



5.4.7 Nor'Easter

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 Nor'Easter hazard in Cape May County.

2021 Plan 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.

5.4.7.1 Profile

Hazard Description

A Nor'Easter is a cyclonic storm that moves along the East Coast of North America. It is called a Nor'Easter because the damaging winds over coastal areas blow from a northeasterly direction. Nor'Easters can occur any time of the year, but are most frequent and strongest between September and April. These storms usually develop between Georgia and New Jersey within 100 miles of the coastline and typically move from southwest to northeast along the Atlantic Coast of the United States (NOAA 2013). A Nor'Easter event can cause storm surges, waves, heavy rain, heavy snow, wind, and coastal flooding. Nor'Easters have diameters that can span 1,200 miles, impacting large areas of coastline. The forward speed of a Nor'Easter is usually much slower than a hurricane, so with the slower speed, a Nor'Easter can linger for days and cause tremendous damage to those areas impacted.

In order to be called a Nor'Easter, a storm must have the following conditions, as per the Northeast Regional Climate Center (NRCC):

- Must persist for at least a 12-hour period
- Have a closed circulation
- Be located within the quadrilateral bounded at 45°N by 65°W and 70°W and at 30°N by 85°W and 75°W
- Show general movement from the south-southwest to the north-northeast
- Contain wind speeds greater than 23 miles per hour (mph)

A Nor'Easter event can cause storm surges, waves, heavy rain, heavy snow, wind, and coastal flooding. Nor'Easters have diameters that can span 1,200 miles, impacting large areas of coastline. The forward speed of a Nor'Easter is usually much slower than a hurricane, so with the slower speed, a Nor'Easter can linger for days and cause tremendous damage to those areas impacted. Approximately 20 to 40 Nor'Easters occur in the northeastern United States every year, with at least two considered severe (Storm Solution 2014). New Jersey can be impacted by 10 to 20 Nor'Easters each year, with approximately five to 10 of those having significant impact on the State. The intensity of a Nor'Easter can rival that of a tropical cyclone in that, on occasion, it may flow or stall off the mid-Atlantic coast resulting in prolonged episodes of precipitation, coastal flooding, and high winds.

For the purpose of this HMP, only Nor'Easter events are being further discussed within this hazard profile, due to their significant historical impact on Cape May County. For information on coastal flooding and surge related to Nor'Easters, refer to Section 5.4.5 (Flood) and Section 5.4.6 (Hurricane). For information on severe winter storms, refer to Section 5.4.9.





Location

The entire State of New Jersey is susceptible to the effects of Nor'Easters; however, coastal communities and other low-lying areas, such as Cape May County, are particularly vulnerable. Nor'Easters usually form off the east coast near the Carolinas, and then follow a track northwards along the coast until they blow out to sea.

Because Cape May County is primarily surrounded by coastal waters, Nor'Easters affect the entire area, particularly communities along the eastern shores of the County. The County has felt the direct and indirect landward effects, including high winds, heavy rains, flash and coastal flooding, and beach erosion associated with Nor'Easters.

Extent

The magnitude or severity of a severe winter storm or Nor'Easter depends on several factors including a region's climatological susceptibility to snowstorms, snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, and time of occurrence during the day (e.g., weekday versus weekend), and time of season.

The extent of a nor'easter can be classified by meteorological measurements and by evaluating its societal impacts. NOAA's National Climatic Data Center (NCDC) is currently producing the Regional Snowfall Index (RSI) for significant snowstorms that impact the eastern two-thirds of the United States. The RSI ranks snowstorm impacts on a scale from 1 to 5. It is based on the spatial extent of the storm, the amount of snowfall, and the interaction of the extent and snowfall totals with population (based on the 2000 Census). The NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA-NCDC 2011). Table 5.4.7-1 presents the five RSI ranking categories.

Table 5.4.7-1. RSI Ranking Categories

Category	Description	RSI Value
1	Notable	1-3
2	Significant	3-6
3	Major	6-10
4	Crippling	10-18
5	Extreme	18.0+

Source: NOAA-NCDC 2011

Note: RSI = Regional Snowfall Index

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with Nor'Easters 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 included the State of New Jersey in seven Nor'Easter-related major disaster (DR) or emergency (EM) declarations classified as one or a combination of the following disaster types: severe storm, high tides, flooding, coastal storm, coastal flooding, or tropical depression. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Cape May County has been included in five Nor'Easter-related declarations. Table 5.4.7-2 lists FEMA DR and EM declarations for Cape May County.



**Table 5.4.7-2. FEMA Declarations for Nor'Easter Events in Cape May County**

FEMA Declaration Number	Date(s) of Event	Event Type
DR-973	December 10-17, 1992	Coastal Storm, High Tides, Heavy Rain, Flooding
DR-1206	February 4-8, 1998	Coastal Storm
DR-1867	November 11-15, 2009	Severe Storms and Flooding Associated with Tropical Depression Ida and a Nor'Easter
DR-4048	October 29, 2011	Severe Weather (Snowstorm / Nor'Easter)
DR-4264	March 14, 2016	Severe Winter Storm and Snowstorm

Source: FEMA 2020; NJ HMP 2019

Previous Events

For this 2021 HMP update, known Nor'Easter events that have impacted Cape May County between 2016 and 2020 are identified in Table 5.4.7-3. 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 5.4.7-3. Nor'Easter Events in Cape May County, 2016 to 2020

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Cape May County Designated?	Location	Description
January 22-24, 2016	Winter Storm & Coastal Flooding (Winter Storm Jonas)	DR-4264	Yes	Cape May County	<p>Snow began to develop on January 22nd from south to north. Across the coastal regions, the snow changed over to rain which limited the totals for those areas. There were intense bands of snow with rates of two to four inches per hour in north-central New Jersey and the Lehigh Valley in Pennsylvania. In addition to snow, there were strong wind gusts that topped out between 30 and 50 mph for most of the region. A 64 MPH wind gust was recorded on the 23rd near Strathmere (Cape May). At one point during the storm, up to 270,000 customers were without power. Outages were concentrated closer to the coast where the strongest winds occurred.</p> <p>New Jersey Governor Chris Christie declared a State of Emergency on Friday, January 22nd for the duration of the event. Schools and many businesses recessed early on Friday afternoon in anticipation of the storm.</p> <p>At the airports, most flights were cancelled due to the storm. Travel became nearly impossible at times for most of the areas impacted. Moderate to major tidal flooding occurred along the New Jersey and Delaware beaches which resulted in severe beach erosion and some property damage in coastal communities.</p> <p>The New Jersey Department of Transportation spent approximately \$25 million dollars to clear and maintain the state's highways and roadways. In seeking federal disaster aid, Governor Chris Christie announced the storm cost the state of New Jersey \$82.6 million in damages and expenses.</p> <p>In Cape May County, snowfall totals ranged from seven inches in the City of Cape May to 11.3 inches in Wildwood Crest. Peak wind gusts ranged from 50 mph in Cape May Point to 64 mph in Strathmere. In addition to snow and wind, coastal flooding impacted the county. In Cape May, there was a record storm surge of 9.4 feet. The tides in the County were as high as 10 feet in some parts which flooded garages and ground floors of buildings. Flood damage was significant as water levels exceeded those observed during Sandy and ranked in the top 10 on record. Beach erosion was moderate to major. Major tidal flooding was reported at the Cape May tide gage – 8.98 feet above MLLW was recorded at 1:30pm on January 23rd (major tidal flooding starts at 8.7 feet above MLLW).</p>
February 8-10, 2016	Nor'Easter & Coastal Flooding	N/A	N/A	Cape May County	A powerful Nor'Easter brought blizzard conditions to eastern Long Island and southeast New England and brought strong winds, rain and snow to the southern half of New Jersey. In Cape May County, snowfall totals were a minimum (0.2 inches in Middle Township and 0.6 inches in Cape May City). However, flooding was an issue in the County. The NWS issued a coastal flood warning for the county. During high tide, numerous streams were flooded and had to be closed. Moderate coastal flooding was reported at the Cape May tide gage – 8.159 feet above MLLW was recorded at 1:54pm on February 9th (moderate tidal flooding starts at 7.7 feet above MLLW).





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Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Cape May County Designated?	Location	Description
January 23, 2017	Nor'Easter & Coastal Flooding	N/A	N/A	Cape May County	Heavy rain and powerful northeast winds combined to create a coastal flooding reaching the moderate threshold.
February 9, 2017	Winter Storm	N/A	N/A	Cape May County	Low pressure developed along a cold front over the Middle Atlantic early Thursday, February 9th. The low rapidly intensified as it moved off the Delmarva coast in the morning and then to the south and east of Long Island late morning into the afternoon. The low brought heavy snow and strong winds to portions of Northeast New Jersey. Numerous flights were cancelled or delayed at Newark Airport
March 14, 2017	Coastal Flood	N/A	N/A	Cape May County	Low pressure systems across the Ohio Valley and Carolinas phased. This led to a rapidly developing storm which tracked just offshore. Wind, coastal flooding, heavy rain and snow all occurred. Heavy rainfall in Southeast New Jersey ranged from 1-3 inches. Widespread roadway flooding accompanied the morning high tide in the coastal communities of Cape May County which led to road closures. George Redding Bridge into Wildwood was closed. Moderate beach erosion also occurred in Ocean City and Wildwood. Ocean City gauge reached 6.92 ft, moderate flooding begins at 6.5 ft. Sea Isle gauge reached 6.98 ft, moderate flooding begins at 6.9 feet.
July 29, 2017	Coastal Flood and Heavy Rain	N/A	N/A	Cape May County	A rare summertime Nor'easter tracked just offshore producing heavy rain, thunderstorms and wind. Coastal flooding and beach erosion also occurred. Rainfall and high tide led to flooding on NJ 47 and West Rio Grand Avenue in Wildwood Crest. Flooding took place on NJ 47 at 5th street in Wildwood Gardens. Tides and rainfall led to street flooding in Stone Harbor. Street flooding was reported on Ocean Drive in Avalon. NJ 47 at CR 624 closed due to flooding in Wildwood. NJ 147 in North Wildwood was closed in both directions due to flooding and street flooding took place at 17 th and North. Parts of Hudson Avenue were flooded in North Wildwood. Street flooding occurred near the Inlet in Sea Isle City. Several inches of water were reported on roads in Avalon. Water was reported on roads in Ocean City from 24th to 33rd and on Haven Avenue.
March 1-3, 2018	Nor'Easter	N/A	N/A	Cape May County	At the Jersey Shore, the storm caused minor flooding and road closures during the high tide on the morning of March 2. Atlantic City Electric reported 29,111 customers without power and PSE&G reported tens of thousands of customers without power. New Jersey Transit cancelled some service.
March 7, 2018	Nor'Easter	N/A	N/A	Cape May County	Two to three feet of snow fell from New Jersey to New England. At least one person died from the storm. This was the second of three Nor'easters to hit the east coast in a two-week span. The third Nor'easter on 3/13 did not significantly impact New Jersey.
March 21, 2018	Winter Storm	N/A	N/A	Cape May County	A complex area of low pressure over the middle Atlantic, which involved several individual centers, slowly consolidated off the Virginia Capes Tuesday morning, March 20th into Wednesday March 21st along a frontal boundary. This primary low, the fourth nor'easter of March, gradually moved northeast Wednesday night, to a position southeast of the benchmark on Thursday morning.





Section 5.4.7: Risk Assessment - Nor'Easter

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Cape May County Designated?	Location	Description
					<p>Rain developed across far southern New Jersey on Tuesday morning, March 20th. As this precipitation moved northward into a colder air mass, snow and sleet developed across the remainder of southern New Jersey during the afternoon hours.</p> <p>Northeast winds increased throughout Tuesday, and gusted 40 to 50 mph along the Atlantic coast from Tuesday afternoon into Wednesday morning. Minor coastal flooding occurred along the New Jersey oceanfront around the times of high tide Tuesday night, Wednesday morning, and again Wednesday night. During Tuesday evening, a mixed bag of precipitation developed, with freezing rain, sleet, and snow, except rain closer to the coast. Freezing rain lead to ice accretion up to 0.20 inches across portions of southern New Jersey, causing downed trees and limbs, which impacted power lines, and led to power outages.</p> <p>Meanwhile, higher elevations of eastern Pennsylvania and northwest New Jersey remained dry through the overnight hours of Tuesday into Wednesday. A change over to snow progressed southeast across New Jersey by late morning on Wednesday, March 21st, with the exception of Cape May County NJ, where it did not occur until the early to mid-afternoon.</p> <p>Moderate to heavy snowfall developed, and gradually overspread New Jersey, from Wednesday morning into the evening. Snowfall rates, particularly outside of the higher elevations of northern New Jersey were around one inch per hour at times. The snow gradually ended from west to east around midnight, except late night closer to the New Jersey shore. Across New Jersey, snowfall amounts varied from less than 3 inches in portions of northern Sussex County and Cape May County, with a general 6 to 12 inches elsewhere, with the exception of portions of Monmouth, Ocean, and Burlington Counties, where some areas received 12 to 15 inches.</p> <p>The weight of the heavy, wet snow brought down trees, limbs, and power lines across portions of southern New Jersey, which led to power outages. In fact, portions of Monmouth, southeast Burlington, Ocean, and Atlantic Counties in New Jersey were particularly hard hit with numerous trees and power lines down.</p>
November 16, 2018	Nor'Easter and Coastal Flooding	N/A	N/A	Cape May County	A coastal storm brought strong northeast winds, peaking at 48 mph for about 12 hours resulting in more than 2.5 feet of surge.
October 9-12, 2019	Nor'Easter and Coastal Flooding	N/A	N/A	Cape May County	A distant but stalled coastal storm generates a week of strong north/northeast winds but no rain. High tides flood streets over the course of four days, reaching the moderate threshold on two days.

Source: NOAA NCEI 2020, NJ HMP 2019, SHELDUS, Ocean City 2020





Probability of Future Occurrences

Cape May County will continue to experience the direct and indirect impacts of Nor'Easters. Secondary hazards may include flooding, extreme wind, erosion, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents, and inconveniences.

As with any weather phenomenon, it is nearly impossible to assign probabilities to Nor'Easters, except over the long-term. High activity seasons are when storm activity exceeds the historical 75th percentile. This means that seasons with this number of storms are expected to occur during one out of four years. Lower activity seasons are defined as when storm activity falls below the historical 75th percentile; meaning this number of storms are expected to occur during three out of four years (East Coast Winter Storms 2013).

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 Partnership, the probability of occurrence for Nor'Easters in the County is considered 'frequent' (100 percent chance of event occurring; occurs multiple times a year).

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).

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.

Some climatologists believe that climate change may play a role in the frequency and intensity of Nor'Easters. Two ingredients are needed to produce strong Nor'Easters and intense snowfall: (1) temperatures which are just below freezing, and (2) massive moisture coming from the Gulf of Mexico. When temperatures are far below





freezing, snow is less likely. As temperatures increase in the winter months they will be closer to freezing rather than frigidly cold. Climate change is expected to produce more moisture, thus increasing the likelihood that these two ingredients (temperatures just below freezing and intense moisture) will cause more intense snow events.

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

5.4.7.2 Vulnerability Assessment

A qualitative assessment was conducted to analyze the Nor'Easter hazard for Cape May County. Quantified residual impacts from Nor'Easters such as flooding can also be reviewed in Section 5.4.5 (Flood). Refer to Section 5.1 (Methodology and Tools) for additional details on the methodology used to assess severe weather risk.

Impact on Life, Health and Safety

The impact of a Nor'Easter on life, health and safety is dependent upon several factors including the severity of the event and whether adequate warning time was provided to residents. The entire population of Cape May County (93,705) is exposed to this hazard (2014-2018 American Community Survey 5-Year Population Estimate).

Typically, a Nor'Easter has a longer duration (potentially lasting days) than a hurricane or tropical storm event, which normally pass through an area in a matter of hours. It is assumed that the entire County's population could be exposed to this hazard (wind and rain/snow and secondary impacts discussed earlier). Further, residents may be displaced or require temporary to long-term sheltering. Refer to Figures 5.4.6-3 and 5.4.6-4 in Section 5.4.6 (Hurricane and Tropical Storm) which display the peak gust wind speeds of the 100- and 500-year mean return period probabilistic wind events modeled in HAZUS-MH. In addition, Nor'Easter events may bring large volumes of precipitation (e.g., rain or snow). Refer to Section 5.4.9 for further discussion on the Severe Winter Weather hazard.

Impact on General Building Stock, Critical Facilities, and the Economy

The entire County's building stock and critical facilities are exposed to the wind and/or rain/snow from the Nor'Easter hazard. Nor'Easter events can greatly impact the economy, including: loss of business function, damage to inventory (utility outages), relocation costs, wage loss, and rental loss due to the repair/replacement of buildings. Damages to buildings can impact a community's economy and tax base. In addition, damages to buildings and critical infrastructure, as well as road closures, can delay emergency response services during these events. Refer to Sections 5.4.5 (Flood) and 5.4.6 (Hurricanes and Tropical Storms), and 5.4.9 (Severe Winter Weather) for estimated potential loss statistics by municipality as a result of flood, wind, and winter weather events, respectively.

Impact on Economy

Damages to buildings and infrastructure, utility outages, and roadways impassable due to snow or flood/surge can lead to closures of municipal or County buildings. These closures impact the services they provide and hinder response time for critical emergency services. Refer to Section 5.4.6 (Hurricanes and Tropical Storms) for a detailed discussion on potential losses to County buildings, critical facilities, and infrastructure due to winds and storm-surge flooding.





Impact on the Environment

Nor'Easters can cause significant impacts to the environment and natural resources. Flood/surge can cause beach and dune erosion, wetland loss, and barrier island breaching that disrupts coastal habitats and migration patterns of species (NYC 2019). Flooding caused by surge may breach structures containing hazardous wastes, which can contaminate water resources and soil resources. Debris caused by surge may also be hazardous to aquatic habitats and species.

Cascading Impacts on Other Hazards

Nor'Easters can escalate the impacts of flooding and coastal erosion. Storm surge may increase erosion along the coastline, which alters the extent of flooding. Further, the associated high winds, snow and ice may impact the continuity of utility services. The structures most at risk of coastal erosion and flooding can be reviewed in Section 5.4.2 (Coastal Erosion) and Section 5.4.5 (Flood).

Future Changes That May Impact Vulnerability

Understanding future changes that impact vulnerability in the county can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. 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.

Project Development

As discussed in Sections 4 and 9, areas targeted for future growth and development have been identified across Cape May County. Any areas of growth could be potentially impacted by the Nor'Easter hazard because the entire planning area is exposed and vulnerable. Please refer to the specific areas of development indicated in tabular form and/or on the hazard maps included in the jurisdictional annexes in Volume II, Section 9 of this plan.

Projected Changes in Population

Between 2000 and 2010, the County lost nearly five percent of its population. Between 2010 and 2020, the County is expected to have experienced a similar decrease. It is expected that in the next 20 years, population growth will be relatively stagnant (U.S. Census Bureau 2020, SJTPO). Overall, aging infrastructure may result in increased stress on existing infrastructure and related services. Although overall County growth is not expected, individual municipalities that experience increases in population may require utility system upgrades to keep up with utility demands (e.g., water, electric) during Nor'Easter events to prevent increased stresses on these systems. Refer to Section 4 (County Profile) for a detailed discussion on population change in Cape May County.

Climate Change

Climatologists predict that climate change may play a role in the frequency and intensity of Nor'easters. Two ingredients are needed to produce strong Nor'easters and intense snowfall: (1) temperatures which are just below freezing, and (2) massive moisture coming from the Gulf of Mexico. When temperatures are far below freezing, snow is less likely. As temperatures increase in the winter months they will be closer to freezing rather than frigidly cold. Future climate change has been predicted to produce more moisture, thus increasing the likelihood





that these two ingredients (temperatures just below freezing and intense moisture) will cause more intense snow events (State of New Jersey HMP 2019).

Change in Vulnerability Since 2016 HMP

Overall, the County's vulnerability has not changed; the entire County continues to be exposed and potentially vulnerable to the Nor'Easter hazard.

Future Growth and 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 the nor'easter hazard.

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