



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 Warren County.

2016 Plan Update Changes

- For the 2016 Plan Update, the Nor'Easter hazard is profiled on its own, which differs from the 2011 HMP where Nor'Easter was included in the High-Wind – Straight Line Winds hazard.
- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, probability of future occurrence, and potential change in climate and its impacts on the Nor'Easter hazard is discussed. The Nor'Easter hazard is now located in Section 5 of the plan update.
- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2008 and 2015.
- A vulnerability assessment was conducted and it now directly follows the hazard profile.

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 2013b).

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.



Location

The entire State of New Jersey, including Warren County, is susceptible to the effects of Nor'Easters; however, coastal communities and other low-lying areas are particularly vulnerable. Warren County is bordered to the west by the Delaware River which is considered a coastal boundary in New Jersey. Therefore, the County is exposed to the direct and indirect impacts of Nor'Easter events.

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 severe winter storm 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 winter storm information regarding previous occurrences and losses associated with Nor'Easters throughout Warren County. With so many sources reviewed for the purpose of this Hazard Mitigation Plan (HMP), loss and impact information for many events may. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

Between 1954 and 2015, FEMA included the State of New Jersey in six 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. Since the original 2011 HMP, Warren County has been included in one FEMA disaster declaration for a Nor'Easter event. Table 5.4.8-2 lists FEMA DR and EM declarations from January 1, 2008 to August 31, 2015 for this HMP Update.



Table 5.4.7-2. FEMA Declarations since 2008 for Nor'Easter Events in Warren County

FEMA Declaration Number	Date(s) of Event	Event Type	Counties Included
DR-4048	October 29, 2011	Severe Weather (Snowstorm / Nor'Easter)	Bergen, Cape May, Essex, Hunterdon, Middlesex, Morris, Passaic, Somerset, Sussex, Union, and Warren

Source: FEMA 2015

For this 2016 Plan update, Nor'Easter events were summarized from 2008 to 2015. Known Nor'Easter events, including FEMA disaster declarations, which have impacted Warren County between 2008 and 2015 are identified in Appendix E. For information regarding Nor'Easter events prior to 2008, refer to the 2011 Warren County HMP. For detailed information on damages and impacts to each municipality, refer to Section 9 (jurisdictional annexes).

Probability of Future Occurrences

Warren 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).

According to the NOAA NCDC Storm Events Database, Warren County has experienced eight Nor'Easter events between 1950 and 2015. This data was used to determine the recurrence interval and the average annual number of events for Warren County. The table below shows these statistics, as well as the annual average number of events and the estimated percent chance of an incident occurring in a given year (NOAA NCDC 2015).

Table 5.4.7-3. Probability of Future Occurrences of Nor'Easter Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence	Recurrence Interval	Probability of event Occurring in Any Given Year	% Chance of Occurring in Any Given Year
Nor'Easter	8	0.12	8.25	0.12	12.12%

Sources: NOAA-NCDC 2015

In Section 5.3, the identified hazards of concern for Warren 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 Nor'Easters in the County is considered 'frequent' (likely to occur within 25 years, as presented in Table 5.3-3).

Climate Change Impacts

In terms of snowfall and ice storms, there is a lack of quantitative data to predict how future climate change will affect this hazard. It is likely that the number of winter weather events may decrease, and the winter weather season may shorten; however, it is also possible that the intensity of winter storms may increase. The exact effect on winter weather is still highly uncertain (Sustainable Jersey Climate Change Adaptation Task Force 2013).



Temperatures in the Northeast United States have increased 1.5 degrees Fahrenheit (°F) on average since 1900. Most of this warming has occurred since 1970. The State of New Jersey, for example, has observed an increase in average annual temperatures of 1.2°F between the period of 1971-2000 and the most recent decade of 2001-2010 (ONJSC, 2011). Winter temperatures across the Northeast have seen an increase in average temperature of 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2013). Due to the increase in temperature, snow cover and sea ice extent are predicted to likely decrease over the next century and the snow season length is very likely to decrease over North America. However, warming of the lower atmosphere could potentially lead to more ice storms by allowing snow to more frequently melt as it falls and then refreeze near or at surface (NPCC 2010).

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5.4.7.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For the Nor'Easter hazard, all of Warren County has been identified as the hazard area. Therefore, all assets in the County (population, structures, critical facilities and lifelines), as described in the County Profile (Section 4), are vulnerable to a Nor'Easter. The following text evaluates and estimates the potential impact of the Nor'Easter hazard on the County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health and safety of residents, (2) general building stock, critical facilities, economy, and (3) future growth and development
- Effect of climate change on vulnerability
- Change of vulnerability as compared to that presented in the 2011 Warren County Hazard Mitigation Plan
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

There are many similarities between Nor'Easter and hurricane events. Both types of events can bring high winds and heavy rainfalls or severe winter weather events, resulting in similar impacts on the population, structures, and the economy. Refer to Sections 5.4.4 (Flood) and 5.4.8 (Severe Weather) for a detailed and quantitative assessment on these hazards using Hazards U.S. Multi-hazard (HAZUS-MH). The section below discusses Nor'Easter events in a qualitative nature.

Data and Methodology

Spatial datasets for the Nor'Easter hazard do not exist. Refer to Sections 5.4.4 (Flood) and 5.4.6 (Hurricane and Tropical Storm) for the data and methodology used in those analyses.

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 or not adequate warning time was provided to residents. 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 associated with a Nor'Easter. Further, residents may be displaced or require temporary to long-term sheltering. Refer to Figures 5.4.6-2 and 5.4.6-3 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.

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 5.4.4 (Flood) and 5.4.8 (Severe Weather) for estimated potential loss statistics by municipality as a result of wind and flood events.

Effect of Climate Change on Vulnerability



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 Nor'Easter events and their 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 (U.S. Environmental Protection Agency [EPA], 2006).

Change of Vulnerability

For the 2016 Plan Update, the Nor'Easter hazard is profiled on its own, which differs from the 2011 HMP where Nor'Easter was included in the High-Wind – Straight Line Winds hazard. There was no quantitative vulnerability assessment conducted for Nor'Easter events in the 2011 or 2016 HMP. Overall, the County's vulnerability has not changed; the entire County continues to be exposed and vulnerable to the Nor'Easter hazard.

Future Growth and Development

As discussed and illustrated in Sections 4 and 9, areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by the Nor'Easter hazard because the entire Planning Area is exposed and vulnerable. Areas targeted for potential future growth and development in the next five (5) years have been identified across the County at the jurisdiction level. Refer to the jurisdictional annexes in Volume II of this HMP.

Additional Data and Next Steps

Over time, the County will obtain additional data to support the analysis of this hazard. Data that will support the analysis would include additional detail on past hazard events and impacts, building footprints and specific building information such as details on protective features (for example, hurricane straps).

For future plan updates, the County can track data on extreme temperature events, obtain additional information on past and future events, particularly in terms of any injuries, deaths, shelter needs, pipe freeze, agricultural losses and other impacts. This will help to identify any concerns or trends for which mitigation measures should be developed or refined. In time, quantitative modeling of estimated extreme heat and cold events may be feasible as data is gathered and improved.