4.3.8 Severe Winter Weather

2024 HMP Changes

- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2018 and 2022.

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 severe winter weather hazard in Burlington County.

Hazard Description

A winter storm is a weather event in which the main types of precipitation are snow, sleet, or freezing rain. They can be a combination of heavy snow, blowing snow, and dangerous wind chills. According to the National Severe Storms Laboratory, the three basic components needed to make a winter storm include the following:

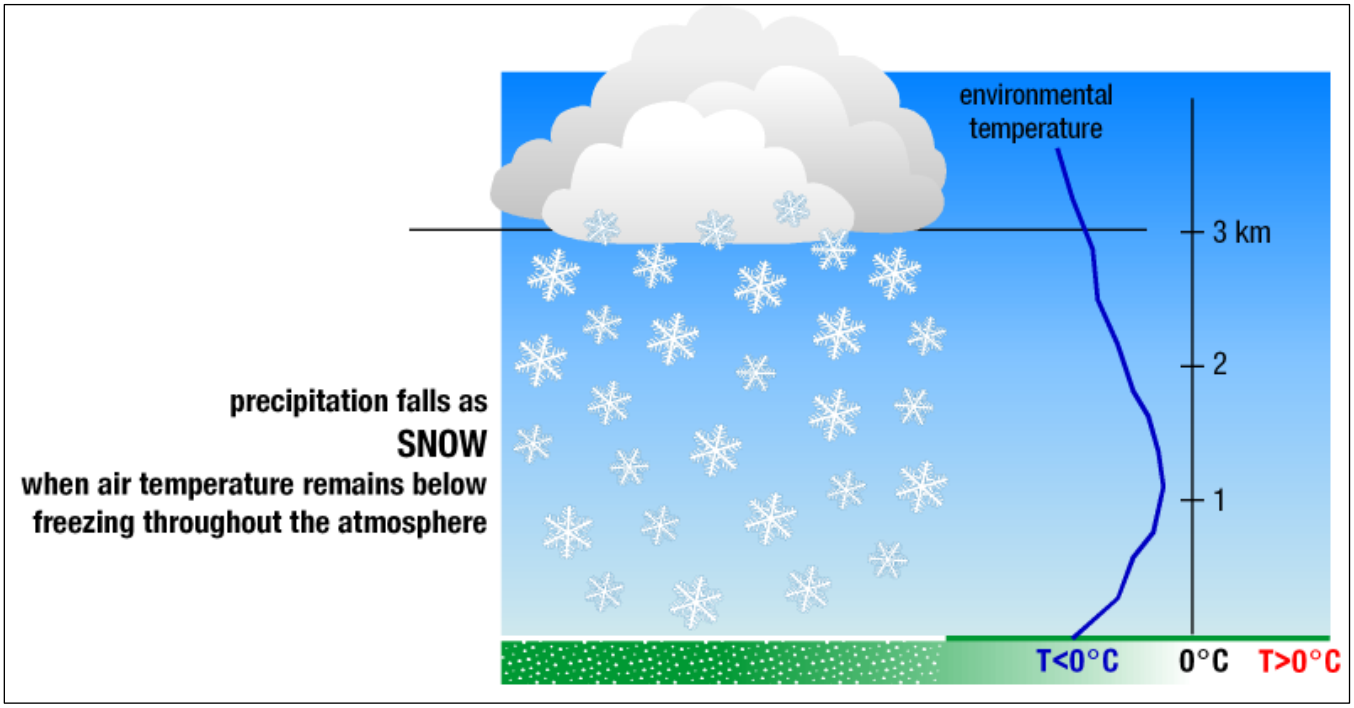
- Below freezing temperatures (cold air) in the clouds and near the ground to make snow and ice.
- Lift, something to raise the moist air to form clouds and cause precipitation, such as warm air colliding with cold air and being forced to rise over the cold dome or air flowing up a mountainside (orographic lifting).
- Moisture to form clouds and precipitation, such as air blowing across a large lake or the ocean (NOAA 2021).

Some winter storms can immobilize an entire region, while others might only affect a single community. Winter storms typically are 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 blocked roadways, downed utility lines, and power outages. Burlington County's winter storms include, but are not limited to heavy snow, blizzards, sleet, ice storms, and nor'easters.

Heavy Snow

According to the National Snow and Ice Data Center (NSIDC), snow is precipitation in the form of ice crystals (NSIDC 2024). It originates in clouds when temperatures are below the freezing point (32 °F) and 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 a snow pellet, which then falls to the earth. Snow falls in different forms: snowflakes, snow pellets, or sleet. Snowflakes are clusters of ice crystals that form from a cloud. Figure 4.3.8-1 depicts snow creation.

Figure 4.3.8-1. Snow Creation



Source: NOAA 2023

Blizzard

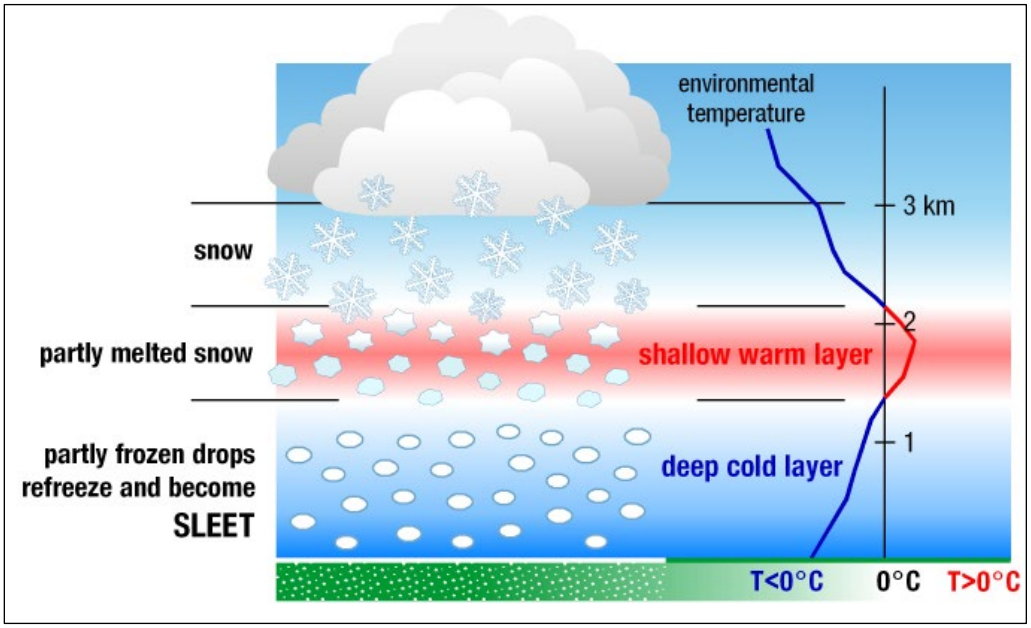
A blizzard is a winter snowstorm with sustained or frequent wind gusts of 35 miles per hour (mph) or more, accompanied by falling or blowing snow reducing visibility to or below 0.25 mile, as the predominant conditions over a 3-hour period (NWS n.d.). Extremely cold temperatures often are associated 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 when temperatures are 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 zero. For more information on the extreme temperature hazard, refer to Section 4.3.5.

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, moister 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 (Lam 2019).

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 (NSIDC 2013). Figure 4.3.8-2 depicts sleet creation.

Figure 4.3.8-2. Sleet Creation

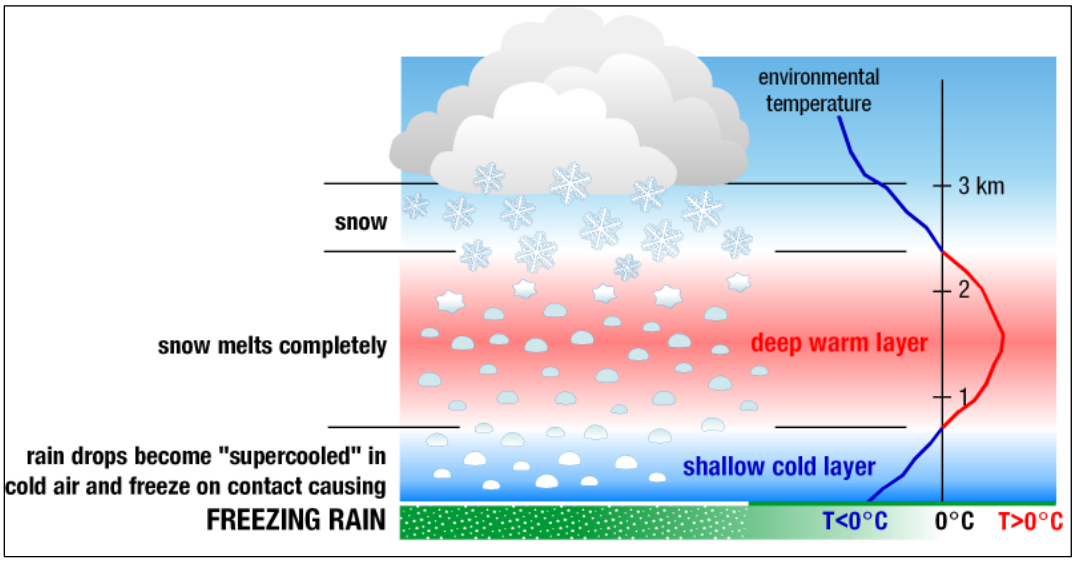


Source: NOAA 2023

Ice Storm

An ice storm describes those events when damaging accumulations of ice are expected during freezing rain situations. Significant ice accumulations typically are accumulations of 0.25-inches or greater (NOAA n.d.). Heavy accumulations of ice can bring down trees, power lines, utility poles, and communication towers. Ice can disrupt communications and power for days. Even small accumulations of ice can be extremely dangerous to motorists and pedestrians (NWS 2019). Figure 4.3.8-3 depicts freezing rain creation.

Figure 4.3.8-3. Freezing Rain Creation



Source: NOAA 2023

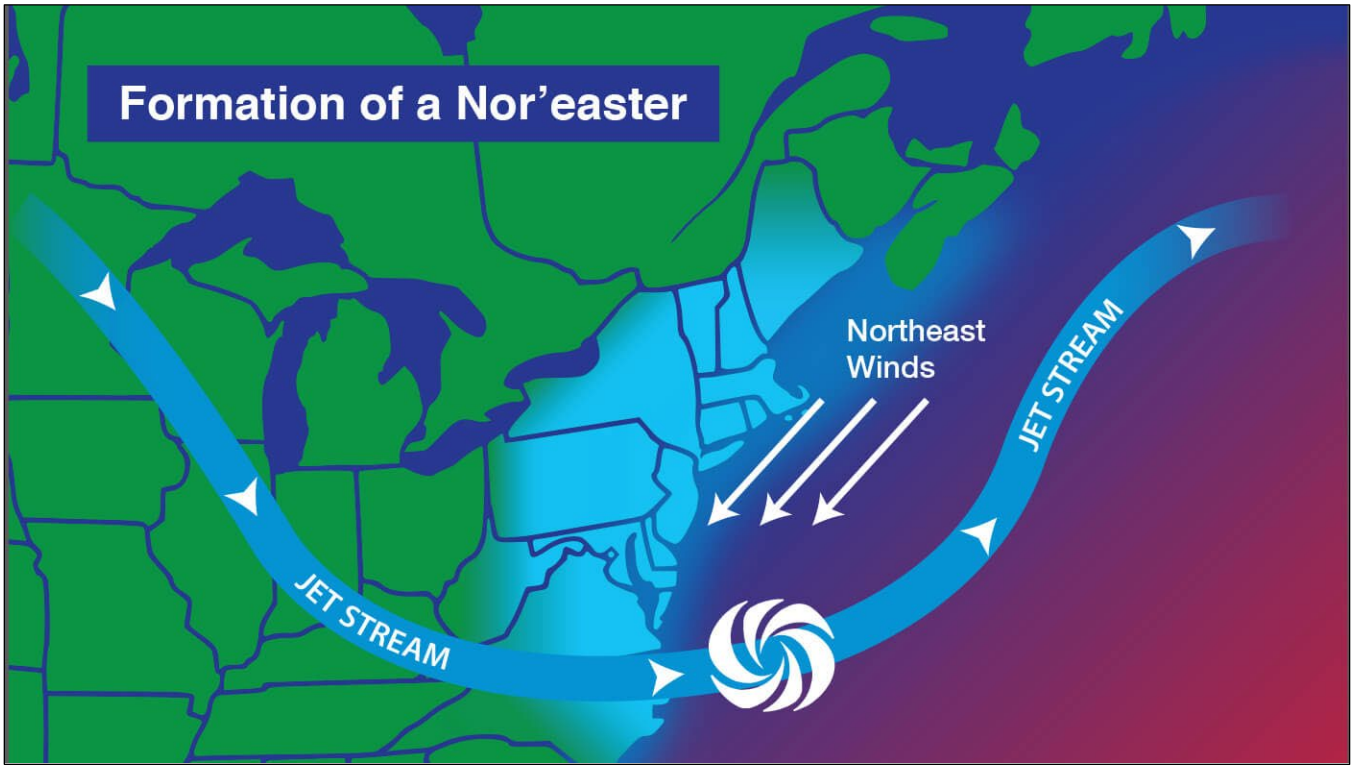
Nor'easter

A Nor'easter is an extratropical cyclone storm that typically brings wind, snow, rain, and flooding to the region. It forms along the east coast of North America and is named after the direction of the strongest winds, which generally blow over the northeast region. Nor'easters form within 100 miles of the coast between New Jersey and Georgia as shown in Figure 4.3.8-4. The polar jet stream blows cold air southward to Canada and eastward towards the warm Atlantic Ocean. When the cold air meets with the warm water, a low-pressure system forms. This low-pressure system results in the formation of clouds in which a nor'easter storm starts to develop (NOAA 2023).

Nor'easters are typically more severe during the winter months. They can produce extremely heavy snow and blizzards, in addition to rain and flooding. These hazards cause coastal erosion and severe damages to structures. Wind gusts are also common during a nor'easter and sometimes can rival that of a tropical cyclone (NOAA 2023). Nor'easters can stall off the mid-Atlantic coast resulting in prolonged episodes of precipitation, coastal flooding, and high winds.

Nor'easters and tropical cyclones can be mistaken as the same type of storm. They are similar in that they are both types of cyclone storm events with spiraling winds around a central pressure zone. However, while tropical cyclones gain their strength from warm, moist air from tropical waters, nor'easters are cold-core systems that do not rely on warm sea surface temperatures (NOAA 2023). Nor'easters can occur any time of the year but are generally common around the months of September and April.

Figure 4.3.8-4. Formation of a Nor'easter



Source: NOAA 2023

Location

Heavy Snow and Blizzards

Heaviest snowfall from winter storms is typically within a 150-mile-wide swath to the northwest of what are generally southwest to northeast moving storms. The trajectory of the snowstorm will determine the location of heaviest snowfalls. In Burlington County the average yearly snowfall is between 20" and 25". There is, however, significant variation from year to year. February is the month when maximum accumulations on the ground are usually reached. The southeastern third of Burlington County receives slightly less snowfall most likely due to the coastal influences moderating temperatures slightly. Snow may fall from about October 15 to April 30 in the highlands and from about November 15 to April 15 in southern counties, including Burlington (Rutgers University 2021).

Ice Storms and Sleet

All regions across New Jersey are subject to ice storms. In addition to temperature, their occurrence depends on the regional distribution of the pressure systems, as well as local weather conditions. The occurrence and intensity of ice storms often coincides with general distribution of snow. In Burlington County, a cold rain may be falling near the Atlantic County border in the southeastern part of the County, transforming into freezing rain in the central region, and snow over the northwestern portion 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, especially given the confined geographical region the storms often reach and affect. Based on data from 1948–2000, Burlington County can anticipate 2-4 days with freezing rain per year. Based on data from 1932–2001, the County can anticipate 9-15 total hours of freezing rain per year (MRCC 2021).

Nor'easter

The entire County is vulnerable to the damaging impacts of nor'easters. While coastal communities within the County are more susceptible to damage, particularly from coastal flooding and strong winds, some inland communities are susceptible to heavy precipitation and blizzard conditions (National Geographic 2022).

Extent

The magnitude or severity of a severe winter storm depends on several factors, including snowfall rates, regional climatological susceptibility to snowstorms, snowfall amounts, wind speeds, temperatures, visibility, storm duration, topography, time of occurrence during the day and week (e.g., weekday versus weekend), and time of season.

The extent of a severe winter storm can be classified both by meteorological measurements and by evaluating societal impacts. The National Oceanic and Atmospheric Administration's (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 and is based on the spatial extent of the storm, the amount of snowfall, and the interaction of the extent and snowfall totals with population. The NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA n.d.). Table 4.3.8-1. presents the five RSI ranking categories.

Table 4.3.8-1. RSI Ranking Categories

Category	Description	RSI Value
1	Notable	1–3
2	Significant	3–6

Category	Description	RSI Value
3	Major	6–10
4	Crippling	10–18
5	Extreme	18.0+

Source: NOAA n.d.
Note: RSI = Regional Snowfall Index

The NWS operates a widespread network of observing 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 what will happen next, ranging from hours to days. The models are then analyzed by NWS meteorologists who then write and disseminate forecasts (NOAA 2017).

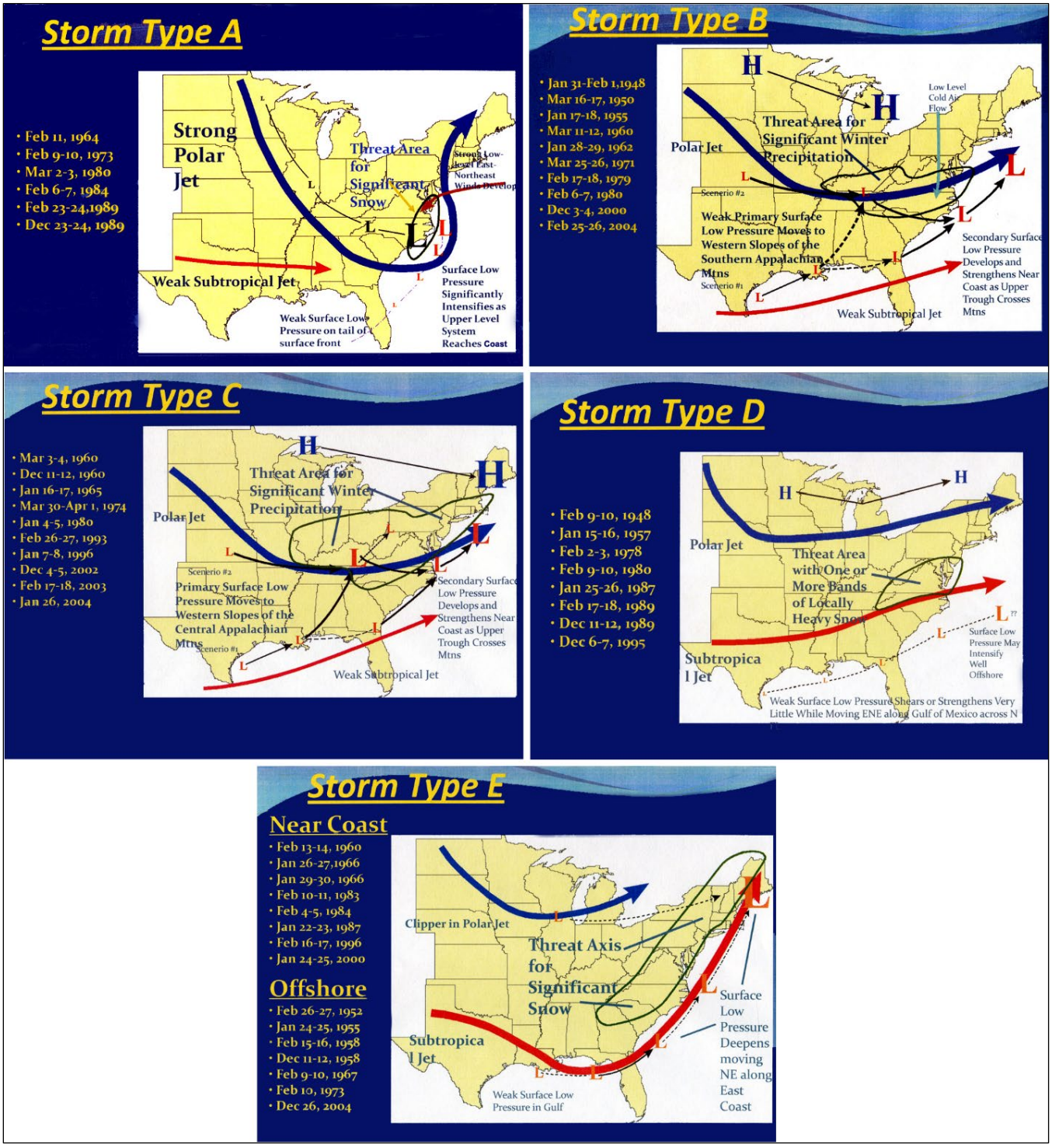
The NWS uses winter weather watches, warnings, and advisories to ensure that people know what to expect in the coming hours and days. Winter weather advisories inform people that winter weather conditions are expected to cause significant inconveniences that may be hazardous. A winter storm watch means that 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 12-to-48-hour notice of the possibility of severe winter weather. A watch is upgraded to a winter storm warning when hazardous winter weather, in the form of heavy snow, heavy freezing rain or heavy sleet, is imminent or occurring. They are usually issued 12 to 24 hours before the event is expected to begin. The NWS may also issue a blizzard warning when snow and strong winds combine and produce a blinding snow, deep drifts, and wind chill (NWS 2021).

Nor'easter

Nor'easters are classified into two major categories, which were developed by researcher J. E. Miller in 1946. The first type of nor'easter, and the most common, is the Miller Type A nor'easter. These classic nor'easters form in the Gulf of Mexico and develop into full-fledged storms that moves along the East Coast. Miller Type B nor'easters originate as low-pressure systems in the United States' Midwest. These less-common systems diminish after crossing the Appalachian Mountains and reform into nor'easters on the East Coast (National Geographic 2022).

A study written by Albright and Cobb (2004) showed that there are five predominant patterns that produce four inches or more of snowfall across the Mid-Atlantic. They added classification types C through E, adding onto the Miller Classification (Siebers n.d.). View Figure 4.3.8-5 below for visuals on the formation of each Miller Category.

Figure 4.3.8-5. Nor'easter Miller Classifications



Source: Siebers n.d.

Previous Occurrences and Losses

FEMA Major Disasters and Emergency Declarations

Between May 1953 and June 2023, FEMA included the State of New Jersey in eight winter-storm related major disaster (DR) or emergency (EM) declarations. These events were classified as one or a combination of the following incidents: severe winter storm, snowstorm, snow, severe winter coastal storm, blizzard, and ice conditions. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Burlington County was included in seven of these declarations. Since the 2020 HMP, the County has not been included in any FEMA disaster declarations. Table 4.3.8-2 lists FEMA declarations from May 1953 to May 2023 for this HMP Update. Detailed information about the declared disasters since 1953 is provided in Section 3 (County Profile).

Table 4.3.8-2. FEMA Declarations for Severe Winter Weather Events in Burlington County

FEMA Declaration Number	Date of Declaration	Date of Event	Event Type	Event Title
DR-528-NJ	February 8, 1977	February 8, 1977	Severe Ice Storm	Ice Conditions
EM-3106-NJ	March 17, 1993	March 13-17, 1993	Snowstorm	Severe Blizzard
DR-1088-NJ	January 13, 1996	January 7-12, 1996	Snowstorm	Blizzard of '96 (Severe Snow Storm)
EM-3181-NJ	March 20, 2003	February 16-17, 2003	Snowstorm	Snow
DR-1873-NJ	February 5, 2010	December 19-20, 2009	Snowstorm	Snowstorm
DR-1889-NJ	March 23, 2010	February 5-6, 2010	Snowstorm	Severe Winter Storm and Snowstorm
DR-1954-NJ	February 4, 2011	December 26-27, 2010	Snowstorm	Severe Winter Storm and Snowstorm

Source: FEMA 2023

U.S. Department of Agriculture Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between August 2018 and June 2023, Burlington County was not included in any severe winter weather-related agricultural disaster declarations (USDA n.d.).

Previous Events

For the 2024 HMP update, known severe winter weather events that impacted Burlington County between August 2018 and May 2023 are discussed below in Table 4.3.8-3. For events prior to 2018, refer to the 2019 Burlington County HMP.

Probability of Future Occurrence

For the 2024 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of severe winter weather events for the County. Information from NOAA-NCEI storm events database was used to identify the number of severe winter weather events that occurred between January 1950 and March 2023. Table 4.3.8-4 presents the probability of future events for severe winter weather in Burlington County.

Table 4.3.8-3. Severe Winter Weather Events in Burlington County, 2018 to 2023

Date of Event	Event Type	Declaration Number	Burlington County Designated?	Description
November 15, 2018	Winter Weather	N/A	N/A	Early season Winter Storm. Additional trace amounts of snow were reported in Cape May County. Totals ranged from 4.2 in Florence to 1.4 in Hainesport. There were no property or crop damages reported from this event in the County.
December 5, 2018	Winter Weather	N/A	N/A	A localized snowfall event occurred across southern NJ and extreme southeast PA in response to a Norlun Trough. Up to 2 fell across the county. There were no property or crop damages reported from this event in the County.
January 12-13, 2019	Winter Weather	N/A	N/A	A weekend winter storm led to a reported 4 inches of snow. There were no property or crop damages reported from this event in the County.
February 10-12, 2019	Winter Weather	N/A	N/A	Light snow fell, impacting the area with light snow changing to a wintry mix and then to rain. Snowfall totals of 2.1 inches was recorded in Mount Laurel; 2.0 inches in Tabernacle; and 3.1 inches near Evesham. It was reported that there was 0.03 inches of ice at the South Jersey Regional Airport. There were no property or crop damages reported from this event in the County.
February 20, 2019	Winter Weather	N/A	N/A	A mix of wintry precipitation, some heavy, impacted Burlington County. Several inches of snow and areas of freezing rain were observed. A report was received of 3.5 inches of snow in Marlton. Some light icing was also observed, including 0.01 inches at the NWS office in Mount Holly. Reports from nearby areas suggest around 2 to 2.5 inches of snow likely fell. There were no property or crop damages reported from this event in the County.
March 1, 2019	Winter Weather	N/A	N/A	A fast-moving weather system brought a short duration but intense burst of snow. A widespread 2 to 4 inches of snow were observed, most of it within a 3-hour window. The NWS office in Mount Holly measured 2.4 inches of snow. There were no property or crop damages reported from this event in the County.
January 18, 2020	Winter Weather	N/A	N/A	Precipitation fell as a mix of snow, sleet, and freezing rain for a considerable time over parts of Burlington County. Precipitation eventually changed over to mainly rain. A light mix of snow and freezing rain occurred. In Florence, there was a reported 1.1 inches of snow and 0.10 inches of ice accumulation. There were no property or crop damages reported from this event in the County.
December 16, 2020	Winter Storm	N/A	N/A	Heavy snow and sleet fell over the area, with some areas also changing to rain. Snowfall amounts were generally in the 4-to-6-inch range, including a storm total of 6.2 inches at the NWS office near Westampton. There were no property or crop damages reported from this event in the County.
January 31 – February 2, 2021	Winter Storm, Winter Weather	DR-4597-NJ	No	A major winter storm affected Burlington County. Widespread snow accumulation occurred, though the heaviest snow did not fall until the final day of the storm. Reports from the area were sparse, but observations from surrounding areas suggest 3 to 5 inches of snow fell. There were no property or crop damages reported from this event in the County.

Date of Event	Event Type	Declaration Number	Burlington County Designated?	Description
February 7, 2021	Winter Storm, Winter Weather	N/A	N/A	A short duration period of snow occurred in Burlington County. The storm produced several inches of snow, with local variations in the snow totals. Snow fell across the area, though heavier banding largely avoided Burlington County. Several reports of 4 to 5 inches of snow were received, including a report of 5.1 inches of snow in Moorestown. Rain changed to snow across the area, though heavier banding avoided this region. Observations from surrounding areas suggest a general 2 to 3 inches of snow likely fell. There were no property or crop damages reported from this event in the County.
February 10, 2021	Winter Weather	N/A	N/A	Snow accumulated in a widespread area, with reports of 3 to 5 inches of snow, and some amounts locally a little higher. Observations from surrounding areas suggest around 3 inches of snow likely fell in Burlington County. A maximum report of 3.7 inches of snow was received from Florence. There were no property or crop damages reported from this event in the County.
February 13, 2021	Winter Weather	N/A	N/A	Freezing rain with some light ice accumulation occurred in Burlington County. The South Jersey Regional Airport reported 0.06 inches of ice accumulation. Icing was observed at the NWS office in Mount Holly. Observations from surrounding areas suggest around a tenth of an inch of freezing rain likely occurred. There were no property or crop damages reported from this event in the County.
February 18-19, 2021	Winter Storm, Winter Weather	N/A	N/A	A wintry precipitation occurred with many areas seeing snow, some locally heavy, with a change to sleet and rain towards coastal areas. A heavy snow band clipped northwestern portions of Burlington County. Snowfall reports include 6.4 inches in Delanco and 6.3 inches in Bordentown. The South Jersey Regional Airport measured 0.15 inches of ice accumulation. Observations from surrounding areas suggest 2 to 3 inches of snow and sleet and up to a tenth of an inch of glaze ice likely occurred. There were no property or crop damages reported from this event in the County.
January 3, 2022	Winter Storm, Winter Weather	N/A	N/A	A widespread snow event was quick moving and had departed by the late afternoon and early evening of the 3rd. No direct snowfall measurements were received from southeast Burlington County, but numerous surrounding reports suggest a general 6 to 10 inches of snow fell. A general 2 to 3 inches of snow fell in most of the County, though little to no snow had fallen closer to the Delaware River. An NWS employee near Leisuretown reported 2.8 inches of snow. There were no property or crop damages reported from this event in the County.
January 5, 2022	Winter Weather	N/A	N/A	Freezing rain and a widespread light icing event transpired across the eastern mid-Atlantic. While ice accumulations were no more than several hundredths of an inch, this event caused significant travel impacts during the busy morning commute hours. Numerous reports of light ice accumulation were received. There were no property or crop damages reported from this event in the County.

Date of Event	Event Type	Declaration Number	Burlington County Designated?	Description
January 7, 2022	Winter Storm	N/A	N/A	A quick moving storm brought a widespread swath of 3 to 6 inches of snow to most of the eastern mid-Atlantic. Some portions of eastern New Jersey saw some slightly higher amounts of 6 to 7 inches, but in general it was a uniform snowfall for most areas. Numerous surrounding reports suggest a widespread 5 to 6 inches of snow fell. A maximum report of 6.0 inches was received from Shamong. There were no property or crop damages reported from this event in the County.
January 16, 2022	Winter Storm	N/A	N/A	What began as snow, transitioned to mixed precipitation then to rain. Frozen precipitation held on for longer, where some higher snowfall amounts occurred. Numerous snowfall reports of 1 inch or less were received, and the South Jersey Regional Airport reported 0.03 inches of ice accretion. Light ice accumulations were also observed at the nearby Mount Holly. There were no property or crop damages reported from this event in the County.
January 28, 2022	Winter Storm	N/A	N/A	A nor'easter spread snow across Burlington County. The storm also brought strong winds, with gusts of 40 to 50 miles per hour with a few over 60 miles per hour were observed. A widespread 6 to 10 inches of snow fell. A report of 10.0 inches of snow was received from Evesham Twp. A report of 9.6 inches of snow was received from Tabernacle. It is likely that higher totals of 12 to 18 inches occurred in less populated areas further southeast. There were no property or crop damages reported from this event in the County.
February 7, 2022	Winter Weather	N/A	N/A	Light freezing rain and drizzle occurred in Burlington County, with areas of light ice accumulation. Observations from surrounding areas suggest trace amounts of icing occurred. There were no property or crop damages reported from this event in the County.
February 13, 2022	Winter Weather	N/A	N/A	Widespread 2 to 6 inches of snow fell over much of New Jersey, with accumulations mainly occurring on cold and/or grassy surfaces. Impacts were minimal overall. There were reports in Burlington Twp of just 2.8 inches of snow. There were no property or crop damages reported from this event in the County.
February 24, 2022	Winter Weather	N/A	N/A	A wintry mix fell across the region, including as several hours of sleet and freezing rain. In some cases, the ice accumulation was enough to cause tree and power line damage. There were no property or crop damages reported from this event in the County.
December 23, 2022	Winter Weather	N/A	N/A	Temperatures plummeted resulting in icy areas on untreated surfaces. Lingering light precipitation resulted in a flash freeze of untreated surfaces and icy roads as temperatures plummeted well below freezing. There were no property or crop damages reported from this event in the County.

Source: NOAA 2023; FEMA 2023

Table 4.3.8-4. Probability of Future Occurrences of Severe Winter Weather Events

Hazard Type	Number of Occurrences Between 1950 and 2023	% Chance of Occurring in Any Given Year
Blizzard	4	5.47%
Extreme Cold/Wind Chill	2	2.73%
Heavy Snow	39	53.42%
Ice Storm	1	1.36%
Sleet	5	6.84%
Winter Storm	39	53.42%
Winter Weather	142	100%
Total	**232**	**100%**

Source: NOAA NCEI 2023

Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected events since 1968. Due to limitations in data, not all severe winter weather events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

In Section 4.4, the identified hazards of concern for the 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 Team, the probability of occurrence for severe winter weather in the County is considered "frequent."

Climate Change Impacts

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes.

Climate change includes major changes in temperature, precipitation, or wind patterns, which occur over several decades or longer. 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, which is faster than the rest of the Northeast region (2 °F [1.1 °C]) and the world (1.5 °F [0.8 °C]). 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). Thus, New Jersey can expect to experience an average annual temperature that is warmer than any to date (low emissions scenario) and future temperatures could be as much as 10 °F (5.6 °C) warmer (high emissions scenario). New Jersey can also expect that by the middle of the 21st century, 70 percent of summers will be hotter than the warmest summer experienced to date. The increase in temperatures is expected to be felt more during the winter months (December, January, and February), resulting in less intense cold waves, fewer sub-freezing days, and less snow accumulation (NJDEP 2020).

As temperatures increase, Earth's atmosphere can hold more water vapor which leads to a greater potential for precipitation. Currently, New Jersey receives an average of 46 inches of precipitation each year. 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 percent increase. By 2050, annual precipitation in New Jersey could increase by 4 percent to 11 percent. By the end of this century, heavy precipitation events are projected to occur two to five times more often and with more intensity than in the last century. New Jersey will experience more intense rain events, less snow, and more rainfalls (NJDEP 2020).

Both northern and southern New Jersey have become wetter over the past century. Northern New Jersey's 1971-2000 precipitation average was over five inches (12 percent) greater than the average from 1895-1970. Southern New Jersey became two inches (5 percent) wetter late in the 20th century. Average annual precipitation is projected

to increase in the region by 5 percent by the 2020s and up to 10 percent by the 2050s. Most of the additional precipitation is expected to come during the winter months (NJDEP 2020).

In terms of snowfall and ice storms in New Jersey, 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 2011). Future enhancements in climate modeling will provide an improved understanding of how the climate will change and impact the Northeast.

Vulnerability Assessment

For the severe winter weather hazard, all of Burlington 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 3), are vulnerable to a winter storm event.

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. Vulnerabilities to flooding are presented in the flood hazard profile (Section 4.3.6).

Nor'easters can cause significant coastal flooding due to storm surge, similar to hurricanes and tropical storms. Vulnerabilities to storm surge are presented in the severe weather profile (Section 4.3.7).

Blizzards and nor'easters can cause high winds. Vulnerabilities to wind are presented in the severe weather profile (Section 4.3.7).

The following subsections discuss the County's vulnerability, in qualitative nature, to the severe winter weather hazard.

Impact on Life, Health, and Safety

The entire population of Burlington County (461,860 people) is exposed to severe winter weather events. According to the NOAA National Severe Storms Laboratory; 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 (NOAA 2023).

Socially Vulnerable Populations

The homeless and elderly are considered most susceptible to this hazard. The elderly are considered susceptible to this hazard due to their increased risk of injuries and death from falls and overexertion and/or hypothermia from attempts to clear snow and ice. According to the 2021 5-year ACS estimates, there are 27,947 total persons living below the poverty level, 78,093 persons over the age of 65 years, 23,350 persons under the age of 5 years, 9,103 non-English speakers, and 51,899 persons with a disability in Burlington County. In addition, severe winter storm events can reduce the ability of these populations to access emergency services.

Additionally, the homeless and residents below the poverty level may 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). For more information on the extreme temperature hazard, refer to Section 4.3.5.

As shown in Table 4.3.8-5, Evesham Township has the highest population over 65 (8,574) and highest population under the age of 5 (2,237). Pemberton Township has the largest population of non-English speaking persons (1,092). Willingboro Township has the greatest population of individuals living in poverty (2,685) and the largest disabled population (5,100). Wrightstown Township has the lowest population over 65 (58). Washington Township has the lowest population of individuals under the age of 5 (8). Bass River Township, Beverly City, Eastampton Township, Fieldsboro Borough, Medford Lakes Borough, Shamong Township, and Woodland Township all have no (0) non-English speaking persons living within the jurisdiction. Fieldsboro Borough has fewest number of disabled persons in their jurisdiction (62). Wrightstown Borough has the lowest population living in poverty (21).

Table 4.3.8-5. Burlington County Socially Vulnerable Populations by Municipality

Jurisdiction[a]	Decennial Population 2020		American Community Survey 5-Year Population Estimates (2021)									
			Population Over 65		Population Under 5		Non-English Speaking Population		Population with Disability		Population Below Poverty Level	
	Jurisdiction Total	% of County Total	Number	% of Jurisdiction Total	Number	% of Jurisdiction Total	Number	% of Jurisdiction Total	Number	% of Jurisdiction Total	Number	% of Jurisdiction Total
Bass River (T)	1,355	0.3%	248	18.3%	67	4.9%	0	0.0%	175	12.9%	95	7.0%
Beverly (C)	2,499	0.5%	292	11.7%	183	7.3%	0	0.0%	249	10.0%	300	12.0%
Bordentown (C)	3,993	0.9%	772	19.3%	216	5.4%	16	0.4%	422	10.6%	227	5.7%
Bordentown (T)	11,791	2.6%	1,601	13.6%	472	4.0%	289	2.4%	1,092	9.3%	194	1.6%
Burlington (C)	9,743	2.1%	1,301	13.4%	661	6.8%	208	2.1%	1,251	12.8%	1,422	14.6%
Burlington (T)	23,983	5.2%	3,526	14.7%	1,497	6.2%	385	1.6%	2,366	9.9%	2,185	9.1%
Chesterfield (T)	9,422	2.0%	760	8.1%	578	6.1%	153	1.6%	423	4.5%	165	1.8%
Cinnaminson (T)	17,064	3.7%	3,103	18.2%	929	5.4%	208	1.2%	1,661	9.7%	584	3.4%
Delanco (T)	4,824	1.0%	1,297	26.9%	191	4.0%	42	0.9%	676	14.0%	322	6.7%
Delran (T)	17,882	3.9%	2,570	14.4%	1,047	5.9%	723	4.0%	1,548	8.7%	902	5.0%
Eastampton (T)	6,191	1.3%	557	9.0%	264	4.3%	0	0.0%	478	7.7%	488	7.9%
Edgewater Park (T)	8,930	1.9%	1,571	17.6%	700	7.8%	367	4.1%	1,465	16.4%	1,645	18.4%
Evesham (T)	46,826	10.1%	8,574	18.3%	2,237	4.8%	749	1.6%	4,504	9.6%	1,476	3.2%
Fieldsboro (B)	526	0.1%	82	15.6%	64	12.2%	0	0.0%	62	11.8%	36	6.8%
Florence (T)	12,812	2.8%	2,122	16.6%	645	5.0%	260	2.0%	1,460	11.4%	827	6.5%
Hainesport (T)	6,035	1.3%	1,327	22.0%	58	1.0%	0	0.0%	744	12.3%	250	4.1%
Lumberton (T)	12,803	2.8%	2,048	16.0%	661	5.2%	107	0.8%	1,490	11.6%	805	6.3%
Mansfield (T)	8,897	1.9%	2,506	28.2%	394	4.4%	330	3.7%	1,465	16.5%	181	2.0%
Maple Shade (T)	19,980	4.3%	2,897	14.5%	1,159	5.8%	694	3.5%	2,433	12.2%	1,971	9.9%
Medford (T)	24,497	5.3%	5,151	21.0%	1,085	4.4%	31	0.1%	2,775	11.3%	724	3.0%
Medford Lakes (B)	4,264	0.9%	879	20.6%	211	4.9%	0	0.0%	407	9.5%	26	0.6%
Moorestown (T)	21,355	4.6%	3,480	16.3%	837	3.9%	603	2.8%	1,654	7.7%	807	3.8%
Mount Holly (T)	9,981	2.2%	1,199	12.0%	454	4.5%	133	1.3%	1,624	16.3%	958	9.6%
Mount Laurel (T)	44,633	9.7%	8,299	18.6%	2,011	4.5%	889	2.0%	4,203	9.4%	1,689	3.8%
New Hanover (T)	6,367	1.4%	311	4.9%	214	3.4%	29	0.4%	192	3.0%	116	1.8%
North Hanover (T)	7,963	1.7%	532	6.7%	975	12.2%	125	1.6%	631	7.9%	481	6.0%
Palmyra (B)	7,438	1.6%	1,077	14.5%	190	2.6%	44	0.6%	961	12.9%	616	8.3%
Pemberton (B)	1,371	0.3%	282	20.6%	56	4.1%	47	3.4%	308	22.5%	140	10.2%

Jurisdiction[a]	Decennial Population 2020		American Community Survey 5-Year Population Estimates (2021)									
			Population Over 65		Population Under 5		Non-English Speaking Population		Population with Disability		Population Below Poverty Level	
	Jurisdiction Total	% of County Total	Number	% of Jurisdiction Total	Number	% of Jurisdiction Total	Number	% of Jurisdiction Total	Number	% of Jurisdiction Total	Number	% of Jurisdiction Total
Pemberton (T)	26,903	5.8%	4,306	16.0%	1,429	5.3%	1,092	4.1%	4,006	14.9%	2,518	9.4%
Riverside (T)	8,003	1.7%	1,039	13.0%	354	4.4%	754	9.4%	972	12.1%	1,257	15.7%
Riverton (B)	2,764	0.6%	554	20.0%	80	2.9%	5	0.2%	187	6.8%	72	2.6%
Shamong (T)	6,460	1.4%	1,313	20.3%	324	5.0%	0	0.0%	671	10.4%	136	2.1%
Southampton (T)	10,317	2.2%	3,153	30.6%	293	2.8%	125	1.2%	1,551	15.0%	589	5.7%
Springfield (T)	3,245	0.7%	479	14.8%	129	4.0%	65	2.0%	311	9.6%	160	4.9%
Tabernacle (T)	6,776	1.5%	1,524	22.5%	380	5.6%	0	0.0%	747	11.0%	233	3.4%
Washington (T)	693	0.2%	138	19.9%	8	1.2%	8	1.1%	87	12.6%	21	3.0%
Westampton (T)	9,121	2.0%	1,139	12.5%	263	2.9%	81	0.9%	802	8.8%	268	2.9%
Willingboro (T)	31,889	6.9%	5,707	17.9%	1,916	6.0%	538	1.7%	5,100	16.0%	2,685	8.4%
Woodland (T)	1,544	0.3%	319	20.7%	49	3.2%	0	0.0%	627	40.6%	363	23.5%
Wrightstown (B)	720	0.2%	58	8.1%	69	9.6%	5	0.7%	119	16.5%	13	1.8%
Burlington County Total	**461,860**	**100.0%**	**78,093**	**16.9%**	**23,350**	**5.1%**	**9,103**	**2.0%**	**51,899**	**11.2%**	**27,947**	**6.1%**

Source: U.S. Census Bureau 2020, 2021

Note: Persons per household = 2.6

Impact on General Building Stock

The entire general building stock inventory is exposed and vulnerable to the severe winter storm hazard. 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, this plan considers percentage damages that could result from severe winter storm conditions. 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, etc.). Therefore, the following information should be used as estimates only for planning purposes with the knowledge that the associated losses for severe winter storm events vary greatly.

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 (NWS 2019).

> Heavy accumulations of ice can bring down trees, electrical wires, telephone poles and lines, and communication towers. Communications and power can be disrupted for days while utility companies work to repair the extensive damage. Even small accumulations of ice may cause extreme hazards to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces (NWS 2019).

Impact on Economy

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 erosion. The weight of snow can cause roofs to collapse and knock down trees and power lines. Homes and farms may be isolated for days, and unprotected livestock may be lost. The economic impact of winter weather each year is huge, with costs for snow removal, damage, and loss of business in the millions (NWS 2019).

The cost of snow and ice removal and repair of roads from the freeze/thaw process can drain local financial resources. Another impact on the economy includes impacts on commuting into, or out of, the area for work or school. The loss of power and closure of roads prevents the commuter population traveling to work within and outside of the County.

Impact on Environment

Severe winter weather can have a major impact on the environment. Not only does winter weather create changes in natural processes, the residual impacts of a community's methods to maintain its infrastructure through winter weather maintenance may also have an impact on the environment. For example, an excess amount of snowfall and earlier warming periods may affect natural processes such as flow within water resources (NSIDC n.d.). Rain-on-snow events can also exacerbate runoff rates with warming winter weather. Consequentially, these flow rates and excess volumes of water can erode banks, tear apart habitat along the banks and coastline, and disrupt terrestrial plants and animals. Road-salt runoff can cause groundwater salinization, modify the soil structure, and result in loss or reduction in lake turnover. Additionally, road salt can cause changes in the composition of aquatic invertebrate assemblages and pose threats to birds, roadside vegetation, and mammals (Tiwari and Rachlin 2018).

> Chemically based winter maintenance practices have its own effect on the natural environment. Melting snow and ice that carry de-icing chemicals onto vegetation and into soils can contaminate the local waterways. Elevated salt levels may hinder vegetation from absorbing nutrients, slowing plant growth.

Cascading Impacts on Other Hazards

Severe winter weather events may exacerbate flooding. As discussed, the freezing and thawing of snow and ice associated with winter weather events can create major flooding issues in the County. Maintaining winter weather hazards through snow and ice removal could minimize the potential risk of flooding during a warming period. Refer to 4.3.6 (Flood) for more information about the flood hazard of concern.

Severe winter weather events often coincide with or are followed by extreme cold events. For more information on the extreme cold hazard, refer to Section 4.3.5 (extreme temperature).

Severe winter weather events can escalate the impacts of utility failure. Ice and snow accumulation can be destructive to the functionality of utilities by breaching power lines and disconnecting the utility systems.

Further Changes that May Impact Vulnerability

Understanding future changes that may 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 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 Sections 3 and 9, areas targeted for future growth and development have been identified across Burlington County. Any areas of growth could be potentially impacted by the severe winter storm hazard because the entire planning area is exposed and vulnerable. Any areas of growth could be potentially impacted by the severe winter weather hazard because the entire County 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

Burlington County has experienced an increase in its population since 2010. According to the U.S. Census Bureau, the County's population increased by approximately 3-percent between 2010 and 2020 (U.S. Census Bureau 2020). The New Jersey Department of Labor and Workforce Development produced populations projections by County from 2014 to 2019, 2024, 2029, and 2034. According to these projections, Burlington County is projected to have a population of 460,400 by 2024, 464,900 by 2029, and 472,700 by 2034 (State of New Jersey 2017). Overall, aging infrastructure may result in increased stress on existing infrastructure and related services. Municipalities that experience increases in population may require utility system upgrades to keep up with utility demands (e.g., water, electric) during winter weather events to prevent increased stresses on these systems. Refer to Section 3 (County Profile) for a detailed discussion on population change in Burlington County.

Climate Change

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 extremes such winter storms. While predicting changes of winter storm events 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 (NASA 2023).

Change of Vulnerability Since 2019 HMP

Overall, the County's vulnerability has not changed, and the entire County will continue to be exposed and vulnerable to severe winter weather events. As existing development and infrastructure continue to age, they can be at increased risk of failed utility and transportation systems if they are not properly maintained and do not adapt to the changing environment.