11,183	99.8%	11,186	99.9%
Sea Isle City	1,955	1,943	99.4%	1,943	99.4%
Stone Harbor Borough	955	947	99.2%	950	99.5%
Upper Township	11,909	5,679	47.7%	8,301	69.7%
West Cape May Borough	1,103	1,103	100.0%	1,103	100.0%
West Wildwood Borough	376	375	99.6%	374	99.4%
Wildwood City	5,073	5,050	99.5%	5,053	99.6%
Wildwood Crest Borough	3,131	3,131	100.0%	3,130	100.0%
Woodbine Borough	2,490	2	0.1%	60	2.4%
Cape May County (Total)	**93,705**	**73,409**	**78.3%**	**85,039**	**90.8%**

Source: American Community Survey 5-year Estimate (2013-2017); NOAA 2014
Notes: SLOSH = Sea – Lake Overland Surge from Hurricanes

Table 5.4.6-7. Estimated Number of Displaced Households and Number of Persons Seeking Shelter During a 100-Year and 500-Year MRP Hurricane Wind Event

Jurisdiction	American Community Survey (2014-2018) Population	Hurricane Wind 100-Year Mean Return Period		Hurricane Wind 500-Year Mean Return Period	
		Displaced Households*	People Requiring Short-Term Shelter*	Displaced Households*	People Requiring Short-Term Shelter*
Avalon Borough	1,409	1	0	5	2
Cape May City	3,491	2	1	136	85
Cape May Point Borough	188	0	0	22	10
Dennis Township	6,244	0	0	6	3
Lower Township	21,838	1	0	492	257
Middle Township	18,492	1	1	126	73
North Wildwood City	3,849	8	4	57	27
Ocean City	11,202	27	13	15	7
Sea Isle City	1,955	2	1	6	3
Stone Harbor Borough	955	1	0	9	3
Upper Township	11,909	0	0	4	3
West Cape May Borough	1,103	0	0	46	21
West Wildwood Borough	376	2	1	16	11
Wildwood City	5,073	7	5	86	58
Wildwood Crest Borough	3,131	7	4	91	48
Woodbine Borough	2,490	0	0	4	4
Cape May County (Total)	**93,705**	**59**	**30**	**1,122**	**615**

Source: Hazus-MH v4.2; U.S. Census Bureau 2010
*Notes: *Number of persons may be over or underestimated because Hazus uses 2010 Census Bureau population statistics.*

Impact on General Building Stock

Wind-Only Impacts

Damage to buildings is dependent upon several factors, including wind speed, storm duration, and path of the storm track. Building construction also plays a major role in the extent of damage resulting from a coastal storm. Due to differences in construction, residential structures are generally more susceptible to wind damage than commercial and industrial structures. Mobile/manufactured homes, and structures constructed of wood and masonry buildings, in general, tend to experience more damage than concrete or steel buildings.

To better understand these risks, Hazus was used to estimate the expected wind-related building damages. Specific types of wind damages are also summarized in Hazus at the following wind damage categories: no damage/very minor damage, minor damage, moderate damage, severe damage, and total destruction. Table 5.4.6-8 summarizes the definition of the damage categories. Table 5.4.6-9 summarizes the damage states estimated for structures during the 100-year and 500-year MRP hurricane wind events by occupancy class. Hazus estimates that zero structures will experience complete damage during the 100-year MRP event and approximately 1.5-percent of residential structures will experience complete damage during the 500-year MRP event.

Table 5.4.6-8. Description of Damage Categories

Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
No Damage or Very Minor Damage Little or no visible damage from the outside. No broken windows, or failed roof deck. Minimal loss of roof over, with no or very limited water penetration.	≤2%	No	No	No	No	No
Minor Damage Maximum of one broken window, door or garage door. Moderate roof cover loss that can be covered to prevent additional water entering the building. Marks or dents on walls requiring painting or patching for repair.	>2% and ≤15%	One window, door, or garage door failure	No	<5 impacts	No	No
Moderate Damage Major roof cover damage, moderate window breakage. Minor roof sheathing failure. Some resulting damage to interior of building from water.	>15% and ≤50%	> one and ≤ the larger of 20% & 3	1 to 3 panels	Typically 5 to 10 impacts	No	No
Severe Damage Major window damage or roof sheathing loss. Major roof cover loss. Extensive damage to interior from water.	>50%	> the larger of 20% & 3 and ≤50%	>3 and ≤25%	Typically 10 to 20 impacts	No	No
Destruction Complete roof failure and/or, failure of wall frame. Loss of more than 50% of roof sheathing.	Typically >50%	>50%	>25%	Typically >20 impacts	Yes	Yes

Source: Hazus-MH Hurricane Technical Manual

Table 5.4.6-9. Damage States for Structures Impacted by the 100-Year and 500-Year MRP Hurricane Wind Events

Occupancy Class	Total Number of Buildings in Occupancy	Severity of Expected Damage	100-year		500-year	
			Building Count	Percent Buildings in Occupancy Class	Building Count	Percent Buildings in Occupancy Class
Residential Exposure (Single and Multi-Family Dwellings)	100,196	None	92,971	92.8%	64,340	64.2%
		Minor	6,731	6.7%	25,227	25.2%
		Moderate	460	0.5%	7,541	7.5%
		Severe	15	0.0%	1,580	1.6%
		Complete Destruction	19	0.0%	1,508	1.5%
Commercial Buildings	9,077	None	8,697	95.8%	6,219	68.5%
		Minor	351	3.87%	1,674	18.44%
		Moderate	28	0.3%	877	9.7%
		Severe	1	<0.1%	307	3.4%
		Complete Destruction	0	0.0%	0	0.0%
Industrial Buildings	37	None	36	97.3%	28	75.7%
		Minor	1	2.7%	5	13.5%
		Moderate	0	0.0%	3	8.1%
		Severe	0	0.0%	1	2.7%
		Complete Destruction	0	0.0%	0	0.0%
Government, Religion, Agricultural, and Education Buildings	2,680	None	2,577	96.2%	1,738	64.9%
		Minor	96	3.6%	628	23.4%
		Moderate	7	0.3%	251	9.4%
		Severe	0	0.0%	62	2.3%
		Complete Destruction	0	0.0%	1	<0.1%

Source: Hazus-MH 4.2

Table 5.4.6-10 summarizes the replacement cost value of building and content damages estimated for the 100- and 500-year MRP hurricane wind-only events. Table 5.4.6-11 summarizes the replacement cost value of building and content damages estimated for the 100-year and 500-year MRP hurricane wind-only events for residential and commercial occupancy classes. Less than 1% of the entire building stock may anticipate damages caused by the 100-year hurricane wind event and approximately 3.5-percent of the entire building stock may anticipate damages caused by the 500-year hurricane wind event. The total damage for all occupancy types across the County is estimated to be $415.7 million for the 100-year MRP wind-only event, and approximately $3.2 billion for the 500-year MRP wind-only event. The majority of these losses are to residential structures.

Table 5.4.6-10. Estimated Losses for the 100-Year and 500-Year MRP Hurricane Wind Events

Jurisdiction	Total Replacement Cost Value (All Occupancies)	Estimated Total Damages			
		100-Year	Percent of Total	500-Year	Percent of Total
Avalon Borough	$8,232,959,879	$45,556,435	0.6%	$142,708,862	1.7%
Cape May City	$5,153,049,612	$18,709,280	0.4%	$568,267,358	11.0%
Cape May Point Borough	$663,183,164	$2,636,428	0.4%	$79,830,434	12.0%
Dennis Township	$3,813,425,173	$12,131,107	0.3%	$48,012,984	1.3%
Lower Township	$9,950,232,225	$37,563,079	0.4%	$908,850,173	9.1%
Middle Township	$11,557,342,752	$35,443,035	0.3%	$344,730,436	3.0%
North Wildwood City	$4,423,365,953	$17,664,110	0.4%	$121,635,223	2.7%
Ocean City	$17,100,920,036	$101,779,622	0.6%	$73,718,096	0.4%

Jurisdiction	Total Replacement Cost Value (All Occupancies)	Estimated Total Damages			
		100-Year	Percent of Total	500-Year	Percent of Total
Sea Isle City	$7,663,928,227	$52,396,504	0.7%	$100,586,788	1.3%
Stone Harbor Borough	$3,291,756,871	$18,644,314	0.6%	$98,106,713	3.0%
Upper Township	$6,506,171,365	$27,896,296	0.4%	$49,218,071	0.8%
West Cape May Borough	$1,178,516,373	$5,450,858	0.5%	$165,050,693	14.0%
West Wildwood Borough	$459,103,094	$3,482,377	0.8%	$30,428,039	6.6%
Wildwood City	$4,379,038,844	$14,497,979	0.3%	$132,807,464	3.0%
Wildwood Crest Borough	$4,552,156,876	$19,719,858	0.4%	$286,440,410	6.3%
Woodbine Borough	$1,335,589,432	$2,166,772	0.2%	$13,861,534	1.0%
Cape May County (Total)	**$90,260,739,877**	**$415,738,054**	**0.5%**	**$3,164,253,276**	**3.5%**

Source: Hazus-MH 4.2
Notes: MRP = Mean return period
**The Total Damages column represents the sum of damages for all occupancy classes (residential, commercial, industrial, agricultural, educational, religious, and government) based on replacement cost value.*

Table 5.4.6-11. Estimated Losses for the 100-Year and 500-Year MRP Hurricane Wind Events – Residential and Commercial Occupancy Classes Only

Jurisdiction	Total Replacement Cost Value (All Occupancies)	Estimated Residential Damages		Estimated Commercial Damages	
		100-Year	500-Year	100-Year	500-Year
Avalon Borough	$8,232,959,879	$45,190,035	$140,894,777	$230,473	$1,309,504
Cape May City	$5,153,049,612	$18,049,569	$507,722,125	$218,154	$30,837,925
Cape May Point Borough	$663,183,164	$2,594,254	$75,810,523	$19,291	$2,146,092
Dennis Township	$3,813,425,173	$11,679,936	$44,268,035	$368,777	$2,436,579
Lower Township	$9,950,232,225	$36,618,753	$844,633,376	$390,377	$34,220,708
Middle Township	$11,557,342,752	$32,817,186	$282,423,878	$1,397,197	$41,348,277
North Wildwood City	$4,423,365,953	$17,092,538	$113,342,260	$304,222	$5,335,252
Ocean City	$17,100,920,036	$100,158,864	$72,898,618	$667,728	$336,658
Sea Isle City	$7,663,928,227	$52,092,081	$99,785,698	$239,376	$640,909
Stone Harbor Borough	$3,291,756,871	$18,527,867	$96,888,250	$89,307	$1,011,580
Upper Township	$6,506,171,365	$26,929,953	$47,165,017	$754,219	$1,455,976
West Cape May Borough	$1,178,516,373	$5,363,662	$156,739,463	$39,885	$4,437,080
West Wildwood Borough	$459,103,094	$3,206,241	$24,275,327	$185,311	$4,981,102
Wildwood City	$4,379,038,844	$13,554,445	$110,141,124	$635,767	$18,031,181
Wildwood Crest Borough	$4,552,156,876	$19,390,664	$277,565,903	$208,662	$6,193,297
Woodbine Borough	$1,335,589,432	$2,003,563	$10,472,374	$31,017	$545,842
Cape May County (Total)	**$90,260,739,877**	**$405,269,612**	**$2,905,026,748**	**$5,779,762**	**$155,267,962**

Source: Hazus-MH 4.2
Notes: MRP = Mean return period

Storm Surge Impacts on Buildings

To estimate potential building exposure, the SLOSH inundation zones were overlaid upon the building stock created for Cape May County. The estimated total number of buildings and replacement cost value located in Categories 1 through 4 SLOSH inundation zones are summarized in Table 5.4.6-12 through Table 5.4.6-15 by municipality. Overall, 52,612, 74,656, 93,640, and 105,238 buildings are exposed to the SLOSH Category 1, Category 2, Category 3, and Category 4 inundation hazard areas, respectively. Up to 94-percent of the total building stock in the County is exposed to the Category 4 inundation area, which is equal to approximately $85.7 billion.

Table 5.4.6-12. Number of Buildings in the SLOSH Category 1 and Category 2 Hurricane Inundation Hazard Areas

Jurisdiction	Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed to the Hurricane and Tropical Storm Hazard Areas			
			Number of Buildings Exposed - Category 1 SLOSH	Percent of Total	Number of Buildings Exposed - Category 2 SLOSH	Percent of Total
Avalon Borough	5,867	$8,232,959,879	5,087	86.7%	5,832	99.4%
Cape May City	4,234	$5,153,049,612	2,420	57.2%	4,049	95.6%
Cape May Point Borough	785	$663,183,164	317	40.4%	782	99.6%
Dennis Township	7,301	$3,813,425,173	92	1.3%	1,128	15.4%
Lower Township	19,597	$9,950,232,225	2,833	14.5%	8,213	41.9%
Middle Township	18,197	$11,557,342,752	2,884	15.8%	7,700	42.3%
North Wildwood City	4,729	$4,423,365,953	4,719	99.8%	4,723	99.9%
Ocean City	18,172	$17,100,920,036	15,193	83.6%	18,127	99.8%
Sea Isle City	6,712	$7,663,928,227	6,061	90.3%	6,671	99.4%
Stone Harbor Borough	3,836	$3,291,756,871	3,067	80.0%	3,817	99.5%
Upper Township	9,627	$6,506,171,365	943	9.8%	2,207	22.9%
West Cape May Borough	1,623	$1,178,516,373	694	42.8%	1,536	94.6%
West Wildwood Borough	805	$459,103,094	792	98.4%	794	98.6%
Wildwood City	3,679	$4,379,038,844	3,666	99.6%	3,667	99.7%
Wildwood Crest Borough	5,410	$4,552,156,876	3,844	71.1%	5,410	100.0%
Woodbine Borough	1,416	$1,335,589,432	0	0.0%	0	0.0%
Cape May County (Total)	**111,990**	**$90,260,739,877**	**52,612**	**47.0%**	**74,656**	**66.7%**

Source: Cape May County GIS 2020; RS Means 2019; NOAA 2014
Notes: SLOSH = Sea – Lake Overland Surge from Hurricanes

Table 5.4.6-13. Total Replacement Cost Value of Buildings in the SLOSH Category 1 and Category 2 Hurricane Inundation Hazard Areas

Jurisdiction	Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed to the Hurricane and Tropical Storm Hazard Areas			
			Total Replacement Cost Value Exposed - Category 1 SLOSH	Percent of Total	Total Replacement Cost Value Exposed - Category 2 SLOSH	Percent of Total
Avalon Borough	5,867	$8,232,959,879	$6,913,855,160	84.0%	$8,173,584,260	99.3%
Cape May City	4,234	$5,153,049,612	$3,057,996,783	59.3%	$4,685,540,368	90.9%
Cape May Point Borough	785	$663,183,164	$284,202,393	42.9%	$660,042,234	99.5%
Dennis Township	7,301	$3,813,425,173	$71,048,250	1.9%	$552,380,903	14.5%
Lower Township	19,597	$9,950,232,225	$1,513,858,697	15.2%	$4,103,712,899	41.2%
Middle Township	18,197	$11,557,342,752	$1,401,878,198	12.1%	$4,450,058,370	38.5%
North Wildwood City	4,729	$4,423,365,953	$4,417,365,798	99.9%	$4,421,076,932	99.9%
Ocean City	18,172	$17,100,920,036	$13,457,420,404	78.7%	$17,053,274,649	99.7%
Sea Isle City	6,712	$7,663,928,227	$6,817,291,009	89.0%	$7,629,205,372	99.5%
Stone Harbor Borough	3,836	$3,291,756,871	$2,561,803,050	77.8%	$3,277,884,115	99.6%
Upper Township	9,627	$6,506,171,365	$674,165,922	10.4%	$1,558,257,463	24.0%
West Cape May Borough	1,623	$1,178,516,373	$542,087,166	46.0%	$1,149,594,226	97.5%
West Wildwood Borough	805	$459,103,094	$451,077,421	98.3%	$453,814,284	98.8%
Wildwood City	3,679	$4,379,038,844	$4,284,578,173	97.8%	$4,374,419,436	99.9%
Wildwood Crest Borough	5,410	$4,552,156,876	$3,008,761,830	66.1%	$4,552,156,876	100.0%
Woodbine Borough	1,416	$1,335,589,432	$0	0.0%	$0	0.0%
Cape May County (Total)	**111,990**	**$90,260,739,877**	**$49,457,390,253**	**54.8%**	**$67,095,002,387**	**74.3%**

Source: Cape May County GIS 2020; RS Means 2019; NOAA 2014
Notes: SLOSH = Sea – Lake Overland Surge from Hurricanes

Table 5.4.6-14. Number of Buildings in the SLOSH Category 3 and Category 4 Hurricane Inundation Hazard Areas

Jurisdiction	Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed to the Hurricane and Tropical Storm Hazard Areas			
			Number of Buildings Exposed - Category 3 SLOSH	Percent of Total	Number of Buildings Exposed - Category 4 SLOSH	Percent of Total
Avalon Borough	5,867	$8,232,959,879	5,838	99.5%	5,843	99.6%
Cape May City	4,234	$5,153,049,612	4,214	99.5%	4,216	99.6%
Cape May Point Borough	785	$663,183,164	785	100.0%	785	100.0%
Dennis Township	7,301	$3,813,425,173	3,567	48.9%	5,829	79.8%
Lower Township	19,597	$9,950,232,225	14,591	74.5%	18,734	95.6%

Table 5.4.6-14. Number of Buildings in the SLOSH Category 3 and Category 4 Hurricane Inundation Hazard Areas

Jurisdiction	Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed to the Hurricane and Tropical Storm Hazard Areas			
			Number of Buildings Exposed - Category 3 SLOSH	Percent of Total	Number of Buildings Exposed - Category 4 SLOSH	Percent of Total
Middle Township	18,197	$11,557,342,752	15,301	84.1%	18,114	99.5%
North Wildwood City	4,729	$4,423,365,953	4,722	99.9%	4,719	99.8%
Ocean City	18,172	$17,100,920,036	18,137	99.8%	18,144	99.8%
Sea Isle City	6,712	$7,663,928,227	6,670	99.4%	6,672	99.4%
Stone Harbor Borough	3,836	$3,291,756,871	3,805	99.2%	3,818	99.5%
Upper Township	9,627	$6,506,171,365	4,518	46.9%	6,845	71.1%
West Cape May Borough	1,623	$1,178,516,373	1,623	100.0%	1,623	100.0%
West Wildwood Borough	805	$459,103,094	796	98.9%	795	98.8%
Wildwood City	3,679	$4,379,038,844	3,662	99.5%	3,667	99.7%
Wildwood Crest Borough	5,410	$4,552,156,876	5,410	100.0%	5,408	100.0%
Woodbine Borough	1,416	$1,335,589,432	1	0.1%	26	1.8%
Cape May County (Total)	**111,990**	**$90,260,739,877**	**93,640**	**83.6%**	**105,238**	**94.0%**

Source: Cape May County GIS 2020; RS Means 2019; NOAA 2014
Notes: SLOSH = Sea – Lake Overland Surge from Hurricanes

Table 5.4.6-15. Total Replacement Cost Value of Buildings in the SLOSH Category 3 and Category 4 Hurricane Inundation Hazard Areas

Jurisdiction	Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed to the Hurricane and Tropical Storm Hazard Areas			
			Total Replacement Cost Value Exposed - Category 3 SLOSH	Percent of Total	Total Replacement Cost Value Exposed - Category 4 SLOSH	Percent of Total
Avalon Borough	5,867	$8,232,959,879	$8,199,965,751	99.6%	$8,201,005,027	99.6%
Cape May City	4,234	$5,153,049,612	$5,123,527,706	99.4%	$5,127,245,204	99.5%
Cape May Point Borough	785	$663,183,164	$663,183,164	100.0%	$663,183,164	100.0%
Dennis Township	7,301	$3,813,425,173	$1,789,222,608	46.9%	$3,135,453,246	82.2%
Lower Township	19,597	$9,950,232,225	$7,333,958,354	73.7%	$9,453,910,981	95.0%
Middle Township	18,197	$11,557,342,752	$9,684,807,237	83.8%	$11,487,391,738	99.4%
North Wildwood City	4,729	$4,423,365,953	$4,420,064,860	99.9%	$4,416,767,820	99.9%
Ocean City	18,172	$17,100,920,036	$17,061,314,149	99.8%	$17,070,398,742	99.8%
Sea Isle City	6,712	$7,663,928,227	$7,626,018,533	99.5%	$7,628,559,959	99.5%
Stone Harbor Borough	3,836	$3,291,756,871	$3,276,825,740	99.5%	$3,275,647,952	99.5%
Upper Township	9,627	$6,506,171,365	$3,101,293,501	47.7%	$4,683,127,959	72.0%

Table 5.4.6-15. Total Replacement Cost Value of Buildings in the SLOSH Category 3 and Category 4 Hurricane Inundation Hazard Areas

Jurisdiction	Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed to the Hurricane and Tropical Storm Hazard Areas			
			Total Replacement Cost Value Exposed - Category 3 SLOSH	Percent of Total	Total Replacement Cost Value Exposed - Category 4 SLOSH	Percent of Total
West Cape May Borough	1,623	$1,178,516,373	$1,178,516,373	100.0%	$1,178,516,373	100.0%
West Wildwood Borough	805	$459,103,094	$455,561,326	99.2%	$452,869,810	98.6%
Wildwood City	3,679	$4,379,038,844	$4,364,378,962	99.7%	$4,374,151,274	99.9%
Wildwood Crest Borough	5,410	$4,552,156,876	$4,552,156,876	100.0%	$4,551,120,707	100.0%
Woodbine Borough	1,416	$1,335,589,432	$114,556	0.0%	$11,861,609	0.9%
Cape May County (Total)	**111,990**	**$90,260,739,877**	**$78,830,909,696**	**87.3%**	**$85,711,211,564**	**95.0%**

Source: Cape May County GIS 2020; RS Means 2019; NOAA 2014
Notes: SLOSH = Sea – Lake Overland Surge from Hurricanes

Impact on Land Uses

An exposure analysis was completed to determine the number of acres residential, non-residential, and natural land use types are exposed to the hurricane SLOSH inundation hazard areas. To estimate exposure the SLOSH Category 1 through Category inundation areas were overlaid upon the 2015 NJDEP land use land cover data and a county boundary provided by Cape May County.

Table 5.4.6-16 summarizes the county-wide assessment of the number of acres that are exposed to the SLOSH Category 1 through Category 4 inundation areas. Table 5.4.6-17 and Table 5.4.6-18 summarize the assessment that evaluated the number of acres land use types are exposed to the SLOSH Category 1 through Category 4 inundation areas, where the land use types are aggregated into residential, non-residential, and natural land use categories. The residential land use category included the following land use types: mixed residential; residential, high density or multiple dwelling; residential, rural, single unit; residential, single unit, low density; and residential, single unit, medium density. The non-residential land use category included all other land use types. The natural land use category was created using a sub-group of the non-residential land use category, including the following land use types: artificial lakes; Atlantic Ocean; Atlantic White Cedar wetlands; bare exposed rock, rock slides, etc; beaches; coniferous brush/shrubland; coniferous forest (>50% crown closure); coniferous forest (10-50% crown closure); coniferous scrub/shrub wetlands; coniferous wooded wetlands; deciduous brush/shrubland; deciduous forest (>50% crown closure); deciduous forest (10-50% crown closure); deciduous scrub/shrub wetlands; deciduous wooded wetlands; disturbed tidal wetlands; disturbed wetlands (modified); freshwater tidal marshes; herbaceous wetlands; managed wetland in built-up maintained rec area; managed wetland in maintained lawn greenspace; mixed deciduous/coniferous brush/shrubland; mixed forest (>50% coniferous with >50% crown closure); mixed forest (>50% coniferous with 10-50% crown closure); mixed forest (>50% deciduous with >50% crown closure); mixed forest (>50% deciduous with 10-50% crown closure); mixed scrub/shrub wetlands (coniferous dom.); mixed scrub/shrub wetlands (deciduous dom.); mixed wooded wetlands (coniferous dom.); mixed wooded wetlands (deciduous dom.); natural lakes; old field (< 25% brush covered); open tidal bays; phragmites dominate coastal wetlands; phragmites dominate interior wetlands; phragmites dominate old field; saline marsh (high marsh); saline marsh (low marsh); streams and canals; tidal

mud flat; tidal rivers, inland bays, and other tidal waters; undifferentiated barren lands; upland rights-of-way undeveloped; and wetland rights-of-way.

Table 5.4.6-16. Total Acres of Cape May County Exposed to the SLOSH Category 1 through Category 4 Hurricane Inundation Hazard Areas

Total Acres in County*	Hazard Area Type	Number of Acres Exposed to the Coastal Storm Hazard Areas	Percent of Total
183,127	Category 1 SLOSH	66,587	36.4%
	Category 2 SLOSH	91,154	49.8%
	Category 3 SLOSH	116,812	63.8%
	Category 4 SLOSH	133,098	72.7%

Source: Cape May County GIS 2020; RS Means 2019; NOAA 2014; NJDEP 2019/2015
Notes: SLOSH = Sea – Lake Overland Surge from Hurricanes; County boundary includes waterways
**Acres is based upon the data provided by the County, which could over or underestimate the number of acres of land area because it includes waterways*

Table 5.4.6-17. Land Use Types Exposed to the SLOSH Category 1 and Category 2 Hurricane Inundation Hazard Areas

Land Use Type	Total Acres of Land Use Type Category in Cape May County	Land Use Types Exposed to Category 1 SLOSH Hazard Area	Percent of Total Acres of Land Use Type	Land Use Types Exposed to Category 2 SLOSH Hazard Area	Percent of Total Acres of Land Use Type
Residential Land Use Type	22,296	6,319	28.3%	10,600	47.5%
Non-Residential Land Use Type	160,338	59,835	37.3%	80,018	49.9%
Natural Land Use Type	139,026	56,183	40.4%	71,937	51.7%
Cape May County (Total)	**182,633***	**66,154**	**36.2%**	**90,619**	**49.6%**

Source: Cape May County GIS 2020; RS Means 2019; NOAA 2014; NJDEP 2019/2015
Notes: SLOSH = Sea – Lake Overland Surge from Hurricanes
**Acres is based upon the NJDEP 2015 boundary, which could over or underestimate the number of acres of land area compared to the County boundary provided by the County*

Table 5.4.6-18. Land Use Types Exposed to the SLOSH Category 3 and Category 4 Hurricane Inundation Hazard Areas

Land Use Type	Total Acres of Land Use Type Category in Cape May County	Land Use Types Exposed to Category 3 SLOSH Hazard Area	Percent of Total Acres of Land Use Type	Land Use Types Exposed to Category 4 SLOSH Hazard Area	Percent of Total Acres of Land Use Type
Residential Land Use Type	22,296	16,235	72.8%	19,696	88.3%
Non-Residential Land Use Type	160,338	100,059	62.4%	112,893	70.4%
Natural Land Use Type	139,026	87,160	62.7%	96,047	69.1%
Cape May County (Total)	**182,633***	**116,294**	**63.7%**	**132,590**	**72.6%**

Source: Cape May County GIS 2020; RS Means 2019; NOAA 2014; NJDEP 2019/2015
Notes: SLOSH = Sea – Lake Overland Surge from Hurricanes
**Acres is based upon the NJDEP 2015 boundary, which could over or underestimate the number of acres of land area compared to the County boundary provided by the County*

Impact on Critical Facilities

Critical facilities are at risk of being impacted by high winds associated with structural damage, or falling tree limbs/flying debris, which can result in the loss of power. Power loss can greatly impact households, business operations, public utilities, and emergency personnel. For example, vulnerable populations in Cape May County are at risk if power loss results in interruption of heating and cooling services, stagnated hospital operations, and potable water supplies. Emergency personnel such as police, fire, and EMS will not be able to effectively respond in a power loss event to maintain the safety of its citizens.

Hazus estimates that critical facilities in Cape May have a low percent probability of sustaining minor to moderate damages from the 100-year MRP hurricane wind event. Hazus also estimates that there are critical facilities that have a 17.8-percent probability of sustaining severe damage from the 500-year MRP hurricane wind event. These probabilities can be found in Table 5.4.6-19 and Table 5.4.6-20 by facility type.

The critical facilities and utilities located in the Category 1 through 4 inundation zones are summarized Table 5.4.6-21 and Table 5.4.6-22 by municipality. Up to 82.9-percent of the critical facilities in Cape May County are exposed to the Category 4 SLOSH inundation area. Table 5.4.6-23 summarizes the number of lifelines categorized by FEMA lifeline categories that are exposed to the Category 1 through 4 SLOSH inundation areas. Overall, critical facilities that provide food, water, and shelter services and provide safety and security are the most exposed to the SLOSH inundation areas. Moreover, the distribution of the critical facilities exposed to the SLOSH Category 1 through Category 4 are summarized in Table 5.4.6-24 through Table 5.4.6-31 by jurisdiction.

Table 5.4.6-19. Estimated Impacts to Critical Facilities for the 100-Year MRP Hurricane Wind Event

		100-Year Event			
		Percent-Probability of Sustaining Damage			
Facility Type	Loss of Days	Minor	Moderate	Severe	Complete
EOC	0	1.7%-9.2%	0.0%-2.3%	<0.1%	0.0%
Medical	0	1.5%-7.0%	0.0%-2.7%	<0.1%	0.0%
Police	0	2.0%-9.2%	0.0%-2.3%	<0.1%	0.0%
Fire	0	0.6%-5.0%	0.0%-1.1%	<0.1%	0.0%
Schools	0	1.0%-7.4%	0.0%-4.3%	<0.1%	0.0%

Source: Hazus-MH v4.2

Table 5.4.6-20. Estimated Impacts to Critical Facilities for the 500-Year MRP Hurricane Wind Event

		500-Year Event			
		Percent-Probability of Sustaining Damage			
Facility Type	Loss of Days	Minor	Moderate	Severe	Complete
EOC	0	3.6%-22.1%	0.1%-29.1%	0.0%-17.8%	0.0%
Medical	0-3	3.8%-15.3%	0.6%-38.6%	0.0%-10.5%	0.0%-0.6%
Police	0	3.6%-23.8%	0.2%-29.1%	0.0%-17.8%	0.0%
Fire	0	1.6%-15.1%	0.1%-23.9%	0.0%-10.9%	0.0%-0.6%
Schools	0-24	3.5%-12.0%	0.7%-46.0%	0.0%-14.7%	<0.1%

Source: Hazus-MH v4.2

Table 5.4.6-21. Critical Facilities and Lifelines Exposed to the SLOSH Category 1 and Category 2 Hurricane Inundation Hazard Areas

Jurisdiction	Total Critical Facilities	Total Lifelines	Category 1 SLOSH				Category 2 SLOSH			
			Number of Critical Facilities Exposed	Percent of Total	Number of Lifelines Exposed	Percent of Total	Number of Critical Facilities Exposed	Percent of Total	Number of Lifelines Exposed	Percent of Total
Avalon Borough	30	30	20	66.7%	20	66.7%	25	83.3%	25	83.3%
Cape May City	32	32	16	50.0%	16	50.0%	19	59.4%	19	59.4%
Cape May Point Borough	10	10	3	30.0%	3	30.0%	10	100.0%	10	100.0%
Dennis Township	60	60	5	8.3%	5	8.3%	12	20.0%	12	20.0%
Lower Township	111	111	31	27.9%	31	27.9%	48	43.2%	48	43.2%
Middle Township	181	181	18	9.9%	18	9.9%	81	44.8%	81	44.8%
North Wildwood City	30	29	30	100.0%	29	100.0%	30	100.0%	29	100.0%
Ocean City	59	58	48	81.4%	48	82.8%	51	86.4%	50	86.2%
Sea Isle City	26	26	24	92.3%	24	92.3%	24	92.3%	24	92.3%
Stone Harbor Borough	26	26	18	69.2%	18	69.2%	24	92.3%	24	92.3%
Upper Township	73	68	9	12.3%	9	13.2%	18	24.7%	17	25.0%
West Cape May Borough	10	10	2	20.0%	2	20.0%	9	90.0%	9	90.0%
West Wildwood Borough	8	8	5	62.5%	5	62.5%	5	62.5%	5	62.5%
Wildwood City	39	37	36	92.3%	34	91.9%	37	94.9%	35	94.6%
Wildwood Crest Borough	23	23	12	52.2%	12	52.2%	22	95.7%	22	95.7%
Woodbine Borough	21	21	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Cape May County (Total)	**739**	**730**	**277**	**37.5%**	**274**	**37.5%**	**415**	**56.2%**	**410**	**56.2%**

Source: Cape May County GIS 2020; NOAA 2014
Notes: SLOSH = Sea – Lake Overland Surge from Hurricanes

Table 5.4.6-22. Critical Facilities and Lifelines Exposed to the SLOSH Category 3 and Category 4 Hurricane Inundation Hazard Areas

Jurisdiction	Total Critical Facilities	Total Lifelines	Category 3 SLOSH				Category 4 SLOSH			
			Number of Critical Facilities Exposed	Percent of Total	Number of Lifelines Exposed	Percent of Total	Number of Critical Facilities Exposed	Percent of Total	Number of Lifelines Exposed	Percent of Total
Avalon Borough	30	30	25	83.3%	25	83.3%	24	80.0%	24	80.0%
Cape May City	32	32	29	90.6%	29	90.6%	29	90.6%	29	90.6%
Cape May Point Borough	10	10	10	100.0%	10	100.0%	10	100.0%	10	100.0%
Dennis Township	60	60	25	41.7%	25	41.7%	47	78.3%	47	78.3%
Lower Township	111	111	70	63.1%	70	63.1%	93	83.8%	93	83.8%
Middle Township	181	181	160	88.4%	160	88.4%	164	90.6%	164	90.6%
North Wildwood City	30	29	30	100.0%	29	100.0%	30	100.0%	29	100.0%
Ocean City	59	58	52	88.1%	51	87.9%	51	86.4%	50	86.2%
Sea Isle City	26	26	24	92.3%	24	92.3%	24	92.3%	24	92.3%
Stone Harbor Borough	26	26	24	92.3%	24	92.3%	24	92.3%	24	92.3%
Upper Township	73	68	32	43.8%	31	45.6%	42	57.5%	40	58.8%
West Cape May Borough	10	10	9	90.0%	9	90.0%	9	90.0%	9	90.0%
West Wildwood Borough	8	8	5	62.5%	5	62.5%	5	62.5%	5	62.5%
Wildwood City	39	37	37	94.9%	35	94.6%	37	94.9%	35	94.6%
Wildwood Crest Borough	23	23	22	95.7%	22	95.7%	22	95.7%	22	95.7%
Woodbine Borough	21	21	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Cape May County (Total)	**739**	**730**	**554**	**75.0%**	**549**	**75.2%**	**611**	**82.7%**	**605**	**82.9%**

Source: Cape May County GIS 2020; NOAA 2014
Notes: SLOSH = Sea – Lake Overland Surge from Hurricanes

Table 5.4.6-23. FEMA Lifelines Exposed to the SLOSH Category 1 through 4 Hurricane Inundation Hazard Areas

FEMA Lifeline Categories	Total Lifelines in County	Number of Lifelines Exposed to SLOSH 1	Number of Lifelines Exposed to SLOSH 2	Number of Lifelines Exposed to SLOSH 3	Number of Lifelines Exposed to SLOSH 4
Communication	70	21	39	59	64
Energy	9	5	7	7	8
Food, Water, Shelter	206	101	141	168	187
Hazardous Materials	27	7	16	19	21
Health and Medical	39	16	24	30	34
Safety and Security	281	92	153	234	259
Transportation	98	32	30	32	32
Cape May County (Total)	**730**	**274**	**410**	**549**	**605**

Source: Cape May County GIS 2020; NOAA 2014
Notes: SLOSH = Sea – Lake Overland Surge from Hurricanes

Table 5.4.6-24. Distribution of Critical Facilities (Critical Facility Type Starting With 'A' Through 'L') Exposed to the Category 1 SLOSH Hurricane Inundation Hazard Area

Jurisdiction	Critical Facilities Exposed to Category 1 SLOSH																
	Airport	Bridge	Bus Station	Communications Facility	Communications Tower	County Facilities	Dams	DPW	Education	Electric Substation	EMS	EOC	Ferry Facilities	Fire Stations	Grocery/Food Processing	Health Services	Library
Avalon Borough	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	2
Cape May City	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0
Cape May Point Borough	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Dennis Township	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0
Lower Township	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0
Middle Township	0	1	0	0	2	3	2	0	0	0	0	0	0	2	0	0	0
North Wildwood City	0	0	0	0	6	2	0	1	0	0	1	1	0	3	1	0	0
Ocean City	1	3	0	0	1	0	0	0	0	0	0	1	1	3	0	0	0
Sea Isle City	0	0	0	0	0	1	0	0	0	0	1	1	0	1	0	0	1
Stone Harbor Borough	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0
Upper Township	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1
West Cape May Borough	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
West Wildwood Borough	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Wildwood City	0	1	1	0	0	0	0	2	1	1	0	0	0	3	1	1	0
Wildwood Crest Borough	0	0	0	0	5	0	0	0	0	0	1	0	0	1	0	0	0
Cape May County (Total)	**1**	**5**	**1**	**3**	**18**	**7**	**5**	**5**	**1**	**1**	**4**	**4**	**2**	**18**	**3**	**1**	**4**

Source: Cape May County GIS 2020; NOAA 2014
Notes: SLOSH = Sea – Lake Overland Surge from Hurricanes

Table 5.4.6-25. Distribution of Critical Facilities (Critical Facility Type Starting With 'M' Through 'W') Exposed to the Category 1 SLOSH Hurricane Inundation Hazard Area

Jurisdiction	Critical Facilities Exposed to Category 1 SLOSH																
	Marinas	Medical Clinics	Municipal Facilities	Natural Gas Facility	Police Stations	Polling Places	Potable Water Facilities	Potable Water Tower	Primary Education	Recreation	Secondary Education	Senior Facility	Shelters	Superfund Sites	Wastewater Facilities	Wastewater Pump Station	Well
Avalon Borough	1	0	2	0	1	0	0	0	1	0	0	0	0	0	0	10	0
Cape May City	1	0	0	0	0	2	1	1	0	0	0	0	0	0	0	5	3
Cape May Point Borough	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Dennis Township	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Lower Township	7	1	0	0	0	0	0	0	0	0	0	0	0	1	0	16	3
Middle Township	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	2	3
North Wildwood City	1	1	1	1	2	1	0	0	2	1	0	1	0	0	0	4	0
Ocean City	3	1	2	0	1	7	0	1	2	0	0	3	0	3	1	14	0
Sea Isle City	3	0	1	0	1	2	0	1	0	0	0	0	0	1	0	7	3
Stone Harbor Borough	1	0	1	0	1	0	0	0	1	0	0	0	0	0	0	4	5
Upper Township	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
West Cape May Borough	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
West Wildwood Borough	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	1	0
Wildwood City	1	5	1	2	1	0	1	2	3	2	0	1	1	2	0	3	0
Wildwood Crest Borough	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	2	0
Cape May County (Total)	**23**	**9**	**10**	**4**	**9**	**14**	**2**	**5**	**10**	**3**	**1**	**6**	**1**	**7**	**2**	**69**	**19**

Source: Cape May County GIS 2020; NOAA 2014
Notes: SLOSH = Sea – Lake Overland Surge from Hurricanes

Table 5.4.6-26. Distribution of Critical Facilities (Critical Facility Type Starting With 'A' Through 'L') Exposed to the Category 2 SLOSH Hurricane Inundation Hazard Area

Jurisdiction	Critical Facilities in Category 2 SLOSH																
	Airport	Bridge	Bus Station	Communications Facility	Communications Tower	County Facilities	Dams	Day Care	DPW	Education	Electric Substation	EMS	EOC	Ferry Facilities	Fire Stations	Grocery/Food Processing	Health Services	Library
Avalon Borough	0	0	0	0	1	0	0	0	0	0	0	1	1	0	1	0	0	2
Cape May City	0	0	0	0	0	0	0	0	2	0	0	1	0	0	1	0	0	0

Table 5.4.6-26. Distribution of Critical Facilities (Critical Facility Type Starting With 'A' Through 'L') Exposed to the Category 2 SLOSH Hurricane Inundation Hazard Area

Jurisdiction	Critical Facilities in Category 2 SLOSH																	
	Airport	Bridge	Bus Station	Communications Facility	Communications Tower	County Facilities	Dams	Day Care	DPW	Education	Electric Substation	EMS	EOC	Ferry Facilities	Fire Stations	Grocery/Food Processing	Health Services	Library
Cape May Point Borough	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0
Dennis Township	0	0	0	0	4	0	3	0	0	0	0	0	0	0	0	0	0	0
Lower Township	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	1	0	0
Middle Township	0	1	0	0	5	29	2	0	0	0	0	1	0	0	2	0	2	0
North Wildwood City	0	0	0	0	6	2	0	0	1	0	0	1	1	0	3	1	0	0
Ocean City	1	3	0	0	2	0	0	0	0	0	0	0	1	1	3	0	0	0
Sea Isle City	0	0	0	0	0	1	0	0	0	0	0	1	1	0	1	0	0	1
Stone Harbor Borough	0	0	0	2	3	1	0	0	0	0	0	1	0	0	1	0	0	1
Upper Township	0	0	0	1	1	1	3	1	0	0	1	0	0	0	1	0	0	1
West Cape May Borough	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
West Wildwood Borough	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Wildwood City	0	1	1	0	0	0	0	0	2	1	1	0	0	0	3	1	1	0
Wildwood Crest Borough	0	0	0	1	13	0	0	0	0	0	0	1	0	0	1	0	0	0
Cape May County (Total)	**1**	**5**	**1**	**4**	**35**	**37**	**8**	**1**	**5**	**1**	**3**	**7**	**4**	**2**	**21**	**3**	**3**	**5**

Source: Cape May County GIS 2020; NOAA 2014
Notes: SLOSH = Sea – Lake Overland Surge from Hurricanes

Table 5.4.6-27. Distribution of Critical Facilities (Critical Facility Type Starting With 'M' Through 'W') Exposed to the Category 2 SLOSH Hurricane Inundation Hazard Area

Jurisdiction	Critical Facilities in Category 2 SLOSH																	
	Marinas	Medical Clinics	Municipal Facilities	Natural Gas Facility	Police Stations	Polling Places	Potable Water Facilities	Potable Water Tower	Primary Education	Recreation	Secondary Education	Senior Facility	Shelters	Superfund Sites	TRI Sites	Wastewater Facilities	Wastewater Pump Station	Well
Avalon Borough	2	0	2	0	1	1	0	0	1	0	0	0	0	0	0	0	12	0
Cape May City	1	0	0	0	0	2	1	1	0	0	0	0	0	1	1	0	5	3
Cape May Point Borough	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	4	0

Table 5.4.6-27. Distribution of Critical Facilities (Critical Facility Type Starting With 'M' Through 'W') Exposed to the Category 2 SLOSH Hurricane Inundation Hazard Area

Jurisdiction	Critical Facilities in Category 2 SLOSH																	
	Marinas	Medical Clinics	Municipal Facilities	Natural Gas Facility	Police Stations	Polling Places	Potable Water Facilities	Potable Water Tower	Primary Education	Recreation	Secondary Education	Senior Facility	Shelters	Superfund Sites	TRI Sites	Wastewater Facilities	Wastewater Pump Station	Well
Dennis Township	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	2
Lower Township	5	1	0	0	0	2	0	0	0	0	0	0	1	1	0	2	22	10
Middle Township	1	2	0	0	0	2	0	0	4	0	2	4	1	5	0	2	8	8
North Wildwood City	1	1	1	1	2	1	0	0	2	1	0	1	0	0	0	0	4	0
Ocean City	2	1	2	0	1	8	0	1	3	1	0	3	0	3	0	1	14	0
Sea Isle City	3	0	1	0	1	2	0	1	0	0	0	0	0	1	0	0	7	3
Stone Harbor Borough	1	0	2	0	1	1	0	0	1	0	0	0	0	0	0	0	4	5
Upper Township	3	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	2
West Cape May Borough	0	1	1	1	0	1	0	0	2	0	0	0	0	0	0	0	0	1
West Wildwood Borough	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0
Wildwood City	1	5	1	2	1	1	1	2	3	2	0	1	1	2	0	0	3	0
Wildwood Crest Borough	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	2	0
Cape May County (Total)	**21**	**11**	**13**	**4**	**9**	**24**	**2**	**7**	**17**	**4**	**2**	**10**	**3**	**14**	**2**	**5**	**87**	**34**

Source: Cape May County GIS 2020; NOAA 2014
Notes: SLOSH = Sea – Lake Overland Surge from Hurricanes

Table 5.4.6-28. Distribution of Critical Facilities (Critical Facility Type Starting With 'A' Through 'L') Exposed to the Category 3 SLOSH Hurricane Inundation Hazard Area

Jurisdiction	Critical Facilities Exposed to Category 3 SLOSH																		
	Airport	Bridge	Bus Station	Communications Facility	Communications Tower	County Facilities	Cultural Building	Dams	Day Care	DPW	Education	Electric Substation	EMS	EOC	Ferry Facilities	Fire Stations	Grocery/Food Processing	Health Services	Library
Avalon Borough	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	1	0	0	2
Cape May City	0	0	0	0	2	0	0	0	0	2	0	0	2	1	0	2	0	0	0
Cape May Point Borough	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0
Dennis Township	0	0	0	0	6	0	0	3	0	0	0	0	0	0	0	2	0	0	0
Lower Township	0	0	0	0	0	1	0	0	0	1	0	0	1	0	1	1	1	0	2
Middle Township	0	1	0	0	17	54	2	2	0	4	0	0	2	0	0	5	1	3	2
North Wildwood City	0	0	0	0	6	2	0	0	0	1	0	0	1	1	0	3	1	0	0
Ocean City	1	3	0	0	2	0	0	0	0	0	0	0	0	1	1	3	0	0	0
Sea Isle City	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	1	0	0	1
Stone Harbor Borough	0	0	0	2	3	1	0	0	0	0	0	0	1	0	0	1	0	0	1
Upper Township	0	1	0	1	5	1	0	3	1	0	0	1	1	1	0	1	0	0	3
West Cape May Borough	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
West Wildwood Borough	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Wildwood City	0	1	1	0	0	0	0	0	0	2	1	1	0	0	0	3	1	1	0
Wildwood Crest Borough	0	0	0	1	13	0	0	0	0	0	0	0	1	0	0	1	0	0	0
Cape May County (Total)	**1**	**6**	**1**	**4**	**55**	**62**	**2**	**8**	**1**	**10**	**1**	**3**	**11**	**6**	**2**	**27**	**4**	**4**	**11**

Source: Cape May County GIS 2020; NOAA 2014
Notes: SLOSH = Sea – Lake Overland Surge from Hurricanes

Table 5.4.6-29. Distribution of Critical Facilities (Critical Facility Type Starting With 'M' Through 'W') Exposed to the Category 3 SLOSH Hurricane Inundation Hazard Area

Jurisdiction	Critical Facilities Exposed to Category 3 SLOSH																		
	Marinas	Medical Clinics	Municipal Facilities	Natural Gas Facility	Police Stations	Polling Places	Potable Water Facilities	Potable Water Tower	Primary Education	Recreation	Secondary Education	Senior Facility	Shelters	Superfund Sites	TRI Sites	Veterinary Services	Wastewater Facilities	Wastewater Pump Station	Well
Avalon Borough	2	0	2	0	1	1	0	0	1	0	0	0	0	0	0	0	0	12	0
Cape May City	1	0	1	0	1	2	1	1	2	0	0	1	0	1	1	0	0	5	3
Cape May Point Borough	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	4	0
Dennis Township	1	0	1	0	0	2	0	0	2	0	0	1	0	0	0	0	0	1	6
Lower Township	5	1	1	0	0	3	0	0	4	0	1	0	1	1	0	0	2	27	16
Middle Township	1	2	1	0	1	8	0	0	8	0	3	6	2	8	0	0	2	10	15
North Wildwood City	1	1	1	1	2	1	0	0	2	1	0	1	0	0	0	0	0	4	0
Ocean City	3	1	2	0	1	8	0	1	3	1	0	3	0	3	0	0	1	14	0
Sea Isle City	3	0	1	0	1	2	0	1	0	0	0	0	0	1	0	0	0	7	3
Stone Harbor Borough	1	0	2	0	1	1	0	0	1	0	0	0	0	0	0	0	0	4	5
Upper Township	3	1	1	0	0	0	0	1	1	0	0	0	0	1	1	1	0	0	3
West Cape May Borough	0	1	1	1	0	1	0	0	2	0	0	0	0	0	0	0	0	0	1
West Wildwood Borough	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0
Wildwood City	1	5	1	2	1	1	1	2	3	2	0	1	1	2	0	0	0	3	0
Wildwood Crest Borough	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	2	0
Cape May County (Total)	**22**	**12**	**18**	**4**	**11**	**33**	**2**	**7**	**30**	**4**	**4**	**13**	**4**	**17**	**2**	**1**	**5**	**94**	**52**

Source: Cape May County GIS 2020; NOAA 2014
Notes: SLOSH = Sea – Lake Overland Surge from Hurricanes

Table 5.4.6-30. Distribution of Critical Facilities (Critical Facility Type Starting With 'A' Through 'L') Exposed to the Category 4 SLOSH Hurricane Inundation Hazard Area

Jurisdiction	Critical Facilities Exposed to Category 4 SLOSH																			
	Airport	Bridge	Bus Station	Commercial Facility	Communications Facility	Communications Tower	County Facilities	Cultural Building	Dams	Day Care	DPW	Education	Electric Substation	EMS	EOC	Ferry Facilities	Fire Stations	Grocery/Food Processing	Health Services	Library
Avalon Borough	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	1	0	0	2
Cape May City	0	0	0	0	0	2	0	0	0	0	2	0	0	2	1	0	2	0	0	0
Cape May Point Borough	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0
Dennis Township	0	0	0	2	0	8	0	0	3	0	0	0	0	0	0	0	3	0	0	0
Lower Township	2	0	0	0	0	0	4	0	0	0	1	0	0	2	0	1	3	1	0	2
Middle Township	0	1	0	0	0	19	54	2	2	0	4	0	0	2	0	0	6	1	3	2
North Wildwood City	0	0	0	0	0	6	2	0	0	0	1	0	0	1	1	0	3	1	0	0
Ocean City	1	3	0	0	0	2	0	0	0	0	0	0	0	0	1	1	3	0	0	0
Sea Isle City	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	1	0	0	1
Stone Harbor Borough	0	0	0	0	2	3	1	0	0	0	0	0	0	1	0	0	1	0	0	1
Upper Township	0	1	0	0	2	5	1	0	3	2	1	0	2	1	1	0	3	0	0	3
West Cape May Borough	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
West Wildwood Borough	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Wildwood City	0	1	1	0	0	0	0	0	0	0	2	1	1	0	0	0	3	1	1	0
Wildwood Crest Borough	0	0	0	0	1	13	0	0	0	0	0	0	0	1	0	0	1	0	0	0
Cape May County (Total)	**3**	**6**	**1**	**2**	**5**	**59**	**65**	**2**	**8**	**2**	**11**	**1**	**4**	**12**	**6**	**2**	**33**	**4**	**4**	**11**

Source: Cape May County GIS 2020; NOAA 2014
Notes: SLOSH = Sea – Lake Overland Surge from Hurricanes

Table 5.4.6-31. Distribution of Critical Facilities (Critical Facility Type Starting With 'M' Through 'W') Exposed to the Category 4 SLOSH Hurricane Inundation Hazard Area

Jurisdiction	Critical Facilities Exposed to Category 4 SLOSH																		
	Marinas	Medical Clinics	Municipal Facilities	Natural Gas Facility	Police Stations	Polling Places	Potable Water Facilities	Potable Water Tower	Primary Education	Recreation	Secondary Education	Senior Facility	Shelters	Superfund Sites	TRI Sites	Veterinary Services	Wastewater Facilities	Wastewater Pump Station	Well
Avalon Borough	1	0	2	0	1	1	0	0	1	0	0	0	0	0	0	0	0	12	0
Cape May City	1	0	1	0	1	2	1	1	2	0	0	1	0	1	1	0	0	5	3
Cape May Point Borough	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	4	0
Dennis Township	1	0	1	0	0	4	0	0	4	0	0	2	0	0	0	0	0	1	18
Lower Township	5	1	1	0	1	6	0	0	6	0	1	2	1	3	0	0	3	30	17
Middle Township	1	2	1	0	1	8	0	0	8	0	3	6	2	8	0	0	2	10	16
North Wildwood City	1	1	1	1	2	1	0	0	2	1	0	1	0	0	0	0	0	4	0
Ocean City	2	1	2	0	1	8	0	1	3	1	0	3	0	3	0	0	1	14	0
Sea Isle City	3	0	1	0	1	2	0	1	0	0	0	0	0	1	0	0	0	7	3
Stone Harbor Borough	1	0	2	0	1	1	0	0	1	0	0	0	0	0	0	0	0	4	5
Upper Township	3	1	1	0	0	2	0	1	1	0	0	0	0	1	1	2	0	0	4
West Cape May Borough	0	1	1	1	0	1	0	0	2	0	0	0	0	0	0	0	0	0	1
West Wildwood Borough	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0
Wildwood City	1	5	1	2	1	1	1	2	3	2	0	1	1	2	0	0	0	3	0
Wildwood Crest Borough	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	2	0
Cape May County (Total)	**20**	**12**	**18**	**4**	**12**	**40**	**2**	**7**	**34**	**4**	**4**	**16**	**4**	**19**	**2**	**2**	**6**	**97**	**67**

Source: Cape May County GIS 2020; NOAA 2014
Notes: SLOSH = Sea – Lake Overland Surge from Hurricanes

At this time, HAZUS-MH v4.2 does not estimate losses to transportation lifelines and utilities as part of the hurricane model. Transportation lifelines are not considered particularly vulnerable to the wind hazard; they are more vulnerable to cascading effects such as flooding, falling debris etc. Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting) transportation needs. Furthermore, evacuation routes are vulnerable to coastal storm surge events and hurricane wind events. Evacuation routes generated by the Cape May Planning Department were reviewed for level of exposure to the SLOSH Categories 1 through 4 inundation extents. Table 5.4.6-32 summarizes the number of miles evacuation routes are exposed.

Table 5.4.6-32. Number of Miles Evacuation Routes Are Exposed to the SLOSH Category 1 Through 4 Hurricane Inundation Hazard Areas

Total Miles of Evacuation Routes in County	Hazard Area Type	Total Miles of Evacuation Routes Exposed to the Coastal Storm Hazard Areas	Percent of Total
224	Category 1 SLOSH	87	38.9%
	Category 2 SLOSH	143	63.9%
	Category 3 SLOSH	189	84.6%
	Category 4 SLOSH	208	93.2%

Source: Cape May County GIS 2020; NOAA 2014; Cape May County Planning Department 2011
Notes: SLOSH = Sea – Lake Overland Surge from Hurricanes

Impact on Economy

Damage to structures from flooding and wind can be the most immediate result of coastal storm events; however, this damage can have long-lasting impacts on the economy. When a business is closed during storm recovery, there is lost economic activity in the form of day-to-day business and wages to employees. Overall, economic impacts include the loss of business function (e.g., tourism, recreation), damage to inventory, relocation costs, wage loss and rental loss due to the repair/replacement of buildings. As evidenced by Hurricane Sandy, the State of New Jersey, including Cape May County, lost millions of dollars in wages and economic activity.

Hazus estimates the total economic loss associated with each storm scenario (direct building losses and business interruption losses). Direct building losses are the estimated costs to repair or replace the damage caused to the building. This is reported in the "Impact on General Building Stock" section discussed earlier. Business interruption losses are the losses associated with the inability to operate a business because of the wind damage sustained during the storm or the temporary living expenses for those displaced from their home because of the event.

For the 100-year MRP wind event, Hazus estimates $22.8 million in business interruption costs (income loss, relocation costs, rental costs, and lost wages). For the 500-year MRP wind-only event, Hazus estimates approximately $387.2 million in business interruption losses for the County which includes loss of income, relocation costs, rental costs, and lost wages.

Debris management can be costly and may also impact the local economy. Hazus estimates the amount of building and tree debris that may be produced as result of the 100- and 500-year MRP wind events. Because the estimated debris production does not include flooding, this is likely a conservative estimate and may be higher if multiple impacts occur. According to the Hazus Hurricane User Manual, estimates of weight and volume of eligible tree debris consist of downed trees that would likely be collected and disposed at public expense. Refer to the User Manual for additional details regarding these estimates. Table 5.4.6-33 summarizes debris production estimates for the 100- and 500-year MRP wind events.

Table 5.4.6-33. Debris Production for the 100-Year and 500-Year MRP Hurricane Wind Events

Jurisdiction	Brick and Wood (tons)		Concrete and Steel (tons)		Tree (tons)		Eligible Tree Volume (cubic yards)	
	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year
Avalon Borough	3,432	10,725	0	0	157	314	797	1,594
Cape May City	1,272	35,696	0	381	683	3,338	4,211	20,585
Cape May Point Borough	128	5,096	0	43	418	2,460	1,035	6,094
Dennis Township	521	3,228	0	0	14,941	53,452	11,097	34,859
Lower Township	2,007	65,364	0	542	7,400	38,578	22,737	123,870
Middle Township	2,017	25,299	0	121	22,493	81,381	33,112	122,370
North Wildwood City	1,636	10,137	0	39	0	0	0	0
Ocean City	10,947	7,520	3	1	313	313	1,499	1,499
Sea Isle City	5,456	10,301	0	0	140	210	962	1,443
Stone Harbor Borough	1,622	8,160	0	23	134	313	919	2,145
Upper Township	1,415	2,981	0	0	17,192	36,884	24,197	43,507
West Cape May Borough	265	10,536	0	88	864	5,086	2,140	12,600
West Wildwood Borough	457	2,861	0	12	19	88	156	704
Wildwood City	1,849	12,406	0	53	93	365	741	2,903
Wildwood Crest Borough	1,931	23,248	1	261	53	232	99	437
Woodbine Borough	100	926	0	4	1,795	6,417	2,743	9,800
Cape May County (Total)	**35,055**	**234,485**	**4**	**1,567**	**66,696**	**229,431**	**106,445**	**384,410**

Source: Hazus-MH 4.2
Notes: MRP = Mean Return Period

Impact on the Environment

According to the State of New Jersey 2019 Hazard Mitigation Plan, coastal storms can impact various natural land resources that can be easily uprooted by major wind events and storm surge. Extreme winds from coastal storms may create several tons of debris because the wind tears apart foliage and trees in Cape May County. Plants along waterways may be uprooted from surge causing even further instability and alterations of the shoreline. Consequentially, natural habitat that shelters the County from wind and storm surge can be destroyed, impacting future mitigation (State of New Jersey 2019).

Cascading Impacts on Other Hazards

Hurricanes can escalate the impacts of flooding and coastal erosion. Storm surge may increase erosion along the shoreline, which alters the extent of flooding. The structures most at risk of coastal erosion and flooding can be reviewed in Section 5.4.1 and Section 5.4.5, respectively.

Future Changes That May Impact Vulnerability

Understanding future changes that affect vulnerability can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The County considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

As discussed in Section 4, areas targeted for future growth and development have been identified across the County. Any areas of growth located along the coastline where storm surge is a larger risk could be impacted. It is recommended that the County and municipal partners implement design strategies that mitigate against the risk of impacts from hurricane and tropical storm hazards.

Projected Changes in Population

According to the U.S. Census Bureau, 2018 American Community Survey 5-Year Estimate, estimates Cape May County's population is approximately 93,705, which is a decrease in population since 2010, or a 5.4-percent decrease. Despite this decrease in the overall population, seasonal population changes that occur because of tourism can alter the number of persons impacted by flooding. Further, any change in population density in the flood hazard boundaries will also alter the number of persons impacted by flooding. Refer to Section 4 (County Profile) which includes a discussion on population trends for the County.

Climate Change

As discussed above, most studies project that the State of New Jersey will see an increase in average annual temperatures and precipitation. An increase in temperatures may also lead to an increase in the frequency and intensity of coastal storms. More frequent and severe storms will increase the County's vulnerability to both wind-related and storm surge impacts.

The New Jersey Protecting Against Climate Threats Program has been implemented to minimize the impact of climate related changes (NJDEP 2020). This PACT highlights a series of regulatory action and goals that the State has set for its jurisdictions. Some of the resolutions relate to coastal storms including, issuing sea level rise guidance frameworks, reforming coastal zone management rules, freshwater wetlands rules, and flood hazard control rules.

Furthermore, the New Jersey Science and Technical Advisory Panel (STAP) on Sea-Level Rise and Coastal Storms published a report in 2019 that found New Jersey coastal areas have at least a 66-percent chance of experiencing sea level rise increasing 0.5 to 1.1 feet between 2000 and 2030, but less than 5-percent change of sea level rise exceeding 2.6 feet by 2050 (Rutgers University 2019). However, the study also found that these sea level rise predictions are extremely dependent on future greenhouse gas emissions. If emissions increase, sea level rise will also increase, which can have an impact on coastal communities in New Jersey. Consequentially, sea level rise will affect the baseline for flooding from high tides and coastal storms (Climate Change Institute 2020). This will exacerbate coastal storm impacts on Cape May County.

Climate is defined not simply as average temperature and precipitation but also by the type, frequency, and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of events like hurricanes. While predicting changes to the prevalence or intensity of hurricanes and the events affects under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society, and the environment (USEPA 2020).

Change of Vulnerability Since the 2016 HMP

This hazard mitigation plan includes population spatial data referencing the 5-Year 2014-2018 American Community Survey population estimates; an updated general building stock using tax assessor data provided by the County and its municipalities supplemented with 2013 MOD-IV parcel data, building footprints data from the County, and 2019 RS Means replacement cost values for buildings and content in the County; and an updated critical facility dataset provided by the County. Furthermore, NOAA 2014 SLOSH Category 1 through Category

4 inundation areas were used to assess the County's hurricane and tropical storm surge inundation risk. An aggregated damage analysis at the census tract level was performed in Hazus-MH v4.2 using the probabilistic 100-year and 500-year MRP hurricane wind events, updated building stock, and updated critical facility data. This data is an update compared to the 2010 U.S. Census population and Hazus version 3.0 hurricane storm information used in the 2016 HMP.

Overall, this vulnerability assessment provides the County an estimated exposure assessment for the flood hazard.