



4.3.9 Severe Winter Weather

The following section provides the hazard profile and vulnerability assessment for the severe winter storm hazard in Essex County.

2020 HMP Update Changes

- All subsections have been updated using best available data.
- Previous occurrences were updated with events that occurred between 2014 and 2019.

4.3.9.1 Profile

Hazard Description

A winter storm is considered a storm with significant snowfall, ice, and/or freezing rain. The quantity of precipitation varies by elevation. Heavy snowfall in non-mountainous areas is four inches or more in a 12-hour period, or six inches or more in a 24-hour period. In mountainous areas, heavy snowfall is considered 12 inches or more in a 12-hour period or 18 inches or more in a 24-hour period. Blizzards are storms with considerable falling and/or blowing snow combined with sustained winds or frequent wind gusts of 35 mph or greater that frequently reduce visibility to less than 0.25 mile for at least three hours.

Some winter storms are large enough to immobilize an entire region while others may only affect a single community. Winter storms are typically accompanied by low temperatures, high winds, freezing rain or sleet, and heavy snowfall. The aftermath of a winter storm can have an impact on a community or region for days, weeks, or even months; potentially causing cold temperatures, flooding, storm surge, closed and/or blocked roadways, downed utility lines, and power outages. In Essex County, winter storms include blizzards, snow storms, Nor'Easters and ice storms. Nor'Easters are also a common type of storm that may occur during winter months within the State of New Jersey; however, given the frequency of these types of storms in the State and their severe potential impact, Nor'Easters are considered by the Planning Committee as a separate hazard and are further discussed in Section 4.3.2 (Coastal Storms) within this plan. Extreme cold temperatures and wind chills are also associated with winter storms; however, based on input from the Planning Committee, these events are further discussed in this Plan in Section 4.3.5 (Extreme Temperatures).

Heavy Snow

According to the National Snow and Ice Data Center (NSIDC), snow is precipitation in the form of ice crystals. It originates in clouds when temperatures are below the freezing point (32 degrees Fahrenheit [°F]), when water vapor in the atmosphere condenses directly into ice without going through the liquid stage. Once an ice crystal has formed, it absorbs and freezes additional water vapor from the surrounding air, growing into snow crystals or snow pellets, which then fall to the earth. Snow falls in different forms, such as snowflakes, snow pellets, or sleet. Snowflakes are clusters of ice crystals that form from a cloud. Snow pellets are opaque ice particles in the atmosphere. They form as ice crystals fall through super-cooled cloud droplets that are below freezing but remain a liquid. The cloud droplets then freeze to the crystals. A heavy snowstorm is defined as a snowstorm with accumulations of 4 inches or more of snow in a 6-hour period, or 6 inches of snow in a 12-hour period (NWS 2009).

Blizzards

A blizzard is a winter snowstorm with sustained or frequent wind gusts of 35 miles per hour (mph) or more, accompanied by falling or blowing snow reducing visibility to or below 0.25 mile. These conditions must be predominant over a 3-hour period to be considered a blizzard. Extremely cold temperatures are often associated



with blizzard conditions but are not a formal part of the definition. The hazard created by the combination of snow, wind, and low visibility significantly increases with temperatures below 20°F. A severe blizzard is categorized as having temperatures near or below 10°F, winds exceeding 45 mph, and visibility reduced by snow to near 0 miles. Storm systems powerful enough to cause blizzards usually form when the jet stream dips far to the south, allowing cold air from the north to clash with warm air from the south. Blizzard conditions often develop on the northwest side of an intense storm system. The difference between the lower pressure in the storm and the higher pressure to the west creates a tight pressure gradient, resulting in strong winds and extreme conditions caused by the blowing snow (The Weather Channel 2012).

Sleet

Sleet is made up of drops of rain that freeze into ice as they fall. They are usually smaller than 0.30 inch in diameter (NSIDC 2013). A sleet storm involves significant accumulations of solid pellets, which form from the freezing of raindrops or partially melted snowflakes causing slippery surfaces, posing a hazard to pedestrians and motorists (NWS 2009).

Freezing Rain

Freezing rain occurs when rain falls into areas that are below freezing. In order for this to occur, ground-level temperatures must be colder than temperatures aloft. Freezing rain can also occur when the air temperature is slightly above freezing but the surface that the rain lands upon is still below freezing from prior cold air temperatures (NWS 2009).

An ice storm is an event caused by damaging accumulations of ice during freezing rain events. An ice storm involves significant accumulation of rain or drizzle freezing on objects (trees, power lines, roadways, etc.) as it strikes them, causing slippery surfaces and damage from sheer weight of ice accumulations (NWS 2009). Significant ice accumulations are typically 0.25 inch or greater (National Weather Service [NWS] 2013).

Location

Snow and Blizzards

The trajectory of the storm center—whether it passes close to the New Jersey coast or at a distance—largely determines both the intensity and the duration of the snowfall over the State. Winter storms tend to have the heaviest snowfall within a 150-mile wide swath to the northwest of what are generally southwest to northeast moving storms. Depending on whether all or a portion of New Jersey falls within this swath, the trajectory determines which portion of the State (or all of the State) receives the heaviest amount of snow. According to the ONJSC, Essex County’s normal seasonal snowfall is approximately 25-28 inches.

Ice Storms

All regions of New Jersey are subject to ice storms. The distribution of ice storms often coincides with general distribution of snow within several zones in the State. A cold rain may be falling over the southern portion of the State, freezing rain over the central region, and snow over the northern counties as a coastal storm moves northeastward offshore. A locality’s distance to the passing storm center is often the crucial factor in determining the temperature and type of precipitation during a winter storm. Based on data from 1948–2000, Essex County can anticipate 3-4 days with freezing rain per year (Changnon & Karl 2003). Based on data from 1932–2001, the County can anticipate 6-9 total hours of freezing rain per year (Changnon 2004).



Extent

The magnitude or severity of a severe winter storm depends on several factors, including a region’s climatological susceptibility to snowstorms, snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, time of occurrence during the day (for example, weekday versus weekend), and time of season. While sleet accumulation is measured and tracked in a method similar to snow events, the extent or severity of freezing rain or an ice storm requires a different and sometimes more challenging process. According to NWS, ice accumulation does not coat the surface of an object evenly, as gravity typically forces rainwater to the underside of an object before it freezes. Wind can also force rainwater downward prior to freezing, resulting in a thicker coating of ice on one side of the object than the other side. Ice mass is then determined by taking the average from the thickest and thinnest portions of ice on the sample used for measurement.

The National Oceanic and Atmospheric Administration’s (NOAA) National Climatic Data Center (NCDC) produces 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 Category 1 to 5, which is similar to the Enhanced Fujita scale for tornadoes or the Saffir-Simpson scale for hurricanes. RSI is based on the spatial extent of the storm, the amount of snowfall, and the combination 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 2018). Table 4.3.9-1 explains the five RSI ranking categories.

Table 4.3.9-1. RSI Ranking Categories

Category	Description
1	Notable
2	Significant
3	Major
4	Crippling
5	Extreme

Source: NOAA-NCDC 2018

Note: RSI = Regional Snowfall Index

NWS operates a widespread network of observation systems, such as geostationary satellites, Doppler radars, and automated surface observing systems that feed into the current state-of-the-art numerical computer models to provide a look into future weather, ranging from hours to days. The models are then analyzed by NWS meteorologists who then write and disseminate forecasts (NWS 2013). While winter weather is normal during the winter season for Essex County, the NWS uses winter weather watches, warnings, and advisories to help people anticipate what to expect in the days and hours prior to an approaching storm.

- A **winter storm watch** is issued when severe winter conditions (heavy snow, ice, etc.) may affect a certain area, but its occurrence, location, and timing are uncertain. A watch is issued to provide 24 to 72 hours of notice of the possibility of severe winter weather.
- A **winter storm warning** is issued when hazardous winter weather, in the form of heavy snow, heavy freezing rain, or heavy sleet, is imminent or occurring. A warning is usually issued 12 to 24 hours before the event is expected to begin.
- A **winter weather advisory** is issued when a hazardous winter weather event is occurring, is imminent, or has a greater than 80 percent chance of occurrence. Advisories are used to inform people that winter weather conditions are expected to cause significant inconveniences and that conditions may be hazardous. These conditions may refer to sleet, freezing rain, or ice storms, in addition to snow events.



- NWS may also issue a **blizzard warning** when snow and strong winds combine to produce the potential for blinding snow, deep drifts, and wind chill (NWS n.d.).

Previous Occurrences and Losses

Between 1954 and March 15, 2019, the Federal Emergency Management Agency (FEMA) included Essex County in six winter storm-related DR or EM declarations classified as one or a combination of the following disaster types: severe winter storm, snowstorm, snow, ice storm, winter storm, and blizzard.

Table 4.3.9-2. Winter Weather Related Disaster (DR) and Emergency (EM) Declarations 1954-2019

Declaration	Event Date	Declaration Date	Event Description
EM-3106	March 13-17, 1993	March 17, 1993	Snow: Severe Blizzard
DR-1088	January 7-12, 1996	January 13, 1996	Snow: Blizzard of 96 (Severe Snow Storm)
EM-3181	February 16-17, 2003	March 20, 2003	Snow: Snow
EM-1954	December 26-27-2010	February 4, 2011	Snow: Severe Winter Storm and Snowstorm
DR-4264	January 22-24, 2016	March 14, 2016	Severe Storm(s): Severe Winter Storm and Snowstorm
DR-4368	March 6-7, 2018	June 8, 2018	Severe Storm(s): Severe Winter Storm and Snowstorm

Source: FEMA 2019

Severe Winter Storm Events

The National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) Storm Events database records and defines severe winter storm events as follows:

- Blizzard is reported in the NOAA-NCEI database when a winter storm which produces the following conditions for 3 consecutive hours or longer: (1) sustained winds or frequent gusts 30 knots (35 mph) or greater, and (2) falling and/or blowing snow reducing visibility frequently to less than 1/4 mile.
- Heavy snow is reported in the NOAA-NCEI database whenever snow accumulation meet or exceed locally/regionally defined 12 and/or 24 hour warning criteria.
- Ice storm is reported in the NOAA-NCEI database when ice accretion meet or exceed locally/regionally defined warning criteria (typical value is 1/4 or 1/2 inch or more).
- Sleet is reported in the NOAA-NCEI database whenever sleet accumulations meet or exceed locally/regionally defined warning criteria (typical value is 1/2 inch or more).
- Winter storm is reported in the NOAA-NCEI database whenever a winter weather event has more than one significant hazard (i.e., heavy snow and blowing snow; snow and ice; snow and sleet; sleet and ice; or snow, sleet and ice) and meets or exceeds locally/regionally defined 12 and/or 24 hour warning criteria for at least one of the precipitation elements.
- Winter weather is reported in the NOAA-NCEI database when a winter precipitation event causes a death, injury, or a significant impact to commerce or transportation, but does not meet locally/regionally defined warning criteria.

Table 4.3.9-3 includes winter storm events and FEMA disaster declarations that occurred between 2014 and 2019.



Table 4.3.9-3. Severe Winter Weather Events in Essex County, 2014 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
January 18, 2015	Winter Weather	N/A	N/A	Eastern Essex County	Warm air overriding a stationary front along the coast, while a shallow Arctic air mass remained entrenched over land, led to light freezing rain through the day, and also into the evening in the higher interior elevations. Freezing rain continued even as air temperatures warmed above freezing due to very cold ground temperatures. The frozen ground also resulted in flooding in Union County. Freezing rain led to widespread motor vehicle accidents, and numerous falls and injuries. NJ Transit suspended bus service, and police issued closures on many roadways.
January 24, 2015	Winter Weather	N/A	N/A	Eastern Essex County	Low pressure moved out of the northern Gulf of Mexico on the morning of the 23rd, to the Mid Atlantic coast on the morning of the 24th, then rapidly intensified on its way northeast to the Canadian Maritimes the following day. This low brought heavy snow to parts of northeast New Jersey on the 24th. Trained spotters measured an average snowfall of 5 inches. The public measured snowfall of 6 inches in Cedar Grove. A trained spotter measured snowfall of 5.6 inches in Bloomfield. Newark Airport measured 5.1 inches of snow.
January 26, 2015	Winter Storm	N/A	N/A	Eastern Essex County	A potent Alberta Clipper low moved from southwestern Canada on January 24th to the Plains states and Ohio Valley on the 25th. The low then redeveloped off the Mid Atlantic coast on the 26th and rapidly intensified into a strong nor'easter, bringing heavy snow and strong winds to parts of northeast New Jersey just west of New York City. Newark Liberty Airport reported snowfall of 6.5 inches, and north winds gusted up to 33 mph, with blowing and drifting of snow.
February 1, 2015	Heavy Snow	N/A	N/A	Essex County	An area of low pressure tracked east from the Ohio Valley the night of February 1 to just south of Long Island the afternoon of February 2. The close proximity of the low with arctic air to the north resulted in snow at the onset, which transitioned to a wintry mix during the morning hours before going back to snow by early afternoon. Northeast New Jersey received 5 to 12 inches of snowfall and up to a third of an inch of ice. Snowfall ranged from 6 to 8 inches across the county, along with up to two tenths of an inch of ice. The highest amount of 7.8 inches was reported in Cedar Grove, NJ.
March 5, 2015	Heavy Snow	N/A	N/A	Essex County	Rain associated with a wave of low pressure moving along a cold front to the south changed to snow before sunrise on March 5, and became heavy across portions of Northeast New Jersey. Newark Airport reported 6.7 inches of snow.



Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
January 22-23, 2016	Winter Storm, Blizzard	DR-4264	Yes	Essex County	<p>Low pressure moving across the deep South on Thursday January 21st and Friday January 22nd intensified and moved off the Mid Atlantic coast on Saturday January 23rd, bringing heavy snow and strong winds to northeast New Jersey, and blizzard conditions to the urban corridor and some nearby areas.</p> <p>Governor Chris Christie declared a state of emergency for New Jersey on Friday January 22nd. New Jersey Transit stopped running trains, buses and light rail at 2 AM Saturday January 23rd. Bridges and tunnels from New York City into New Jersey were shut down by mid-afternoon Saturday.</p> <p>Travel in and out of airports lagged through Monday January 25th as airlines pre-emptively cut hundreds of flights. More than 1,000 flights out of area airports were cancelled, and Teterboro Airport were shuttered due to whiteout conditions.</p> <p>At Newark Airport, the storm total snowfall was 24.5 inches, where winds gusted to 39 mph. Newark Airport ASOS observations showed blizzard conditions, with visibility less than one quarter mile in heavy snow and frequent wind gusts over 35 mph through the day and into the early evening on Saturday January 23rd.</p>
February 5, 2016	Winter Weather	N/A	N/A	Western Essex County	<p>Low pressure developing along a cold front moving through the region on Thursday February 4th moved off the southern Mid Atlantic coast on Friday February 5th, bringing locally heavy snow to parts of interior Northeast New Jersey on the fifth.</p> <p>Trained spotters reported a widespread 4 to 5 inch snowfall, with locally up to 6 inches in North Caldwell.</p>
February 9, 2017	Winter Storm	N/A	N/A	Essex County	<p>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.</p> <p>Trained spotters, CoCoRaHS observers, and the public reported 6 to 8 inches of snowfall.</p>
March 14, 2017	Winter Storm	N/A	N/A	Essex County	<p>Rapidly deepening low pressure tracked up the eastern seaboard on Tuesday March, 14 bringing blizzard conditions to Western Passaic county. Heavy snow and sleet along with strong winds occurred across the rest of Northeast New Jersey.</p> <p>The storm cancelled numerous flights at Newark airport with some mass transit services suspended. Large trees fell onto homes in Bergen county and approximately 4,500 power outages resulted from the strong winds and heavy snow.</p> <p>Trained spotters and the public reported 8 to 13 inches of snow and sleet.</p>



Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
December 9, 2017	Winter Weather	N/A	N/A	Essex County	Low pressure along a slow moving cold front off the eastern seaboard brought locally heavy snow to portions of northeast New Jersey. A strong upper jet stream enhanced the snow across the Tri-State as the low pressure passed well offshore. Trained Spotters and the public reported 4 to 5 inches of snow.
January 4, 2018	Winter Storm	N/A	N/A	Essex County	The development of the blizzard/winter storm began along the southeast coast on Wednesday January 3, 2018. An amplifying upper level trough spawned the development of low pressure off the coast of Florida. The low pressure rapidly intensified on Wednesday night through Thursday January 4, 2018 as it moved north-northeast along the coast. The low passed just east of the benchmark Thursday afternoon. The central pressure when the storm developed was around 1004 millibars at 1 pm Wednesday. 24 hours later, the central pressure fell to around 950 mb, approximately a 54 millibar drop. The rapid intensification of the storm led to heavy snow, strong winds, and near-blizzard conditions across portions of Northeast New Jersey. Thousands of flights were cancelled at Newark Airport on January 4, 2018. Homes and businesses lost power and there were numerous accidents on area roadways. The public reported 6 inches of snow in West Caldwell. Winds gusts 30 to 40 mph at the Caldwell Airport during the afternoon and evening on January 4, 2018. The FAA Contract Observer at nearby Newark-Liberty Airport reported 8.4 inches of snowfall. Winds also gusted to 44 MPH at 4:38 PM at the airport.
February 7, 2018	Winter Weather	N/A	N/A	Western Essex County	A wave of low pressure developed across the southeastern states and tracked towards the northeast on February 7, 2018. The low brought a mixture of light snow and light freezing rain. The low pressure tracked a long a warm front which lifted across portions of the region helping to change any snow to freezing rain. The Caldwell Airport ASOS reported 0.14 inches of freezing rain. The Public reported 1.5 inches of snow in Cedar Grove.
February 17-18	Winter Weather	N/A	N/A	Essex County	A low pressure developed along a frontal boundary along the southeast coast on the evening of Saturday, February 17, 2018. This low gradually became better organized as it moved up the coast towards the benchmark early Sunday, February 18, 2018. This system brought heavy snow to northern portions of northeast New Jersey. CoCoRahs observers and nearby Newark Liberty Internal Airport reported 3 to 5 inches of snowfall.



Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
March 7, 2018	Winter Storm	N/A	N/A	Essex County	A strong low pressure system developed along the Middle Atlantic coast during the morning of Wednesday, March 7, 2018. The low tracked along the coast through the early morning hours on Thursday, March 8, 2018. The storm brought heavy wet snow, strong gusty winds, and even some thundersnow across northeast New Jersey. Snowfall rates ranged from 1 to 3 inches per hour at times in the heaviest snow bands. Trained spotters and the public reported 1 to 2 feet of snow. 23.0 inches was reported in North Caldwell and 19.7 inches in Roseland. The heavy wet snow and strong winds also brought down trees and some power lines.
March 21-22, 2018	Heavy Snow	N/A	N/A	Essex County	A large and slow moving low pressure developed along the Middle Atlantic coast on Wednesday, March 21st and moved slowly north and east along the coast through Thursday, March 22nd. Moderate to occasionally heavy snow bands moved across portions of northeast New Jersey. A trained spotter reported 6.6 inches of snow in Bloomfield.
April 2, 2018	Heavy Snow	N/A	N/A	Essex County	Waves of low pressure moved along a stalled frontal boundary across the Middle Atlantic. Moderate to heavy snow fell during the morning commute across northeast New Jersey. Snowfall rates reached 1 inch per hour at times. A daily record snowfall for April 2nd of 5 inches was set at Newark, NJ. Trained spotters, CoCoRaHS, and the public reported 6 to 8 inches of snowfall.
November 15, 2018	Winter Storm	N/A	N/A	Essex County	A wave of low pressure developed along the Middle Atlantic coast during Thursday November 15, 2018. The low was associated with a closed upper level trough across the Midwest. As the trough translated eastward into Friday November 16, 2018, the low pressure moved up the northeast coast. The antecedent air mass ahead of the low was cold and dry for the middle of November with temperatures during the morning and afternoon of November in the upper 20s and low 30s. The moisture associated with the trough and low pressure was able to produce moderate to heavy bands of snow as the precipitation began across the entire Tri-State area due to the cold air in place. Once the low drew warmer air from the south, the precipitation gradually changed to a wintry mix and then plain rain, especially for the New York City metro and Long Island. The moderate to heavy wet snowfall significantly impacted the evening rush hour with 1-2 inch per hour snowfall rates. Hundreds of trees, tree limbs, and branches were brought down by the weight of the snow, which caused many power outages. Numerous accidents were reported and many motorists were stranded on roads until the early morning hours the next day. There were over 1,000 flights cancelled at the New York City metro airports (Kennedy, La Guardia, and Newark). The FAA contract observer at nearby Newark Airport reported 6.4 inches of snow. Trained spotters, social media, and the public reported 4 to 6 inches of snow. Impacts were widely felt across eastern Essex county with major disruption to the evening commute. Trees branches and limbs were downed due to the weight of the heavy wet snow. Nearby Newark airport reported 1-2 inch per hour snowfall rates at times during the evening commute.



Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
January 30, 2019	Winter Weather	N/A	N/A	Essex County	A strong cold front initiated a broken line of snow squalls to the region. The snow squalls quickly moved across northeast New Jersey in the afternoon and early portion of the evening commute. Traffic was brought to a standstill during the squalls and created life-threatening travel. Snow squalls quickly moved through bringing whiteout conditions, strong winds, and dangerous driving conditions. The public reported 1 inch of snow in 30 minutes in West Orange and Cedar Grove.
March 2, 2019	Winter Weather	N/A	N/A	Essex County	A wave of low pressure brought light accumulating snow to northeast New Jersey early on the morning of Saturday March 2, 2019. The low pressure quickly moved away from the coast after day break bringing an end to the accumulating snow. The public reported 3 to 4 inches of snow.
March 3-4, 2019	Heavy Snow	N/A	N/A	Essex County	Low pressure developed across the southeast on Sunday March 3, 2019 and then tracked off the Middle Atlantic coast early on Monday March 4, 2019. The low moved just inside the 40N/70W benchmark and continued out to sea. The low brought a widespread snowfall to northeast New Jersey with the heaviest accumulations occurring across the interior. Much of the significant snow occurred overnight with improved conditions during the Monday morning commute. Trained spotters, CoCoRaHS, and the public reported 7 to 9 inches of snow.

Source: NOAA-NCDC 2019; NWS 2019; FEMA 2019
 DR Disaster Declaration
 FEMA Federal Emergency Management Agency
 N/A Not Applicable
 NCDC National Climatic Data Center
 NOAA National Oceanic and Atmospheric Administration
 NWS National Weather Service



According to the Storm Events Database, Essex County has been impacted by 37 severe winter storm events between 1950 and January 2019 (Table 4.3.9-4). No events resulted in deaths, property damages, or crop damages. One event resulted in an injury.

Table 4.3.9-4. Severe Winter Storm Events in Essex County 1950 to 2019

Hazard Type	Number of Occurrences Between 1950 and 2019	Total Fatalities	Total Injuries	Total Property Damage (\$)	Total Crop Damage (\$)
Blizzard	2	0	0	\$0	\$0
Heavy Snow	12	0	1	\$0	\$0
Ice Storm	1	0	0	\$0	\$0
Sleet	0	0	0	\$0	\$0
Winter Storm	12	0	0	\$0	\$0
Winter Weather	10	0	0	\$0	\$0
TOTAL	37	0	1	\$0	\$0

Note: Not all events that have occurred in Essex County are included due to the extent of documentation and the fact that not all sources have been identified or researched.

Source: NOAA-NCEI 2019



Probability of Future Occurrences

Essex County is estimated to continue experiencing direct and indirect impacts of severe winter storms annually. Table 4.3.9-5 provides the probability of occurrences of severe winter storm events. However, the information used to calculate the probability of occurrences is only based on NOAA-NCEI storm events database results.

Table 4.3.9-5. Severe Winter Storm Events in Essex County 1950 to 2019

Hazard Type	Number of Occurrences Between 1950 and 2019	Rate of Occurrence	Recurrence Interval	Probability of Event Occurring in Any Given Year	% Chance of Event Occurring in Any Given Year
Blizzard	2	0.03	35.0	0.03	2.9
Heavy Snow	12	0.17	5.8	0.17	17.1
Ice Storm	1	0.01	70.0	0.01	1.4
Sleet	0				
Winter Storm	12	12	0.17	5.83	0.17
Winter Weather	10	0.17	5.8	0.17	17.1
Total	37	0.14	7.0	0.14	14.3

Note: Not all events that have occurred in Essex County are included due to the extent of documentation and the fact that not all sources have been identified or researched.

Source: NOAA-NCEI 2019

In Section 4.4 (Hazard Ranking), the identified hazards of concern for Essex County are ranked using a variety of parameters. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Steering Committee and Planning Committee, the probability of occurrence for severe winter storms in the County is considered “frequent”.

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).

Average annual temperatures have increased by 3°F in New Jersey over the past century (NOAA NCEI 2019). Most of this warming has occurred since 1970. The State of New Jersey 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 2009).



4.3.9.2 Vulnerability Assessment

All of Essex County is exposed to the severe winter storm hazard; therefore, all assets in the County (population, structures, critical facilities, and lifelines), as described in the County Profile (Section 4), are potentially vulnerable to a severe winter storm event. The following discusses Essex County’s vulnerability, in a qualitative nature, to the severe winter weather hazard.

Impact on Life, Health, and Safety

The entire population of Essex County is exposed to severe winter weather events (population of 800,401 people, according to the 2013-2017 American Community Survey population estimates). The homeless and elderly are considered most susceptible to this hazard; the homeless due to their lack of shelter and the elderly due to their increased risk of injuries and death from falls and overexertion or hypothermia from attempts to clear snow and ice.

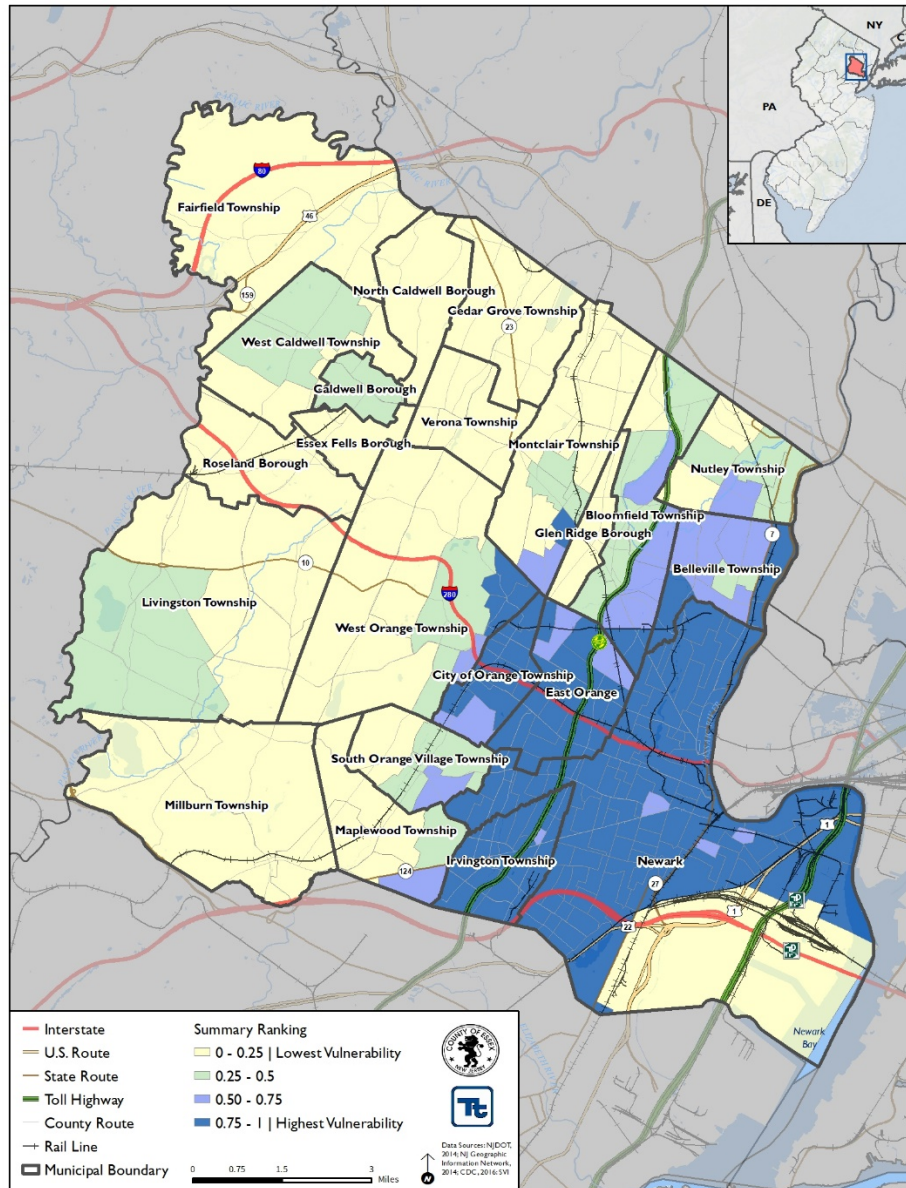
According to the 2017 ACS 5-Year Population Estimate, 12.8 percent of the population in Essex County is over 65 years in age. Severe winter storm events can reduce the ability of these populations to access emergency services. In Essex County, each municipality has areas of high concentration of elderly population (over 100 persons per square mile) with higher concentrations located in the more urban, densely populated areas of the County. Refer to Figure 3-X in Section 3 (County Profile) that displays the densities of populations over 65 in Essex County.

The homeless and residents below the poverty level might not have access to housing or their housing could be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply). Residents with low incomes might not have access to housing or their housing can be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply). In Essex County, areas with the highest concentration of population below the poverty level are located in and near the Cities of East Orange and Newark and Townships of Irvington and Orange. Refer to Figure 3-X in Section 3 (County Profile) that displays the densities of low-income populations in Essex County.

The CDC 2016 Social Vulnerability Index (SVI) ranks U.S. Census tracts on socioeconomic status, household composition and disability, minority status and language, and housing and transportation. Census tracts throughout the Cities of East Orange and Newark and the Townships of Irvington and Orange have been ranked in the highest vulnerability category with values between 0.75 and 1.0; Census tract 92 in the City of Newark has the highest social vulnerability with a ranking of 1.0. These Census tracts may be more susceptible to impacts from severe winter weather. Figure 4.3.9-1 below displays the CDC 2016 SVI.



Figure 4.3.9-1. CDC's Social Vulnerability Index 2016



According to the NOAA National Severe Storms Laboratory (NSSL); every year, winter weather indirectly and deceptively kills hundreds of people in the U.S., primarily from automobile accidents, overexertion and exposure. Winter storms are often accompanied by strong winds creating blizzard conditions with blinding wind-driven snow, drifting snow and extreme cold temperatures and dangerous wind chill. They are considered deceptive killers because most deaths and other impacts or losses are indirectly related to the storm. People can die in traffic accidents on icy roads, heart attacks while shoveling snow, or of hypothermia from prolonged exposure to cold. Heavy accumulations of ice can bring down trees and power lines, disabling electric power and communications for days or weeks. Heavy snow can immobilize a region and paralyze a city, shutting down all air and rail transportation and disrupting medical and emergency services. Storms near the coast can cause coastal flooding and beach erosion as well as sink ships at sea. The economic impact of winter weather each year is huge, with costs for snow removal, damage and loss of business in the millions (NSSL, 2018).



Impact on General Building Stock

All buildings in Essex County are exposed to the severe winter storm hazard; however, properties in poor condition may be more vulnerable to impacts. In general, structural impacts include damage to roofs and building frames rather than building content. Current modeling tools are not available to estimate specific losses for this hazard. As an alternate approach, the percent damage to structures that could result from severe winter storm conditions is considered. This allows planners and emergency managers to select a range of potential economic impact based on an estimate of the percent of damage to the general building stock. Table 4.3.9-6 summarizes the estimated loss to structures because of 1-, 5-, and 10-percent loss. Given professional knowledge and the currently available information, the potential loss for this hazard is considered to be overestimated because of varying factors (building structure type, age, load distribution, building codes in place). Therefore, this should be used as estimates only for planning purposes with the knowledge that the associated losses for severe winter storm events vary greatly.

Table 4.3.9-6. General Building Stock Exposure and Estimated Losses from Severe Winter Storm Events

County	Total (All Occupancies)	1% Damage Loss Estimate	5% Damage Loss Estimate	10% Damage Loss Estimate
Essex County	\$73,368,036,940	\$733,680,369	\$3,668,401,847	\$7,336,803,694

Source: NJOIT, 2018; Microsoft, 2018; Open Street Maps, 2019

A specific area that is vulnerable to the severe winter storm hazard is the floodplain. Severe winter storms can cause flooding through blockage of streams or through snow melt. At-risk residential infrastructures are presented in Section 4.3.6 (Flood). Generally, losses resulting from flooding associated with severe winter storms should be less than that associated with a 1-percent annual chance flood event. In addition, coastal areas are at high risk during winter storm events that involve high winds, as presented in Section 4.3.2 (Coastal Storms) for losses resulting from wind.

Impact on Critical Facilities

Full functionality of critical facilities such as police, fire and medical facilities is essential for response during and after a severe winter storm event. These critical facility structures are largely constructed of concrete and masonry; therefore, they should only suffer minimal structural damage from severe winter storm events. Because power interruption can occur, backup power is recommended. Infrastructure at risk for this hazard includes roadways that could be damaged due to the application of salt and intermittent freezing and warming conditions that can damage roads over time. Severe snowfall requires the clearing roadways and alerting citizens to dangerous conditions; following the winter season, resources for road maintenance and repair are required.

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Impact on Economy

The cost of snow and ice removal and repair of roads from the freeze/thaw process can drain local financial resources. Impacts on the economy also include commuter difficulties into or out of the area for work or school. The loss of power and closure of roads prevent commuters within the County.



Future Changes that May Impact Vulnerability

Understanding future changes that impact vulnerability in the County can assist in planning for future development and ensure that appropriate mitigation, planning, and preparedness measures are in place. The County considered the following factors to examine potential conditions that can 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

Areas targeted for future growth and development have been identified across Essex County (refer to Sections 3 and 9). Any areas of growth could be potentially impacted by the severe winter storm hazard because the entire planning area is exposed and vulnerable. However, due to increased standards and codes, new development may be less vulnerable to the severe winter weather hazard compared with the aging building stock in the County.

Projected Changes in Population

According to population projections from the State of New Jersey Department of Labor and Workforce Development, Essex County will experience an increase in population through 2034 (approximately 40,000 people between 2017 and 2034). Each year a non-profit organization in New Jersey, Monarch Housing Associates, conducts a point-in-time count of homeless populations across the State. On January 22, 2019, 2,235 homeless persons were counted in Essex County (Monarch Housing Associates, 2019). This accounted for 25-percent of the State’s total count. The homeless population has been increasing since 2015, at which time 1,723 homeless persons were counted (Kiefer, 2019). If the increase in homeless population trend continues, the County’s vulnerability to severe winter weather will continue to increase as well.

Climate Change

As discussed earlier, it is uncertain how climate change will influence extreme winter storm events. An increase in the frequency and severity of severe winter storms could result in an increase of snow loads on the County’s building stock and infrastructure, putting each building at risk to structural damage. More frequent and severe events also will result in increased resources spent to prepare for and clean-up after an event. However, as winter temperatures continue to rise, climate projections indicate the increase in precipitation is likely to occur during the winter months as rain. Increased rain on snowpack or frozen or saturated soils can lead to increased flooding and related impacts on the County’s assets.

Change of Vulnerability

Overall, the County’s exposure and vulnerability have not changed, and the entire County will continue to be exposed and vulnerable to severe winter storm events.